welcome to the National Air and Space Museum in our beautiful moving beyond Earth gallery today on what's new an aerospace we're going to talk about practicing underwater for walking in space this is a really important technique and we wouldn't know how to do extra vehicular activity or Eevée a without having mastered this technique of working underwater I would also like to welcome all of our viewers on NASA TV and online later in the program we will have a Q&A session and if you go to our website you can send questions to be
asked in the Q&A session and if we're lucky we'll also be able to send questions to the engineers working in the pool because today we're going to connect live to the neutral buoyancy laboratory in Houston outside the Johnson Space Center and actually talked to them when they're working underwater so but first I want to show you a short video which kind of gives a preview of what I want to talk about on the history of neutral buoyancy or working underwater for EPA so why don't we roll a video the 50th anniversary or
yesterday was the 50th anniversary of

Alexei Leonov is the first man to walk in space and he went outside of his spacecraft for like 12 minutes in 965 a few months later on June the 3rd 1965 Edie White became the first American to walk in space and this is a picture of movie of him leaving the spacecraft Germany 4 and Gemini 4 is right down the hall in this museum and a lot of the equipment you see him wearing is now in a gallery called or exhibit called outside the spacecraft that's just upstairs in the museum this video is
actually of some of the things I'm going

to talk about today it's from a little

corporation called ER a outside Baltimore

working in the mid-1960s they are one of

the pioneers in the development of the

practice of working underwater for

practicing EDA and the shows video shows

and the pictures that follow show more

of this work that's going to be I'm

going to talk about a little bit more in

my introductory PowerPoint hears that

somebody coming out of the airlock

you're wearing a so-called mark for

arrowheads suit and and these are some
of the tests that took place outside Baltimore in the mid-60s they moved on to using a Gemini suit this is one of the founders who I'll talk about more in a minute of ER a scott carpenter working underwater with it with a test section for Skylab and you can see the Skylab module just outside here and this these pictures are from Gemini 12 and Gemini 9 simulations that took place this is Gene Cernan the astronaut and then Jesu turn and working underwater and here's at Buzz Aldrin in in Baltimore in about 19 November 1966 and
shows him getting into the water and working underwater this is really the first time and I'll come back to this the first time that walking in space was really trained and astronauts were trained to do it and then you see here some of the Apollo era so once Houston had its own tank in in 1967 it began working on the underwater training and for the later Apollo missions they had to go outside and retrieve film from the service and the construction of a new facility
which I’ll again mention in my talk and

this is the the second Houston facility

and then you have here some of the

training that took place in the shuttle

era underwater for working in the

shuttle payload Bay and and then for

going outside this is of course

McCandless in space than mu and finally

at the end of this

do you see a little bit of the training

for the Hubble repair missions and this

is a video from the training for the

last Hubble repair mission and if you go

right outside this gallery you can see
the instruments removed from the Hubble

and you can see much more about this and

also within this gallery there's some

there's information

and artifacts related to the working in

space by the astronauts on the Hubble

repair so what I want to talk about

today is how do we get here and and and

and the beginning of our

understanding that working underwater

was absolutely crucial to learning

how to do EDA this was not as

straightforward as it seemed to be so if

I could have my first slide please

and go to the next one so early on in
the program there was a very wasn't a

very good idea about how to train for

ETA how to go into space and as a

picture on the upper left at NASA

picture which was a conception that

somehow a guy in a spacesuit was turning

a wrench and you can see he has

absolutely nothing to support him or or

hold him into place in many ways some of

the effects of working in weightlessness

were just not anticipated what NASA had

for training for for EDA or for for at

weightlessness was the was the aircraft

you can in an aircraft actually
experience freefall for you know 10 to 30 seconds that's not a simulation that is actually weightlessness but the aircraft goes up and down and you only have it most maybe around 30 seconds of actual weightless experience it's pretty hard to simulate or experience what it's like to work in in weightlessness if you only have 30 seconds and another tool that they had was a so called air bearing table where there was an extremely smooth surface and a thing that created an airflow that created a floated you above the surface and you
could practice on a friction free surface but it only allows you to move around in two dimensions it didn't allow you to really experience what it's like to work in zero-gravity next please and this is there was some interest in using water to understand the effects on the human body so there were physiological experiments made like this one at Brooks Air Force Base in San Antonio in the early 60s you know well how would or were the effects of zero gravity on the human body and so subjects were immersed
in water for some time but no one really thought about could we train astronauts

that way and certainly after the program moved to Houston they just really weren't interested in is this technique yet and next slide please

so the actual history of learning how to use the water came out of Langley NASA Langley which is down in Hampton Virginia down near Norfolk and it started with a space station project called manned orbiting research laboratory and this model shows a I concept for a small space station that a Gemini capsule which is attached to the
top would go to so could we start a small station in space meanwhile of course the president commits us to go to the moon and that was our overwhelming and important mission in the 1960s in human spaceflight next please now one of the problems of this station was how do you get in and out of it and and one of the founders of this little company I’m going to talk about now Sam Mattingly actually suggested to them that they needed an airlock on the station you needed a way to get in and out of the station without letting the
pressure out of the whole station and so
this picture shows a couple of
space-suited test subjects working
inside a plastic airlock which Langley built to try to understand how you would go through such a thing and open the
hatch and close the hatch but the problem was of course this is a 1g simulation this is on earth they're not floating they're not they do not have
the reality of zero gravity and so the suggestion was we should take this airlock in a mersa T in a pool and and that suggestion actually came out of
this little company

er eh next slide please

these are the founders of ER a

Environmental Research Associates it was

a tiny company outside Baltimore

headquartered in Randallstown and the

founders were hairy loads who was the

scientist of the one with more

scientific training and G Samuel

Mattingly who was the business and

engineering genius behind this company

and I wanted to recognize today because

we have in the audience actually the

sons and grandson with son Randy and
Dave grandson Brett and also two of the
divers and guys who worked in the pool a
tra Bruce Tharpe and John Mick so if you
could welcome them so this tiny company
began to work with Langley on on how you
would immerse this airlock in a pool so
if we go to the next slide please
they actually went to a school outside
Baltimore the McDonough school which is
still there in Owings Mills and Sam
Mattingly knew that their pool was a
pretty good quality pool and didn't have
a pool of their own so they suggested to
Langley that they take their experiments
into this and they may hit and they made
a deal with McDonough school to work in this pool literally outside normal hours or when the swim teams this is you there's a school pool you have the swim team you have the swim hours and whatever and you're going to fit some experimentation in at night or on the weekends or in the more in the early mornings and things like that it's the picture actually taken on the McDonough school pool in the mid 60s who we just go to the next slide please and this shows some of the experiments that took place at the McDonough pool
some of these slides you saw before in the initial presentation shows the testing of going through the airlock how you'd open the hatches close the hatches

turn around inside with water one of the important things that Harry lode Sam Mattingly and his divers including John and Bruce learn was just how to work in this environment and make it a realistic simulation so if you're in a spacesuit you're gonna float I mean you're in a bag of air essentially so if you if you
have no weight on you you're just going
to pop to the surface and so one of the
many things I had to learn was the
proper weighting of lead weights around
the suit to create a neutral balance the
so-called neutral buoyancy in all in all
axes not just going up and down but in
every dimension that you move around and
makes a pretty reasonable simulation of
what zero-g is like next slide and you
see in this next slide another one of
these tests getting in and out of the
airlock they also had to learn a safety
I think that's one of the really
important things I learned in studying

00:11:53,389 --> 00:11:57,289
about this they had to learn a safety

00:11:55,250 --> 00:11:58,610
culture about how to work in this you

00:11:57,289 --> 00:12:00,980
had to have divers you know to have

00:11:58,610 --> 00:12:02,570
scuba divers always with you in case

00:12:00,980 --> 00:12:05,690
there was a problem with the suit and

00:12:02,570 --> 00:12:07,760
there's at times people including Bruce

00:12:05,690 --> 00:12:10,370
Tharpe who's here experienced personally

00:12:07,759 --> 00:12:12,169
you know a an emergency created by

00:12:10,370 --> 00:12:14,960
losing the air connection to the suit

00:12:12,169 --> 00:12:16,939
water potentially coming into your into

00:12:14,960 --> 00:12:18,650
your suit of your facemask and so they

00:12:16,940 --> 00:12:19,870
had to learn how to work with this next

00:12:18,649 --> 00:12:27,039
slide please

00:12:19,870 --> 00:12:28,909
now simultaneously simultaneously
Marshall Space Flight Center in Huntsville Alabama was working on neutral buoyancy they started working in 1965 and this is a picture of an outdoor tank that was covered it they heated it and so neutral buoyancy training began in two places in NASA one was through Langley and the ER a project and second one was through Marshall next slide please

now in between as I mentioned the interactive video the first humans went
into outside the spacecraft that Alexei

Leonov and Dex please and white these

walks in space could have the next slide

please these walks in space demonstrated

that we could go outside

but they were also kind of misleading we

didn't realize how hard it was because

they were just floating around for the

most part and secondly the Soviets

covered up the difficulties that liyan

off had getting back in his in his air

walk in his spacecraft and even ed white

had a lot of problem getting down in his

suit and closing the hatch but in
general the message we got from the first two walks in space and half in 1965 that isn't so hard next slide please this is a picture of it that you saw before of Gene Cernan so when we really found out how hard it was to walk in space without proper preparation and training was when Gene Cernan went outside almost exactly one year after ed white on June the 5th 1966 he went outside he was to go on the back of the Gemini 9 spacecraft put on this fancy backpack that the Air Force had had
built and he was supposed to jet around

with this jet pack on his back but that

turned out to be a disaster because just

getting into this strapping himself in

hooking up the hoses hooking everything

up and getting ready to go prove to be

so incredibly exhausting that he was

completely fatigued his sweat ran down

from his forehead ran into his eyes

fogged up his faceplate he couldn't see

he was almost completely exhausted and

and his commander Tom Stafford told him

to get back in the spacecraft and so he

had to come back to the spacecraft it

was a near-fatal accident and it
demonstrated how little prepared we were
to actually do effective work in space
that how little we actually knew about

it grab the next slide please

now coincidentally er a 10 days after

the Cernan walk gave a demonstration to

a bunch of officials at NASA this was
done in large part because at that point

ers contract was about to run out and
the whole business might go away and in

the ER a stage the demonstration for

NASA officials well it happened to come

at exactly the right time because now

somebody from Houston was sympathetic to
the idea

that maybe we can learn something from working underwater for walking in space

and so on the upper left there's a picture of a Gemini 10 simulation Jemma
t10 was going to be launched next in July and and then Gene Cernan came back

next slide please

and this is a Gemini 9 simulation that he took place in in the summer of 66

next slide please

a really important moment for Houston

was when Bob Gill Ruth who was a great pioneer and head of the Houston Center
decided on July 25th 66 we want to have

a we want to have our own tank and we

want to learn from what ara has done and

so from that point on Houston then

committed to to working on on neutral

buoyancy next slide please

and one of these things was they was

working on a so-called sky lab type

simulation with scott Carpenter next

working on a pieman e 11 on a simulation

and then and then next Buzz Aldrin Buzz

Aldrin he'd go in being prepped for the

pool next going into the pool and next

and working underwater the training of

and working underwater the training of
Buzz Aldrin was really a crucial thing

that was the point at which with the e

ra experiences passed on to Houston and

they understood how important it was

next you can see here the Germany to the

Germany mock-up entirely in the pool and

Buzz Aldrin working underwater in the

McDonough pool and next you see this is

a picture that Buzz Aldrin took and he

recently tweeted out as quote the

greatest selfie ever with typical

modesty and it's a and it's scientist

Sam Mattingly it is personally dedicated

to him because the Germany 12 walk in

space in November 1966 was such a great
success next and so you see here the the

the tank that Houston put actually

rebuilt it was used for water training

forget

the spacecraft the astronauts are

trained in scuba and next they began

working under the water with the within

the Apollo program next slide please

we have the next slide please and we're

going to underwater in the Apollo

program in the Houston tank and and next

and Marshall also built a huge tank 75

feet across and that was a really

important tank for the development of
Skylab next this is the second facility which we saw in the opening video with it with is called wet F this is used for the shuttle training and then finally in 1992 NASA built a huge neutral buoyancy laboratory in outside Houston and we have a little introductory video which just tells you something about about the neutral buoyancy laboratory is one of the largest indoor bodies of water in the world as a world-class facility near
NASA's Johnson Space Center the NBL plays a key role in meeting time-critical challenges for astronaut training and refining procedures for successful spacewalks continuing in the spirit of advancing technology and science the pool's 6.2 million gallons of chlorinated fresh water is maintained at a comfortable 84 to 86 degrees Fahrenheit with a system capable of turning over the entire pool in 19 hours the water is filtered and cleaned keeping a hygienic environment for any operation logistical planning for moving
large scale models for testing as never

been easier conveniently located next to

Ellington Airport with access to a

taxiway Hardware can be brought directly

to the facility from there the NBL's two

overhead cranes each rated at 20 tons

for jib cranes each rated at 1.6 tons or

2 dabit grains can carry your workload

directly to the pool or to the poolside

so here we are and I think we should not

have a connection to Houston Houston can

you hear me even though it's attempts

though we want the okay we're seeing now

simulations that's taking place on

airlock work under underwater at the NBL
copy so Farooq for you you'll be looking along the cable the three length of the cable for that Center wire tie and that'll go on to a six the forward stanchion and we may need the divers to help move the aft part of the coil out of the bag and a little closer to you to make that reach sandy you're going back to the bag and getting the apt coil out so I believe what they're doing here is trying to understand how to repair a particular airlock on the space station without Prelude so in the bag you can release those I'm sorry standing this
what you just said a little time we're not accessing I do not.

so for both crew sandy and Farouk you are now live to the NBL there are I'm sorry the Smithsonian they are observing you and listening in and probably in a few minutes we'll begin the interview so you're gonna be able to ask them questions.

Twitter 3 trysts on the forward stanchion of that handrail shortly you're gonna be able to ask them questions.

okay
and sandy I'm here in one minute until

you start your QA so we'll have you hold

till on pulling the cable out of the bag

okay yep put your local down and for the

flow camera if we can just get a nice

view of Sandy's faced in torso and

Farouk we'll let you finish wire tying

your cable all right the divers might

have to all me face an area inside of

the cow hi gentlemen can you hear me

or and BL can you hear me hi it's not

only gentleman I'm apologizing

could you tell me your names and who you

are and what you're doing today which
will come up later at the end of this

year mm-hmm so are you pioneering the

technique that the astronauts will have

to use that's correct sir I'm in charge

of the choreography for this EBA and I

actually am practicing it today and

it'll work for my upcoming career

development run

so tell me oh yes go ahead

yes my name is Farouk sabor I am the Evy

to position in the water today and I am

helping with sandy was working out the

choreography and the plan on the FE 2

side of the cable so there are a number

of cables that we have to lay out right
now so you're in the and the stocking

adapter is being refitted for new spacecraft with the docking adapter that

you're working on is is going to be refitted for new spacecraft to dock to

the space station yes it is so these cables are more for the second docking adapter on a previous EBA

USEPA 29 and 30 they were setting out the cables for the first vacuum adapter so could you to tell us about tell the audience who here in online and in the audience here in the museum who you are your engineers working at Johnson Space
Center

that's our engineers astronaut instructors and flight controllers so we help we help certify crew members for spacewalk and then we help execute and Mission Control while they are on orbit and help real time problem self when they run into issues must've had a lot of training as clearly you have learned how to use the spacesuit work in the space of just like an astronaut so maybe you could tell us something about what it takes to actually to do what you're doing now
that's a one of the questions I get the

most is how can you train astronauts if

you're not an astronaut so most of the

training that we get is right here at

Johnson Space Center where we we train

we do many of the same things that the

astronaut to do including getting into

suit and running these these

choreography runs in the water we also

talked to a lot of other astronauts

about their experiences in space and how

they differ from being in the water and

then so a lot of these training that we

we get right here at Johnson Space

we get right here at Johnson Space
Center and then we use the engineering training that we get from schooling to help us be able to plan and develop choreographies that will work best for the astronauts right all right thank you now we'd like to go to the audience and if anybody in the audience here would like to ask a question directly to the engineers in the pool in Houston we're happy if you could just go up and go to the mic here and come around and go to the microphone and maybe you can talk directly to Houston so if you took a little patience here we have a young man here is why we have many of our we have
actually a number of school classes here

and he'd like to ask you a question

my name is Malik at in from freeship

charter school and my question is how do you

would you do you fix the specific cable that

little while or things like I have fixed

a little cables I think he's asking how

do you fix the specific cable that

you're working on

yeah you know what's described a little

bit how that works and how you're doing

it in the pool but on the orbiter that's
the thickest tables we've ever insult we
actually started at a center point and
we attached a wire tie and then we're
out part of the cable
Afton station and then we'll go out the
rest forward we kind of started in the
middle so it makes it a little easier
than handling the whole table all at
once we attach them using something
called a Russian wire tie and it's just
a piece of copper and it allows us to
twisted and bend it looks like a twist
tie you now I told that we have a viewer
question on a first from from online or
from TV

600
00:29:46,118 --> 00:29:49,898
does it feel like you were in space when

601
00:29:48,338 --> 00:29:52,948
you're underwater or is it much

602
00:29:49,898 --> 00:29:56,468
different as a question sent by Betty

603
00:29:52,949 --> 00:29:59,259
yeah so there are similarities and there

604
00:29:56,469 --> 00:30:02,199
are differences so in the water the suit

605
00:29:59,259 --> 00:30:04,929
is the only thing that is neutral

606
00:30:02,199 --> 00:30:06,609
buoyant so your body your blood pumping

607
00:30:04,929 --> 00:30:09,009
and all of that stuff they all have

608
00:30:06,608 --> 00:30:11,798
gravity and the tools is you can see

609
00:30:09,009 --> 00:30:14,709
they still fall with gravity as well so

610
00:30:11,798 --> 00:30:16,418
the the gravity of the tools and when

611
00:30:14,709 --> 00:30:18,219
you turn upside down and you feel the

612
00:30:16,419 --> 00:30:21,009
blood rushing to your head that is very

613
00:30:18,219 --> 00:30:23,469
different but the sensation of being able to orient your body that is a very similar oftentimes we hear from the astronauts how similar turning in the pole is now one of the biggest differences the drag of water so in space it is really easy to get started moving and really hard to stop because you have a lot of momentum from the mass of the suit and then and then the water is really hard to get started as you're displacing the same amount of water as the mass of the suit and it's really easy to stop okay next we have a question from another young man oh he
forgot his question and we have a young lady would you like to ask how long do you train before you actually go up into space she go into space ER for the astronauts how long do they have to work before they go into space or execute a particular EBA they come as a scam and they sued several runs to be certified as an astronaut once they're certified they can be a sire and they do ten full runs and at that point they haven't skill set that they take with them and they could do
any ABA EPA's in particular or design

and trained about four times in the

water and then we send it up to the crew

and they execute it on orbit they may

only do the actual UVA in the pole once

maybe twice if they're lucky quite a bit

differently than we need to it'll be

okay

thank you now the next is an online

question that that we've been sent and

do astronauts wear the same EMU suit in

the NBL as they do in space

and then so for the most part there are

awful lot of similarities so one of the
things that don't work so well in the water is electronics so they took all of the electronics out of the EMU that we currently have on as opposed to the one in space so with that the entire backpack for in the water is just a volumetric simulation so we get our water and oxygen from an umbilical cable as opposed to the backpack the backpack that would have all the electronics as mu and straight okay thank you and next we have an audience question from how do the space astronauts breathes underwater how do you breathe in the space suits
underwater very hard pressurized and

00:33:26,630 --> 00:33:30,170
there is oxygen that is fed into our

00:33:28,940 --> 00:33:32,750
pressurized suit so basically we're a

00:33:30,170 --> 00:33:36,830
big balloon right now and we breathe

00:33:32,750 --> 00:33:39,980
that oxygen and then we release our co2

00:33:36,829 --> 00:33:44,119
and they keep flushing new oxygen in and

00:33:39,980 --> 00:33:51,049
that's how we breathe in the search term

00:33:44,119 --> 00:33:53,989
from a young man how do you how do you

00:33:51,049 --> 00:34:00,219
move around for heavy suit how do you

00:33:53,990 --> 00:34:07,210
move around with such a heavy suit so

00:34:00,220 --> 00:34:08,980
the quick

00:34:07,210 --> 00:34:11,380
how do you move around in a pressurized

00:34:08,980 --> 00:34:13,690
suit yeah so largely it's similar to how

00:34:11,380 --> 00:34:17,860
you would move around anywhere except

00:34:13,690 --> 00:34:18,360
for the suit is a little stiff around
you because it kind of expands like a little bit of balloon but it is constrained by all of the Rings inside of it so you can move it has rings right here where you can move your entire wrist around and then the shoulder joints are not like our shoulder joints outside of this is you have to roll them and then so once you get used to this sort of action you can use this to translate across the station or do any actions within this work envelope right here and then you have to use your arms to react against different forces in
order to move around question from a young man how do you talk

how are you able to talk underwater

that's a question mark Oh

the question was how you were able to talk to us up from underwater question

so we actually we're a concept and within that communication step it has the ability for us to communicate using communication electronics up to the top connector room and the test director room and they can talk back to us via our voice loop within our home tab

sometimes is referred to as a Snoopy cap
yes so it looks like the once movie

where the commercial venue flying the

airplane these are based off the Apollo
days home okay and they I think the

design is not saying very much q yes

so yeah they have a little cap with a

microphone and headphones inside of it

and a wire to the outside so we have

have another question how much does the

suit way yeah so from my understanding

when the suit is it is on the dry it's

about 300 pounds

so it would be really difficult to walk

in this suit but when you're in space


300 pounds has no weight it just has the

00:36:36,909 --> 00:36:45,009
mass of 300 pounds so it's really easy

00:36:38,949 --> 00:36:46,569
to move in space okay thank you and I'm

00:36:45,010 --> 00:36:51,550
told that we have one more online

00:36:46,570 --> 00:37:00,550
question that we have can you drink

00:37:00,550 --> 00:37:04,720
water in this in the suit in space and

00:37:02,829 --> 00:37:05,769
underwater says Joe and actually we have

00:37:04,719 --> 00:37:08,799
a drink bag with about 32 ounces of

00:37:05,769 --> 00:37:12,090
water and this blue thing right here by

00:37:08,800 --> 00:37:12,090
how we drink it opens and closes with by

00:37:15,960 --> 00:37:35,039
biting it for the fight though

00:37:18,909 --> 00:37:35,039
so do we we have one more question from

00:37:35,730 --> 00:37:41,820
the audience or who built the spacesuits

00:37:41,820 --> 00:37:47,709
they say who built the spaces yes I

think you look Hamilton Sundstrand is

that correct and then Phil there are

several different spaces right now that

are in the process of being designed but

the one that we have now it's been

around for like almost around 30 years

okay well thank you very much we're just

thank you for coming on line with us and

talking to us and we don't want to hold

you up any longer but we're gonna watch

you for a little while longer

at while you work underwater thank you

okay

you could sort of see that they working
outside because with the International Space Station it's being continuously refitted modified in order to get new spacecraft to go and dock to it in order to keep it in operation it requires continuous maintenance and so we have the the the people in Houston down here these guys and guess you didn't get it our engineers but they train the astronauts so they first figure out how to do it and then then the astronaut crews come in and they and they they do the same thing they or at least try to understand it one of the
differences is that on the space shuttle
it would train very specifically likely
the Hubble Space Telescope to for very
specific missions and they trained over
and over and over again to do that
mission until they had it perfect but on
the space station though guys are up
there for six months or women are up
there for six months at a time and they
have to be flexible so they have to be
able to go outside and do something
sometimes they've actually gone outside
and fixed things on the space station
and so they weren't able to get the
absolute choreographed perfect spacewalk

00:40:18,010 --> 00:40:22,490
beforehand they had to get general

00:40:20,630 --> 00:40:24,619
training from these people who are in

00:40:22,489 --> 00:40:26,479
the pool today and from others like them

00:40:24,619 --> 00:40:28,639
and then they had to work a bit on the

00:40:26,480 --> 00:40:30,889
pool on various procedures and so that

00:40:28,639 --> 00:40:32,719
in in an emergency that could go outside

00:40:30,889 --> 00:40:35,859
to fix something and they'll be ready

00:40:32,719 --> 00:40:38,119
that or or sometimes just for routine

00:40:35,860 --> 00:40:39,950
activities that they need to go outside

00:40:35,860 --> 00:40:39,950
activities that they need to go outside

00:40:38,119 --> 00:40:43,569
so the space station and it needs

00:40:38,119 --> 00:40:43,569
so the space station and it needs

00:40:39,949 --> 00:40:46,579
constant upkeep and in and maintenance

00:40:43,570 --> 00:40:49,220
during during its staying in orbit and

00:40:46,579 --> 00:40:50,900
you know even though we don't have a

00:40:49,219 --> 00:40:52,909
spacecraft that what can launch
astronauts to the space station I should underline the fact that Americans are in space now you know on the space station new crews are always being launched right now we're only using a Russian spacecraft to get there but by 2017 we're again supposed to have this time commercially operated spacecraft to take cruise up to the space station so that they will be keeping the space station going at least until the 2020s and right behind me here is a model of the full International Space Station which is a huge thing it
was the size of many football fields and

at some point here we're gonna open it

up again for QA for me personally since

we they we had to let those guys go back

and the lady in and man to go back to

their jobs working under the in the pool

but whenever we're ready we can we can

have a Q&A session so yes go ahead how

do they go to the bathroom well in the

suit or they these days they wear

diapers basically is the answer yeah but

in the space station they have real

toilets in the space station they

actually have a zero-g toilets one l
think one in the Russian part one in the American part of the space station but you know when you're inside a spacesuit for eight hours you obviously have to have some back-up plan and that's the kind of time we're talking about when you're when you're inside that suit in for a long period I'm sick thinking there's six seven eight hours they have the drink bag so that they at least can be can not be thirsty and and they have to have some way to go to the bathroom so another question my question is how do you face the wires underwater
well I mean essentially what they're doing is figuring out how to tie these cables to the space station so what do you need to do how do you need to move them what how do you divide up the tasks to do that so that they have you know put ties and things that enable them to pin it down to the spacecraft no that's it that's what they're doing they're learning how to do that and then they're learning how to do that and then they can tell the astronauts how to do it and the astronauts can do it in space yes yes next question what tools do they use when they build the space Charlemagne you work on the space
station what tools well they actually

have a whole lot of special tools that

they have to build for space they're

both lightweight and you see some of

them over here if you want to go after

the show's over and look at some of the

exhibits in here that they have to have

special tools there and sometimes they

have like drills and things there's zero

reaction tool that means when you when

you try to take an a bolt out or screw a

bolt in it doesn't create a force that

turns you on your on your own axis

because here's one of the realities I
mentioned this in passing in my talk you know with in space you don't have the ground and the gravity holding you there so if you turn a screw your body wants to go in the opposite direction Isaac Newton third law of motion for a reaction is equal opposite reaction and one of the good things about this kind of neutral buoyancy or underwater training is that gives you some sense of that if you're not anchored properly or if you don't have a special tool you're gonna turn and so it's understanding that process and how you can work in
space it turns out you have to do everything slow and carefully rather than rushing one more question I was an online question I've been told first do other countries have similar training facilities for the for their astronauts sin on land or absolutely in fact in 1980 the Russians built their own so-called hydro lab which they use to train for their space stations that now train for the Russian cosmonauts to work on ISS and then in more recent times the Japanese built a tank
the Europeans built a tank that and now

999
00:45:33,269 --> 00:45:36,719
the Chinese built a tank and so the

900
00:45:35,159 --> 00:45:38,129
Chinese actually have their own manned

901
00:45:36,719 --> 00:45:39,779
space program and they have their own

902
00:45:38,130 --> 00:45:42,240
small stations they've been launching

903
00:45:39,780 --> 00:45:44,730
and they've actually already had caught

904
00:45:42,239 --> 00:45:48,179
Chinese astronauts going outside so yeah

905
00:45:44,730 --> 00:45:50,369
every that's become a NASA really is the

906
00:45:48,179 --> 00:45:53,149
pioneer of this but it's going around

907
00:45:50,369 --> 00:45:56,429
the world or has gone around the world

908
00:45:53,150 --> 00:45:58,289
hi my name is Quinn tomorrow and I've

909
00:45:56,429 --> 00:46:00,509
got a blue pants friendship charter

910
00:46:00,510 --> 00:46:02,730
school and my question is do they

911
00:46:02,730 --> 00:46:07,050
practice the same things over and over

912
00:46:07,050 --> 00:46:07,050
again or new things every day do they
practice the same things over and over

again or new things every day well sort

of both and it's a good question I mean

to do a lot of things they have to

repeat and repeat and repeat in order to

be comfortable that we have the

technique down that we need to do

something but they and so anyway thank

you very much for coming I want to thank

the Boeing Company for sponsoring what's

new and aerospace and for sponsoring

this show

I want to thank NASA and for the NBL for

working along with us and talking to us
today so maybe we should give them another hand and I wanted to thank the crew here in the Air and Space Museum for supporting our show today thank you very much for coming