



1
00:00:08,440 --> 00:00:12,459
Why did you want to be an astronaut?

2
00:00:12,459 --> 00:00:14,940
When I was little I didn't know I wanted
to be an astronaut.

3
00:00:14,940 --> 00:00:17,340
I just knew I loved spaceflight.

4
00:00:17,340 --> 00:00:21,192
I was inspired by the Neil Armstrong walking
on the moon.

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00:00:21,192 --> 00:00:25,610
I remember where I was, sitting in the living
room in a robe and slippers, because I was

6
00:00:25,610 --> 00:00:30,800
supposed to be in bed but I was watching the
landing and watching him walk.

7
00:00:30,800 --> 00:00:31,800
Never forgot that.

8
00:00:31,800 --> 00:00:37,250
I didn't think of myself as being able to
do that but I was a big fan of adventure stories,

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00:00:37,250 --> 00:00:42,699
I read a lot of Jules Verne and I began to
think, I could do something like that, and

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00:00:42,699 --> 00:00:48,399
I was very curious what would happen to me,
so I picked up backpacking and mountain climbing

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00:00:48,399 --> 00:00:51,310
and it became my, one of my favorite sports.

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00:00:51,310 --> 00:00:55,719
I backpacked across the United States, through the mountains from Canada to Mexico just to

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00:00:55,719 --> 00:01:01,809
see what would happen to me, what kind of challenges somebody faced when they do that.

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00:01:01,809 --> 00:01:08,741
When I decided to become an engineer and decided to become a doctor, my interest in the space

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00:01:08,741 --> 00:01:10,770
program surged quite a bit.

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00:01:10,770 --> 00:01:15,342
I was following the shuttle at that time, the shuttle was not in its infancy but it

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00:01:15,342 --> 00:01:16,342
was maturing.

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00:01:16,342 --> 00:01:19,820
It was a lot of exciting things going on, I wanted to be a part of that, but I just

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00:01:19,820 --> 00:01:24,270
wanted to work for NASA someday, had no idea I could actually fly on the space shuttle.

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00:01:24,270 --> 00:01:28,930
When I then got the opportunity to work at NASA as a flight surgeon, began to work with

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00:01:28,930 --> 00:01:34,020
astronauts and began to see what they were doing, I loved to fly already, I was a private

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00:01:34,020 --> 00:01:39,730

pilot with a lot of hours, and so I just thought, maybe I could do this, and, even though I

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00:01:39,730 --> 00:01:42,931

would have loved to have done it at any time in my life I think it was that point when

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00:01:42,931 --> 00:01:46,360

I realized that maybe I could apply and actually do this.

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00:01:46,360 --> 00:01:49,770

Let me get you to tell us The Tom Marshburn Story.

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00:01:49,770 --> 00:01:53,120

Just go back to the beginning, tell me about your hometown and what it was like for you

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00:01:53,120 --> 00:01:54,120

growing up.

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00:01:54,120 --> 00:01:58,530

I was born in Statesville, North Carolina, a little town, a wonderful place to grow up,

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00:01:58,530 --> 00:02:00,040

and a very tight community.

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00:02:00,040 --> 00:02:04,730

My father was a preacher so we knew, I should say everyone in the community knew us, and

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00:02:04,730 --> 00:02:10,530

as a small child up to the age of eight or nine, I didn't know all the people but I

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00:02:10,530 --> 00:02:12,420

remembered there were always friendly faces

around.

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00:02:12,420 --> 00:02:17,230

It was a place where you could run off into the woods and spend hours there and not get

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00:02:17,230 --> 00:02:20,130

back until dinner it was a lot of great memories there.

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00:02:20,130 --> 00:02:27,530

We then moved to Atlanta, my father's work called us to Atlanta, Georgia, so I was raised

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00:02:27,530 --> 00:02:29,980

there near the big city, got to enjoy that.

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00:02:29,980 --> 00:02:36,170

All along the way though we had some family property, a farm in north Georgia, spent a

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00:02:36,170 --> 00:02:43,140

lot of time there, fixing fences, fixing stuff, and spending, a lot of time outdoors, getting

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00:02:43,140 --> 00:02:47,959

lost in the woods or going off on hikes and even spent a lot of nights outside.

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00:02:47,959 --> 00:02:53,240

So the outdoors and the countryside, small town, were very informative for me.

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00:02:53,240 --> 00:02:58,740

Sounds like you have a feeling that all those places and those people there were important

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00:02:58,740 --> 00:03:01,620

in making you the person that you turned out to be.

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00:03:01,620 --> 00:03:02,620

Absolutely.

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00:03:02,620 --> 00:03:07,980

There's a lot of individuals that come to mind but some of the most important people,

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00:03:07,980 --> 00:03:12,600

obviously my siblings—I'm the last of seven children—and I was already surrounded

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00:03:12,600 --> 00:03:17,430

by a lot of people just inside the house, and they, my six brothers and sisters, three

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00:03:17,430 --> 00:03:23,940

of each, definitely had the most influence on me of anyone, besides my parents, obviously.

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00:03:23,940 --> 00:03:28,470

But the ones I remember most, the contacts I remember the most, are with my siblings.

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00:03:28,470 --> 00:03:32,190

When you flew, did you get a chance to see these places from orbit?

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00:03:32,190 --> 00:03:33,810

Yes, you sure do.

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00:03:33,810 --> 00:03:38,160

You have to plan it out ahead of time, you hope there are no clouds and then if there's

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00:03:38,160 --> 00:03:41,990

a break in the work you go over to the window and take a look.

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00:03:41,990 --> 00:03:45,700

Everybody does that, see if they can find their hometown, and while I can't say that

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00:03:45,700 --> 00:03:50,489

I could see Statesville itself because one of the nice things about it, it's covered

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00:03:50,489 --> 00:03:55,891

with trees, and trees that are overarching all the streets, but I knew where it was and

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00:03:55,891 --> 00:03:57,010

I could see it and I got a picture.

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00:03:57,010 --> 00:04:00,319

It looks like a big forest, but that's what Statesville looks like, it's beautiful.

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00:04:00,319 --> 00:04:01,500

Easier to find Atlanta, right?

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00:04:01,500 --> 00:04:03,349

Yes, it's much easier to find Atlanta.

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00:04:03,349 --> 00:04:08,460

You touched on it, let me ask you to fill in a little bit for us on your, education

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00:04:08,460 --> 00:04:11,530

and then your professional background because you had a lot of different things that you

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00:04:11,530 --> 00:04:15,900

did before you ended up at NASA, and not even an astronaut when you did that.

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00:04:15,900 --> 00:04:18,120

Yes, I wanted to be an artist to start with.

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00:04:18,120 --> 00:04:21,180

I always loved to draw and to paint.

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00:04:21,180 --> 00:04:26,570

It was in high school that I thought the space program is interesting to me and it was specifically

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00:04:26,570 --> 00:04:30,449

the space program that got me into a technical field and I just switched completely.

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00:04:30,449 --> 00:04:35,860

I concentrated on math, science and fell in love with the physics classes, to the point

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00:04:35,860 --> 00:04:39,240

where in college, at Davidson College, I was a physics major there.

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00:04:39,240 --> 00:04:43,669

I decided to go into engineering, I was at the University of Virginia getting my master's

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00:04:43,669 --> 00:04:49,170

degree in engineering, when I realized I really like working with people and I felt like maybe

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00:04:49,170 --> 00:04:52,050

that's more where my talents lay.

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00:04:52,050 --> 00:04:56,030

I actually came down to the Johnson Space Center and started knocking on doors asking

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00:04:56,030 --> 00:04:59,100

for a job after I received my master's degree.

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00:04:59,100 --> 00:05:03,350

Someone said, one of the doctors that worked

here said, you ought to get a medical degree

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00:05:03,350 --> 00:05:06,870

because NASA's going to need doctors someday,
so I did.

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00:05:06,870 --> 00:05:11,890

I went to medical school, found out I fell
in love with medicine and I had forgotten

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00:05:11,890 --> 00:05:16,480

the NASA dream for a while just because medicine's
so engrossing and working with patients is

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00:05:16,480 --> 00:05:23,470

so incredible, but then it came back and they
opened up a space medicine fellowship, hiring

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00:05:23,470 --> 00:05:28,540

on practicing physicians to begin to train
to be flight surgeons at NASA, so I was in

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00:05:28,540 --> 00:05:33,680

the first class of that back in 1993, and
then became a flight surgeon here.

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00:05:33,680 --> 00:05:37,800

And the flight surgeon, you did a lot of different
things here, too, right?

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00:05:37,800 --> 00:05:42,970

Yes, as soon as I came on board I began to
train for a shuttle mission, to support it,

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00:05:42,970 --> 00:05:47,580

but at the same time they started putting
me in Russian class and sent me over to Russia;

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00:05:47,580 --> 00:05:52,440

it was a real privilege to go over to Russia

as one of the first people to support our

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00:05:52,440 --> 00:05:56,449
missions to the MIR space station, when we
were flying U.S. astronauts there.

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00:05:56,449 --> 00:06:01,590
I got to live and work in Russia and I couldn't
imagine a more exciting job at the time.

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00:06:01,590 --> 00:06:07,070
Now as you said, you got some closeup experience
seeing the astronauts work and...

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00:06:07,070 --> 00:06:08,070
Right.

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00:06:08,070 --> 00:06:10,660
...and that had its influence on you, too.

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00:06:10,660 --> 00:06:17,330
Even better, everybody had to figure out this
Russian system, in Russian, I was able to

91
00:06:17,330 --> 00:06:22,510
pull out; they call them the comspecs, the
original Russian documents on how the stuff

92
00:06:22,510 --> 00:06:27,710
worked, and got to help them out in deciphering
that, so I learned a lot and it was great.

93
00:06:27,710 --> 00:06:34,340
To take the job to fly in space is to assume
some risks that most of the rest of us don't

94
00:06:34,340 --> 00:06:38,169
have, risks that you didn't have when you
were an, an emergency room doctor.

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00:06:38,169 --> 00:06:39,169

Yes.

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00:06:39,169 --> 00:06:45,580

But I think the question is why—what is it that you think we are getting or learning

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00:06:45,580 --> 00:06:51,370

as a result of flying people in space that makes it worth taking those risks?

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00:06:51,370 --> 00:06:54,480

It's certainly worth taking the risks.

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00:06:54,480 --> 00:07:01,490

As an aviator, as an astronaut, we love to travel up and we want to fly in space.

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00:07:01,490 --> 00:07:05,770

It's been a lifelong dream.

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00:07:05,770 --> 00:07:10,460

When you fly humans in space, though, that is so incredibly hard to do, you have to figure

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00:07:10,460 --> 00:07:15,240

out things that you've never would have been inspired to do before.

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00:07:15,240 --> 00:07:20,240

It's not a matter of a market, will people buy this thing, it's a matter how do you

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00:07:20,240 --> 00:07:22,030

keep people alive.

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00:07:22,030 --> 00:07:29,330

So when you build these complex machines, all kinds of benefits fall out of it.

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00:07:29,330 --> 00:07:34,670

Just as an example, I mean there's thousands of examples like this, but the high flow oxygen

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00:07:34,670 --> 00:07:35,670

systems.

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00:07:35,670 --> 00:07:39,630

We were trained to get ready for the space station by the people who figured out that

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00:07:39,630 --> 00:07:45,009

high flow oxygen systems; these are NASA people working out at White Sands, that you don't

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00:07:45,009 --> 00:07:48,070

necessarily need an ignition source to cause an explosion.

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00:07:48,070 --> 00:07:52,080

It's just a little tiny piece of metal hitting another piece of metal, it can increase the

112

00:07:52,080 --> 00:07:56,930

temperature in a little area just enough to be the ignition source.

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00:07:56,930 --> 00:08:01,800

They found out that this is probably one of the causes of home oxygen systems that went

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00:08:01,800 --> 00:08:07,169

awry on the ground, causing some deaths every year, spontaneous fires that were occurring

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00:08:07,169 --> 00:08:14,110

in like neo-native, neonatal intensive care units, and now that group has gone on outside

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00:08:14,110 --> 00:08:19,770

of NASA and is going around the world giving talks about oxygen safety to hospitals and

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00:08:19,770 --> 00:08:22,449

other areas that use compressed high flow oxygen systems.

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00:08:22,449 --> 00:08:24,320

They're going to be publishing on that.

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00:08:24,320 --> 00:08:26,539

That's just one example.

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00:08:26,539 --> 00:08:30,389

They figured out how to do that and look at all the things that they can do with it, but

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00:08:30,389 --> 00:08:35,190

that applies to just about every system that had not existed before, required a lot of

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00:08:35,190 --> 00:08:36,190

motivated people.

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00:08:36,190 --> 00:08:41,510

There's no better motivation than exploring the stars, so highly motivated to solve a

124

00:08:41,510 --> 00:08:44,470

very difficult problem.

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00:08:44,470 --> 00:08:51,680

You're about to launch to the International Space Station for Expedition 34 and 35.

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00:08:51,680 --> 00:08:57,000

Tom, tell me what is the goal of your mission overall and what are your jobs going to be

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00:08:57,000 --> 00:08:58,029

when you get there.

128

00:08:58,029 --> 00:09:05,880

This is Expedition 35, we've done this 34 times by the time I get there and my crewmate

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00:09:05,880 --> 00:09:08,260

becomes commander on Expedition 35.

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00:09:08,260 --> 00:09:13,630

We've built the space station, I had the privilege of helping do that on STS-127, but

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00:09:13,630 --> 00:09:19,820

now it's a laboratory, U.S. national laboratory, as well as an international partner laboratory,

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00:09:19,820 --> 00:09:21,100

and we're going to be doing science.

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00:09:21,100 --> 00:09:24,230

We're going to be doing a whole series of experiments.

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00:09:24,230 --> 00:09:29,470

Our job is also to maintain the space station, we need to keep it going, and be able to fix

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00:09:29,470 --> 00:09:31,390

anything that breaks on it.

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00:09:31,390 --> 00:09:34,800

Our goal is to fulfill that mission as best we can.

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00:09:34,800 --> 00:09:39,390

We're building a lot of accomplishments

and successes of astronauts that have gone

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00:09:39,390 --> 00:09:43,820

up there before us, and they've been able to build efficiencies and get more science

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00:09:43,820 --> 00:09:44,820

done.

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00:09:44,820 --> 00:09:47,170

We want to do that and, if we can, do it even better.

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00:09:47,170 --> 00:09:51,600

The ground's been learning a lot as well, we want to implement what they've learned

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00:09:51,600 --> 00:09:55,250

as well, so we're going to be the eyes, the ears and the hands of the ground and we're

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00:09:55,250 --> 00:09:59,450

going to be working in the laboratory the entire time.

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00:09:59,450 --> 00:10:02,550

As you mentioned, you've been to the space station once before.

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00:10:02,550 --> 00:10:06,520

What is it that you're looking forward to about seeing it the second time?

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00:10:06,520 --> 00:10:10,600

A few additions; The Cupola: can't wait to see that.

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00:10:10,600 --> 00:10:15,750

That's the big view of the Earth, people feel like they're looking down when the

148

00:10:15,750 --> 00:10:18,730

look into the Cupola although there's no
up or down in space, and then looking down

149

00:10:18,730 --> 00:10:19,730

at the Earth.

150

00:10:19,730 --> 00:10:25,360

Can't wait to see the overall size of it,
it's grown in size, new modules, more space,

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00:10:25,360 --> 00:10:27,760

but that's really the main thing.

152

00:10:27,760 --> 00:10:32,980

Again I've experienced 11 days docked at
the space station, 16 days in space on my

153

00:10:32,980 --> 00:10:37,940

last flight, so getting back to life in zero
gravity, that is never boring, everything

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00:10:37,940 --> 00:10:43,380

from putting on your clothes to brushing your
teeth to working to transfer of hardware,

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00:10:43,380 --> 00:10:44,640

all of its fun in zero g.

156

00:10:44,640 --> 00:10:46,910

I can't wait to do that again.

157

00:10:46,910 --> 00:10:52,320

When you were there the last time one of the
station crew members who was there was Roman

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00:10:52,320 --> 00:10:53,320

Romanenko...

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00:10:53,320 --> 00:10:54,320

Yes.

160

00:10:54,320 --> 00:10:55,440

...with whom you're flying now.

161

00:10:55,440 --> 00:11:00,209

You also "flew" underwater with Chris Hadfield, your other Soyuz crewmate.

162

00:11:00,209 --> 00:11:01,209

Right.

163

00:11:01,209 --> 00:11:06,209

Has that previous mission experience with those guys helped you get prepared for this

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00:11:06,209 --> 00:11:07,209

flight?

165

00:11:07,209 --> 00:11:08,900

Yes, the previous mission experience helps a lot.

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00:11:08,900 --> 00:11:12,529

As you mentioned, Chris Hadfield and I spent two weeks on the bottom of the ocean in a

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00:11:12,529 --> 00:11:16,529

laboratory there, just by chance—it just so happened I had just been assigned to this

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00:11:16,529 --> 00:11:23,279

spaceflight, just days before we took off to join a few others working on the bottom

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00:11:23,279 --> 00:11:24,610

of the ocean.

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00:11:24,610 --> 00:11:25,959

I got to see his style.

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00:11:25,959 --> 00:11:29,060

He was the commander of that mission, he's going to be commander on the space station

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00:11:29,060 --> 00:11:34,440

when I'm there, I got to see how he likes things to work, he got to see how I work,

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00:11:34,440 --> 00:11:37,640

and I think it's immensely beneficial.

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00:11:37,640 --> 00:11:41,730

Now we've had two and a half years since then, but working underwater is a great analog

175

00:11:41,730 --> 00:11:43,080

for spaceflight.

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00:11:43,080 --> 00:11:48,060

The outside is a little bit dangerous you can't come up, once you're down there

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00:11:48,060 --> 00:11:52,339

after about 18 hours because you'll get the bends and you could die, it's a somewhat

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00:11:52,339 --> 00:11:53,339

harsh environment.

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00:11:53,339 --> 00:11:56,820

There's a little bit of time pressure, not like in space, but somewhat similar.

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00:11:56,820 --> 00:11:58,589

It's a great analog of spaceflight.

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00:11:58,589 --> 00:12:02,010

So we got to see how we work together.

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00:12:02,010 --> 00:12:07,519

Seeing Roman Romanenko, in the space station,
I didn't get a chance to work with him much

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00:12:07,519 --> 00:12:13,029

but interacted with him a little bit, but
that allowed us, when we get into our Soyuz

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00:12:13,029 --> 00:12:17,111

flow and we're really spending a lot of
time together, usually speaking Russian, working

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00:12:17,111 --> 00:12:21,790

on the Russian spacecraft, getting ready for
launch and landing, that just kind of segued

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00:12:21,790 --> 00:12:27,980

right in knowing he's got a great sense
of humor, he's technically very good, and

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00:12:27,980 --> 00:12:34,040

that helped in allowing us to start off work
very well in the Soyuz.

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00:12:34,040 --> 00:12:37,290

Anytime you're going to make a spaceflight
you're going to miss some things on Earth,

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00:12:37,290 --> 00:12:41,590

and in this particular case you're going
to be in space for the Christmas and New Year's

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00:12:41,590 --> 00:12:42,590

holidays.

191

00:12:42,590 --> 00:12:43,590

Right.

192

00:12:43,590 --> 00:12:44,590

What are your thoughts about that?

193

00:12:44,590 --> 00:12:49,170

We planned for it a long time ago and so we're ready for it.

194

00:12:49,170 --> 00:12:53,580

I have a nine, or ten year old daughter—she'll be ten at the time—and that'll be tough,

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00:12:53,580 --> 00:12:56,830

thinking about her waking up in the morning, enjoying things, but the fact is we've got

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00:12:56,830 --> 00:13:04,269

some technology that'll allow me, hopefully through an Internet, or I guess an Internet

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00:13:04,269 --> 00:13:09,570

protocol session, to be able to join in with them and see their faces and they can see

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00:13:09,570 --> 00:13:10,570

me.

199

00:13:10,570 --> 00:13:17,370

It'll be a little bit tough for me, as it would be for anybody, but I think the price

200

00:13:17,370 --> 00:13:19,170

is certainly well worth it, to be up there.

201

00:13:19,170 --> 00:13:21,800

Well, let's talk about the "there" in this case...

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00:13:21,800 --> 00:13:22,800

Yes.

203

00:13:22,800 --> 00:13:23,800

...the International Space Station.

204

00:13:23,800 --> 00:13:27,100

Tell me about the place as it's going to exist when you arrive.

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00:13:27,100 --> 00:13:32,390

What modules and facilities are there to help support the mission that you guys have?

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00:13:32,390 --> 00:13:36,570

Overall it's, one-third of it's a Russian spacecraft and—one-third in volume—and

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00:13:36,570 --> 00:13:41,990

two-thirds is international partner and U.S.; about the size of a five bedroom house, that

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00:13:41,990 --> 00:13:44,970

doesn't take into account the height of the ceilings or anything.

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00:13:44,970 --> 00:13:48,950

When you're in a module, if it's well-packed, which many of them are now, it's kind of

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00:13:48,950 --> 00:13:51,330

like being inside of a school bus.

211

00:13:51,330 --> 00:13:55,820

You can use the space a lot better there because you can use the ceiling, you can float up

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00:13:55,820 --> 00:13:57,470

and get in the nooks and crannies.

213

00:13:57,470 --> 00:14:02,720

I've heard that it's big enough to where you could lose somebody.

214

00:14:02,720 --> 00:14:07,070

You could have to go off and find them if they're not answering on an intercom and

215

00:14:07,070 --> 00:14:10,970

wonder where someone is for a while.

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00:14:10,970 --> 00:14:13,010

Generally, very livable.

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00:14:13,010 --> 00:14:18,920

When I was there, some of modules such as the Japanese Experiment Module are quite big,

218

00:14:18,920 --> 00:14:23,649

and you can float through there, fly through and really enjoy the zero gravity.

219

00:14:23,649 --> 00:14:28,649

Humans, I find out, are part hamster, perhaps; there're also lots of places where things

220

00:14:28,649 --> 00:14:34,700

are packed and you can get in there and, and get snug into a tight place.

221

00:14:34,700 --> 00:14:39,110

So it's big; as you probably know, it's about two acres in size including the solar

222

00:14:39,110 --> 00:14:43,480

arrays so it's really a big power station in orbit that we happen to be living attached

223

00:14:43,480 --> 00:14:44,570

to.

224

00:14:44,570 --> 00:14:48,570

Because of the water processing facilities,
it's now a water processing facility and

225

00:14:48,570 --> 00:14:49,889

has to keep us going.

226

00:14:49,889 --> 00:14:54,140

We're learning all the time about water
reclamation up there and how to do that, so

227

00:14:54,140 --> 00:15:00,080

we're a completely closed-loop, we only
use the water that we make with just a little

228

00:15:00,080 --> 00:15:02,420

bit of supplementation beyond that.

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00:15:02,420 --> 00:15:08,220

Then, of course, it's a U.S. national laboratory,
it's an international partner laboratory,

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00:15:08,220 --> 00:15:11,950

there's science going on, experiments going
on the Russian side, so that part's going

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00:15:11,950 --> 00:15:12,950

to be really active.

232

00:15:12,950 --> 00:15:17,170

We're going to be very busy with the timeline
as well.

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00:15:17,170 --> 00:15:19,670

Let's talk about some of the different areas.

234

00:15:19,670 --> 00:15:24,399

First of all, you mentioned how this environment affects a human body; that's one of the

235

00:15:24,399 --> 00:15:28,790

main areas of the research that's being done, to find out what those effects are and

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00:15:28,790 --> 00:15:30,300

what you can do about it.

237

00:15:30,300 --> 00:15:36,139

Give me some examples of these experiments in this area that you're going to be working

238

00:15:36,139 --> 00:15:38,079

on.

239

00:15:38,079 --> 00:15:45,410

About a quarter of the experiments going on are human life sciences, I'm, actually a

240

00:15:45,410 --> 00:15:47,949

guinea pig, if you will, in most of those experiments.

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00:15:47,949 --> 00:15:49,649

They're being done on my body.

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00:15:49,649 --> 00:15:53,050

First of all, if you just think about just flying humans in space, trying to do it as

243

00:15:53,050 --> 00:15:56,959

safely as you can that in itself has a lot of things that fallout from it.

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00:15:56,959 --> 00:16:01,880

I'm going to be exposed to a lot of radiation, about 400 times what we experience just sitting

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00:16:01,880 --> 00:16:03,839

here in Houston, Texas, right now.

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00:16:03,839 --> 00:16:08,329

It's going to affect my blood vessels, it's going to affect my heart, my immune system,

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00:16:08,329 --> 00:16:13,329

and NASA's tracking that all very closely, for my health and for the purpose of exploration,

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00:16:13,329 --> 00:16:17,470

but also from what we learn from that, for radiation workers, for people that live near

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00:16:17,470 --> 00:16:27,399

radiation, bad events that have happened on the ground, but also its accelerated aging

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00:16:27,399 --> 00:16:31,500

because radiation does affect all of us as we spend our lives on the Earth.

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00:16:31,500 --> 00:16:33,360

It's an accelerated aging process.

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00:16:33,360 --> 00:16:39,420

The zero gravity reduces our muscle tone, our muscles atrophy including our heart, and

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00:16:39,420 --> 00:16:44,610

the cardiovascular system atrophies, the bone, bones atrophy, decrease in bone mineral density.

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00:16:44,610 --> 00:16:49,930

So all of this accelerated aging process and the means by which we figure out exactly what's

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00:16:49,930 --> 00:16:56,760

going down, going on, even in the cellular level, how to fix it—exercise, diet, medications,

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00:16:56,760 --> 00:17:02,870

other things—all of those things stand to benefit us on the Earth simply because we

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00:17:02,870 --> 00:17:09,799

know more about how this process occurs even at a cellular level, and how we can fix it.

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00:17:09,799 --> 00:17:18,329

So if people that are in the ICU for a long period of time, as we all get older, all of

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00:17:18,329 --> 00:17:22,169

these processes occur in those people.

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00:17:22,169 --> 00:17:27,010

Very specifically, providing medical care in space, we are doing things that you never

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00:17:27,010 --> 00:17:31,669

would have thought of on the ground: using an ultrasound to detect a fracture, using

262

00:17:31,669 --> 00:17:37,210

an ultrasound to look at the discs between your vertebrae, ultrasound to look at a lung.

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00:17:37,210 --> 00:17:40,909

These are things that x-rays and MRIs are for, but we don't have those in space, and

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00:17:40,909 --> 00:17:44,690

by the way they don't have those in underserved areas around the world; they don't even

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00:17:44,690 --> 00:17:49,710

have them in the waiting room of an inner city ER, where people wait eight hours to

266

00:17:49,710 --> 00:17:52,149

get their medical care.

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00:17:52,149 --> 00:17:56,179

In using these techniques that are well known in the medical world but in a very novel way,

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00:17:56,179 --> 00:18:02,229

because we have to in space, has opened up enormous number of possibilities for how we

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00:18:02,229 --> 00:18:07,570

can bring medical care much more quickly—particularly diagnostic imaging— to people who otherwise

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00:18:07,570 --> 00:18:10,690

wouldn't get it.

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00:18:10,690 --> 00:18:17,210

Very specifically, the American College of Surgeons now uses NASA-funded and NASA-accelerated

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00:18:17,210 --> 00:18:21,330

techniques for using ultrasound in the diagnosis of trauma, and that's taught all around

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00:18:21,330 --> 00:18:22,330

the country.

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00:18:22,330 --> 00:18:26,450

One of the principal investigators that used ultrasound to teach astronauts on orbit has

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00:18:26,450 --> 00:18:30,729

been implementing that across the country, and that's just one little tiny example.

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00:18:30,729 --> 00:18:35,950

They've even, implemented using the ultrasound to detect collapsed lungs, which had never

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00:18:35,950 --> 00:18:40,850

been used before but we did it for spaceflight and said, it's a great idea, works really

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00:18:40,850 --> 00:18:41,850

well.

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00:18:41,850 --> 00:18:46,509

Totally different category, turns out astronauts have problems with their vision.

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00:18:46,509 --> 00:18:52,220

I didn't even know there's this many things you could do to the human eye without hurting

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00:18:52,220 --> 00:18:56,990

it—to find out what's going on the outside, on the inside, the nerve behind it, the optic

282

00:18:56,990 --> 00:18:59,860

nerve, and in the brain behind that.

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00:18:59,860 --> 00:19:04,299

We're trying to figure out, why do astronauts have vision changes.

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00:19:04,299 --> 00:19:11,059

Turns out the techniques have been used on the ground but in a novel way, that they've

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00:19:11,059 --> 00:19:17,340

been using some of these techniques on patients and have found causes for intracranial hypertension

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00:19:17,340 --> 00:19:21,330

that it had heretofore been seen before, so increased pressure in the brain.

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00:19:21,330 --> 00:19:24,500

A lot of patients have this, they don't know the reasons for it, they're starting

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00:19:24,500 --> 00:19:29,070

to find out the reasons for some of these patients by using these techniques, and no

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00:19:29,070 --> 00:19:32,580

one had just, hadn't even thought to use these techniques before but NASA needed it

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00:19:32,580 --> 00:19:35,880

and we found out it works pretty well.

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00:19:35,880 --> 00:19:40,619

In the area of human life sciences research, you not only have been to space yourself and

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00:19:40,619 --> 00:19:45,779

experienced that, but as a doctor and a former flight surgeon, you've helped crew members

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00:19:45,779 --> 00:19:47,940

recover from that.

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00:19:47,940 --> 00:19:52,830

What do you think we need to look at, to concentrate on, in order to maximize the chances that

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00:19:52,830 --> 00:19:58,470

people who are going to leave Earth for long periods of time for future missions of exploration

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00:19:58,470 --> 00:20:01,870

are going to be able to do their work when they get there, they're going to be strong

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00:20:01,870 --> 00:20:04,080

and healthy when they arrive?

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00:20:04,080 --> 00:20:08,479

We need to keep doing what we've been doing that's been successful.

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00:20:08,479 --> 00:20:11,980

We've been very successful with maintaining bone and muscle health.

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00:20:11,980 --> 00:20:15,169

We've been very good at maintaining cardiovascular health.

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00:20:15,169 --> 00:20:17,389

I feel like we've solved those problems.

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00:20:17,389 --> 00:20:22,129

From a behavioral health and performance standpoint, we've been very successful there with keeping

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00:20:22,129 --> 00:20:27,269

people in contact with their families and giving them lots of very important, interesting

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00:20:27,269 --> 00:20:29,379

work to do with the laboratory there.

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00:20:29,379 --> 00:20:32,769

People, my colleagues, that have come back from space station talk about what a wonderful

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00:20:32,769 --> 00:20:35,509

place it is to live and work and they're sad to go.

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00:20:35,509 --> 00:20:38,590

If it weren't for being away from their families, if they could bring their families

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00:20:38,590 --> 00:20:43,929

up with them they would just stay indefinitely, because it's critical work and they feel

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00:20:43,929 --> 00:20:46,419

very good about being a part of that.

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00:20:46,419 --> 00:20:48,320

Radiation is still a problem we haven't solved.

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00:20:48,320 --> 00:20:55,429

The neurovestibular aspects, if we get to another planetary body or coming back to Earth,

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00:20:55,429 --> 00:21:00,440

if we have to pilot a vehicle coming back to Earth, that's still a problem to solve,

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00:21:00,440 --> 00:21:04,399

and the radiation, it could be a showstopper for us.

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00:21:04,399 --> 00:21:08,610

A solar flare could affect a crew so we need to figure that one out as well.

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00:21:08,610 --> 00:21:10,460

The other thing we need to do is keep looking.

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00:21:10,460 --> 00:21:17,019

I mentioned the vision problems in astronauts, that came up rather, relatively late in our

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00:21:17,019 --> 00:21:21,710

station flow, and you'd think with our long history of spaceflight this would have come

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00:21:21,710 --> 00:21:24,460

up before, but it's important to us too.

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00:21:24,460 --> 00:21:27,629

While I feel like we'll solve that eventually,
figure out what's going on there, I think

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00:21:27,629 --> 00:21:31,270

it's important to keep looking because we
might unearth other problems that we'd like

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00:21:31,270 --> 00:21:36,669

to solve before we actually send a crew one
way, or at least a trip that's going to

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00:21:36,669 --> 00:21:41,080

take us out there and it's going to take
about a year, two or three years to get back,

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00:21:41,080 --> 00:21:45,470

we need to have those problems solved so they
don't crop up on that trip.

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00:21:45,470 --> 00:21:49,950

Figuring out how the environment affects people
is just one of the areas of research on the

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00:21:49,950 --> 00:21:50,950

station.

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00:21:50,950 --> 00:21:57,090

The station now is packed with all kinds of
specialized gear in the different laboratories

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00:21:57,090 --> 00:22:00,309

in a number of other scientific disciplines,
too.

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00:22:00,309 --> 00:22:03,750

Give me a couple of examples of the other kinds of science research that you're going

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00:22:03,750 --> 00:22:04,789

to be working on.

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00:22:04,789 --> 00:22:08,460

There is Earth obs[ervation] that's going on all the time, not just crews looking out

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00:22:08,460 --> 00:22:13,279

of windows and taking pictures, which is an exciting part I'm looking forward to, but

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00:22:13,279 --> 00:22:20,379

the outside of the space station is covered with sensors that are both looking at things

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00:22:20,379 --> 00:22:25,460

that are going on the Earth or are being tested to see how good they are at looking at things.

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00:22:25,460 --> 00:22:30,749

The space station is a wonderful platform for quickly bringing thin sensors, techniques

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00:22:30,749 --> 00:22:35,659

and systems up into space, see how well they work, and then bringing them back down again.

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00:22:35,659 --> 00:22:41,739

So you can, with the space station you can look at a whole generation's worth of spaceflight

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00:22:41,739 --> 00:22:44,570

hardware and figure out what works best in Earth obs.

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00:22:44,570 --> 00:22:50,330

There's going to be a device up there that's going to be looking at the maritime, situation

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00:22:50,330 --> 00:22:51,330
on the Earth.

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00:22:51,330 --> 00:22:55,669
Right now all we can do is check what ships are close to shore; that's the limit of

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00:22:55,669 --> 00:23:00,610
the extent of radar and the techniques they use to find out what ships are going where.

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00:23:00,610 --> 00:23:04,429
We're going to have a whole global view so they're; it's going to be just like

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00:23:04,429 --> 00:23:08,889
air traffic control: you look out over the entire ocean, look at every ship, and you

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00:23:08,889 --> 00:23:12,330
can identify each one, know what its purpose is and know what it's doing.

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00:23:12,330 --> 00:23:20,730
That seems to be for, when it comes to natural disasters and big climate events, knowing

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00:23:20,730 --> 00:23:26,659
what ships are where, you could save lives, increase efficiency of tracking, and decrease

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00:23:26,659 --> 00:23:32,200
the risk of maritime, ocean travel.

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00:23:32,200 --> 00:23:33,989
That's just one little example.

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00:23:33,989 --> 00:23:38,720

I've been reading about all different kinds of sensors and materials that are on the outside

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00:23:38,720 --> 00:23:41,960

of the space station that are going to be used in future satellites.

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00:23:41,960 --> 00:23:44,509

Some of them don't work so well so they're not going to use them, but they know that,

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00:23:44,509 --> 00:23:48,419

they don't have to, send up a separate satellite to go figure that out.

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00:23:48,419 --> 00:23:51,580

So that's the Earth obs section.

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00:23:51,580 --> 00:23:57,470

I can keep talking about that, but the fluid physics and the material science I've also,

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00:23:57,470 --> 00:24:02,450

just happened to find very exciting, and just to talk about one, I was talking to the principal

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00:24:02,450 --> 00:24:05,059

investigator about a capillary fluid flow experiment.

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00:24:05,059 --> 00:24:11,119

This was, it's original intent was to look at how fuels flow in space when you've taken

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00:24:11,119 --> 00:24:16,560

away gravity and turns out you can develop a system for spacecraft that'll deliver

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00:24:16,560 --> 00:24:20,389

fuel to an engine without having to use a pump so you have something less that'll

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00:24:20,389 --> 00:24:21,389

break on you.

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00:24:21,389 --> 00:24:28,320

Turns out that the physics behind that works out very well, for microliter fluid flow in

362

00:24:28,320 --> 00:24:33,830

these little channels and little microchips that are used in medical devices, and they've

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00:24:33,830 --> 00:24:36,779

been able to increase the efficiency, and there are patents out now, where they've

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00:24:36,779 --> 00:24:41,499

increased the efficiency of these microchips and they can incorporate them into little

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00:24:41,499 --> 00:24:46,559

tiny laboratories that you can hold, about the size of a DVD player, and they intend

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00:24:46,559 --> 00:24:50,289

to begin building these again to go to underserved areas.

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00:24:50,289 --> 00:24:57,700

The one company I was talking to in particular was looking at an AIDS detection, rapid AIDS

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00:24:57,700 --> 00:25:00,950

detection, HIV detection device.

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00:25:00,950 --> 00:25:06,370

So the capillary fluid flow I found to be

particularly exciting, but that's just one

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00:25:06,370 --> 00:25:09,440

of about a hundred and twenty, a hundred and, going on up there.

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00:25:09,440 --> 00:25:14,950

And all of these experiments are coming from places all over the world, from principal

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00:25:14,950 --> 00:25:19,059

investigators in not only the United States but elsewhere, and you get to work with all

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00:25:19,059 --> 00:25:24,440

of those people as you learn about the experiment and then when you execute it on orbit.

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00:25:24,440 --> 00:25:26,279

Yes, I do.

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00:25:26,279 --> 00:25:27,509

It's exciting.

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00:25:27,509 --> 00:25:31,409

They are able to train us very well.

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00:25:31,409 --> 00:25:37,190

There's enough similarity in every country: Canada, in Europe, for all the international

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00:25:37,190 --> 00:25:43,759

partners in the European Space Agency, and Japan and in Russia, and we're able to communicate

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00:25:43,759 --> 00:25:45,820

very well and they're excellent teachers.

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00:25:45,820 --> 00:25:51,379

It's fun when we all get excited about what their experiment's doing, and it kind of

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00:25:51,379 --> 00:25:53,119

knocks down international barriers.

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00:25:53,119 --> 00:25:54,529

It's really cool.

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00:25:54,529 --> 00:26:00,940

The station crew members are also responsible for keeping the station functioning, not just

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00:26:00,940 --> 00:26:05,539

the laboratory work but keeping the whole thing operating.

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00:26:05,539 --> 00:26:10,130

Outside of that science lab work, what other kinds of things does a station crew member

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00:26:10,130 --> 00:26:12,919

do on a daily or weekly basis?

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00:26:12,919 --> 00:26:13,919

We have to keep it running.

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00:26:13,919 --> 00:26:15,870

First of all, we have to take care of ourselves.

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00:26:15,870 --> 00:26:21,429

We'll spend two hours a day exercising, six days a week.

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00:26:21,429 --> 00:26:25,479

Beyond that, we're going to be, as I mentioned, it's a power station, we're going to be

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00:26:25,479 --> 00:26:30,039

maintaining all of the devices on the inside,
answering the ground if anything comes up

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00:26:30,039 --> 00:26:33,809

that the power's not being delivered appropriately.

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00:26:33,809 --> 00:26:37,739

It is a water-processing station, we're
going to be recycling water quite a bit.

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00:26:37,739 --> 00:26:41,890

There's household chores and cleaning that
has to be done.

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00:26:41,890 --> 00:26:46,789

One of our tasks, as well, is going to be
to figure out stowage, and a lot of the smart

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00:26:46,789 --> 00:26:49,999

people have been working on this, we've
made a lot of advances; it doesn't sound

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00:26:49,999 --> 00:26:55,269

too technical but the fact is when you've
got people living up there continuously, and

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00:26:55,269 --> 00:27:02,249

we have been living off the Earth now continuously
for well over a decade, how do you keep resupplying

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00:27:02,249 --> 00:27:06,730

those people with what they need to live and
what's the best way to stow it?

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00:27:06,730 --> 00:27:11,049

You can't just continue to fly up years
and years' worth of supplies because there's

401

00:27:11,049 --> 00:27:12,739

no place to put it.

402

00:27:12,739 --> 00:27:14,559

How do you increase crew efficiency?

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00:27:14,559 --> 00:27:18,489

So in everything we're going to be doing we'll be making comments to the ground and

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00:27:18,489 --> 00:27:24,539

what we think, and just adding our little bit to the knowledge that hopefully will make

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00:27:24,539 --> 00:27:26,639

work up there more efficient.

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00:27:26,639 --> 00:27:32,589

Any plan for a mission like this has got to, be, have enough flexibility to respond to,

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00:27:32,589 --> 00:27:34,989

when things break, and they do.

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00:27:34,989 --> 00:27:39,499

Sometimes it even calls for people to go outside to do some work.

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00:27:39,499 --> 00:27:45,330

As we talk today, what's the plan for any spacewalks during your time on board?

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00:27:45,330 --> 00:27:47,499

Currently there's none planned.

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00:27:47,499 --> 00:27:54,580

However there was a trip in a direct current switching unit out on the space station caused

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00:27:54,580 --> 00:27:56,629

by something, they're not quite sure what.

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00:27:56,629 --> 00:28:01,869

But everything that's the most likely candidate to have caused it, we found out about that,

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00:28:01,869 --> 00:28:06,359

just in the last week, we've been training on those items, three or four actual boxes

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00:28:06,359 --> 00:28:11,210

and cable connections that would need to be removed and replaced.

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00:28:11,210 --> 00:28:15,499

And so we've spent a lot of time in the pool, we've had a chance to see hi-fi mockups

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00:28:15,499 --> 00:28:19,460

of these; that is things that look almost exactly like they do in space.

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00:28:19,460 --> 00:28:22,730

I had a chance in the POGO lab [Partial Gravity Simulator], which is a laboratory where you

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00:28:22,730 --> 00:28:27,640

can suspend a large, heavy object and, at least in one dimension, up and down, make

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00:28:27,640 --> 00:28:33,010

it act as if it were in zero gravity and work with it and see how it works.

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00:28:33,010 --> 00:28:40,659

We had some problems with some bolts on the last EVA, and it turns out when a large, heavy

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00:28:40,659 --> 00:28:45,919

mass like that is attached by one bolt, little tiny movements of that mass make a big difference

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00:28:45,919 --> 00:28:49,749

on how easy it is to bolt in and bolt out,
so we've gotten all that training as well.

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00:28:49,749 --> 00:28:57,960

So we're prepared to go out if this is something
we need to fix, we're prepared to do that,

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00:28:57,960 --> 00:29:00,789

but we also have gotten the training that
everyone else gets.

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00:29:00,789 --> 00:29:06,940

There's about 12 big tasks that we all train
on and every little skill the sockets, the

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00:29:06,940 --> 00:29:10,590

little tools you use, the positions you need
to be in, we've gone through that whole

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00:29:10,590 --> 00:29:13,950

training flow so we're ready to go outside
if we need to.

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00:29:13,950 --> 00:29:14,950

Would you like to...

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00:29:14,950 --> 00:29:15,950

I'd love to.

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00:29:15,950 --> 00:29:16,950

...have another chance at that?

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00:29:16,950 --> 00:29:17,950

It's a two-edged sword.

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00:29:17,950 --> 00:29:22,570

You don't want something to break that would

necessitate getting out there but going outside

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00:29:22,570 --> 00:29:24,769

is almost like another space mission.

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00:29:24,769 --> 00:29:26,539

You're literally in your own little spaceship.

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00:29:26,539 --> 00:29:28,259

That's what a spacesuit is.

437

00:29:28,259 --> 00:29:29,649

It's got everything a spaceship does.

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00:29:29,649 --> 00:29:34,809

The only thing different is that it's tethered to the space station with your safety tether.

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00:29:34,809 --> 00:29:36,589

The view is incredible.

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00:29:36,589 --> 00:29:41,009

The feeling in the temperature differences, which is very profound between the daylight

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00:29:41,009 --> 00:29:46,330

and the night side of Earth, a 300° difference, that, you can feel that very much.

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00:29:46,330 --> 00:29:51,340

I think every astronaut feels like they're having a whole new space experience when they

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00:29:51,340 --> 00:29:54,200

have the chance to go outside.

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00:29:54,200 --> 00:29:59,029

These days the International Space Station is getting supplies delivered by a small fleet

445

00:29:59,029 --> 00:30:01,159
of unmanned cargo ships.

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00:30:01,159 --> 00:30:05,360
A few of them are coming and going during
the time that you are going to be up there.

447

00:30:05,360 --> 00:30:10,419
Tell me about the different ships that will
be bringing supplies, including the new American

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00:30:10,419 --> 00:30:14,580
commercial cargo ships that could be showing
up while you're there, too.

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00:30:14,580 --> 00:30:16,760
Those are the things that stand out the most.

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00:30:16,760 --> 00:30:21,440
We have a lot of experience with the Progress
vehicle, that's the Russian vehicle, for

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00:30:21,440 --> 00:30:27,460
starters, and we'll see about three of those
either coming or going or with us during our

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00:30:27,460 --> 00:30:32,629
stay there, and those'll be docking to the
Russian side so that means there's going

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00:30:32,629 --> 00:30:35,179
to be a hatch about that big [holds hands
at shoulder width] so we can get a fair amount

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00:30:35,179 --> 00:30:36,549
of supplies through that.

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00:30:36,549 --> 00:30:40,540

We'll be helping to unpack that and will be very happy when it arrives; it has some

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00:30:40,540 --> 00:30:42,059

of our things in there.

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00:30:42,059 --> 00:30:45,139

We're very excited about commercial vehicles that will be coming up.

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00:30:45,139 --> 00:30:49,450

We're not quite sure when that's going to happen yet, everybody's got their time

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00:30:49,450 --> 00:30:56,089

constraints for getting something up there, but the Cygnus we hope to see during our expedition.

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00:30:56,089 --> 00:31:02,879

We'll be reaching out, it'll get into an orbit right next to us, in its own orbit

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00:31:02,879 --> 00:31:08,559

but very close to us, both traveling at 17,500 miles an hour, but our relative velocity hopefully

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00:31:08,559 --> 00:31:13,899

will be about zero, and then we'll reach a robotic arm out, grab it, pull it in and

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00:31:13,899 --> 00:31:18,909

dock it to the United States' side, and that vehicle has a huge hatch—we can put,

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00:31:18,909 --> 00:31:21,679

pull experiment racks through it.

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00:31:21,679 --> 00:31:26,470

Likewise the SpaceX Dragon, we hope to get another one of those up to see us as well.

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00:31:26,470 --> 00:31:30,609

We've had a chance to see that on the ground, their mockups, and looking forward very much

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00:31:30,609 --> 00:31:35,539

to opening that up, again a huge hatch, a lot of capability for getting things on the

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00:31:35,539 --> 00:31:40,609

space station and getting things off, in that case, getting them back to return to the ground,

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00:31:40,609 --> 00:31:42,570

so that's a very exciting capability.

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00:31:42,570 --> 00:31:46,470

Beyond that we might have a chance to see an ATV [Automated Transfer Vehicle], the European

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00:31:46,470 --> 00:31:49,249

version of the cargo vehicle; we hope so.

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00:31:49,249 --> 00:31:52,889

It's huge, it's beautiful, they have a great capability there, but it's going to

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00:31:52,889 --> 00:31:57,229

come right close to the end of our increment, so we'll see.

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00:31:57,229 --> 00:32:06,059

With private companies flying spaceships now, not just nations that are helping to explore

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00:32:06,059 --> 00:32:12,929

space, is that kind of the way you see things going in the future, where there's cooperation

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00:32:12,929 --> 00:32:18,999

among countries with one another and private companies involved, too, all together instead

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00:32:18,999 --> 00:32:21,529

of being a competition?

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00:32:21,529 --> 00:32:26,860

It seems to be, although competition can be a good thing.

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00:32:26,860 --> 00:32:31,279

Certainly for low Earth orbit it seems to make sense to have commercial companies.

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00:32:31,279 --> 00:32:35,279

NASA's provided all of the, much of the knowledge and the expertise to get us into

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00:32:35,279 --> 00:32:36,799

low Earth orbit.

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00:32:36,799 --> 00:32:42,840

Private companies have done a wonderful job of building on that technology, and then NASA's

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00:32:42,840 --> 00:32:48,330

helped to fund them so they can build up an actual business model for getting things and

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00:32:48,330 --> 00:32:49,429

people into space.

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00:32:49,429 --> 00:32:56,700

That's very exciting, it's the way every major transportation step in evolution occurs,

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00:32:56,700 --> 00:33:00,590

whether it's an airplane or the big steamships going across the ocean or automobiles, it's

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00:33:00,590 --> 00:33:05,830

the private companies, it may be expensive at first but they, get the ball rolling, and

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00:33:05,830 --> 00:33:11,129

I certainly hope that in a few days or in a few years, five to ten years, anybody would

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00:33:11,129 --> 00:33:16,849

be able to buy a ticket to come up into space.

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00:33:16,849 --> 00:33:20,209

That level of competition is very good.

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00:33:20,209 --> 00:33:24,129

Working with international partners, we found that everybody brings something to the table

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00:33:24,129 --> 00:33:27,969

and the whole is so much better than the parts.

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00:33:27,969 --> 00:33:33,309

We're docked to the Russian space station, they have a completely different method of

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00:33:33,309 --> 00:33:41,019

generating oxygen, of getting rid of carbon dioxide and multiple other life support technologies,

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00:33:41,019 --> 00:33:45,830

propulsion technologies, and that's good because if ours fails, theirs probably is

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00:33:45,830 --> 00:33:47,369

not going to and vice versa.

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00:33:47,369 --> 00:33:50,969

If they have a failure, ours is probably not

going to because the failure path would be

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00:33:50,969 --> 00:33:53,479

different and they have a totally different technology.

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00:33:53,479 --> 00:33:56,729

So we've been able to stay up in space for this long, we've been able to feed off of

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00:33:56,729 --> 00:33:58,739

each other quite a bit and learn a lot.

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00:33:58,739 --> 00:34:04,200

I anticipate that the international partnership would always be with us but a lot of smart

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00:34:04,200 --> 00:34:09,339

people paid to figure that out.

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00:34:09,339 --> 00:34:15,190

The missions, this mission, this cooperation, what is it that we're learning from it now

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00:34:15,190 --> 00:34:21,629

that you can see that is going to help prepare us for human exploration beyond Earth in the

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00:34:21,629 --> 00:34:22,629

future?

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00:34:22,629 --> 00:34:30,109

Well, like I mentioned, our partnership with the Russians has taught us a lot about long-duration

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00:34:30,109 --> 00:34:33,669

spaceflight, about keeping humans permanently in space, because they've did it for quite

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00:34:33,669 --> 00:34:36,019

a bit on the Mir and the Salyut space stations.

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00:34:36,019 --> 00:34:40,179

They lost a lot of hardware and they almost lost lives; they did in the Soyuz, they did

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00:34:40,179 --> 00:34:45,099

lose lives, as they learned how to do these things.

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00:34:45,099 --> 00:34:49,369

No one knew how to do it, how to keep people up in space for a long time and build hardware

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00:34:49,369 --> 00:34:53,110

that'll last for a long time, critical hardware to keep you alive.

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00:34:53,110 --> 00:34:58,071

You would never want to build a brand new spaceship, put in a crew and send them to

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00:34:58,071 --> 00:35:02,970

Mars right away or send them to an asteroid right away because something could fail; you'd

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00:35:02,970 --> 00:35:07,590

have to build something and then test it out over a long period of time.

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00:35:07,590 --> 00:35:13,930

That's what the space station is and with the Russian technology, with a lot of technology

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00:35:13,930 --> 00:35:20,490

the international partners have come up with, we're able to find out how we can maintain