



1  
00:00:20,900 --> 00:00:23,830  
I look down, and the Earth is down here.

2  
00:00:23,830 --> 00:00:25,060  
Oh, okay.

3  
00:00:25,060 --> 00:00:26,060  
Okay.

4  
00:00:26,060 --> 00:00:27,470  
Hurry, get back and do some more things.

5  
00:00:27,470 --> 00:00:28,940  
And I had another rest period.

6  
00:00:28,940 --> 00:00:34,060  
And so, this time, I took one foot out and  
did a little agility.

7  
00:00:34,060 --> 00:00:36,680  
And I looked.

8  
00:00:36,680 --> 00:00:38,430  
Oh, uh-oh.

9  
00:00:38,430 --> 00:00:40,129  
The Earth's not there.

10  
00:00:40,129 --> 00:00:41,170  
Oh, there it is, up there.

11  
00:00:41,170 --> 00:00:47,840  
To be in the space suit outside and to look  
out in any direction was pretty neat.

12  
00:00:47,840 --> 00:00:48,870  
It's humans out there.

13

00:00:48,870 --> 00:00:50,450

It's humans out here.

14

00:00:50,450 --> 00:00:52,110

It's humans on the frontier.

15

00:00:52,110 --> 00:00:56,940

When I opened the hatch, I mean I had the whole universe in front of me.

16

00:00:56,940 --> 00:00:58,360

It was spectacular.

17

00:00:58,360 --> 00:01:00,360

Then you sort of poke your head out and flip around.

18

00:01:00,360 --> 00:01:02,470

And you take a look around.

19

00:01:02,470 --> 00:01:06,210

And, you know, it's really a holy moly kind of moment.

20

00:01:06,210 --> 00:01:10,220

that was when I first learned I think what the definition of what it truly is to be alone.

21

00:01:10,220 --> 00:01:16,920

Being in space, being in Earth orbit, floating is truly a magical experience.

22

00:01:16,920 --> 00:01:18,189

It means an exciting day.

23

00:01:18,189 --> 00:01:23,860

And it means it's a day that's going to be a lot of work,

24  
00:01:23,860 --> 00:01:28,500  
NASA's astronauts and their international partners suit up for modern space walks with

25  
00:01:28,500 --> 00:01:30,860  
training and experience.

26  
00:01:30,860 --> 00:01:31,860  
Humans suited up.

27  
00:01:31,860 --> 00:01:37,970  
Leaving the vehicle and going out on spacewalks, exploring and always going into a situation

28  
00:01:37,970 --> 00:01:43,400  
we've never been to before to fix something, space station to deploy an experiment or longer

29  
00:01:43,400 --> 00:01:45,830  
term I think of spacewalking on Mars.

30  
00:01:45,830 --> 00:01:51,900  
Spend a lot of time thinking about how humans are going to explore Mars suited with some

31  
00:01:51,900 --> 00:01:54,960  
new cool technology.

32  
00:01:54,960 --> 00:02:00,140  
when floating out in the void of space, they are standing on the shoulders of giants, making

33  
00:02:00,140 --> 00:02:06,000  
new discoveries by building on a prestigious legacy.

34  
00:02:06,000 --> 00:02:12,890  
: Why did the Russians put Sputnik up?

35

00:02:12,890 --> 00:02:18,489

Why didn't the US do that?

36

00:02:18,489 --> 00:02:20,799

We were shaken-up by Sputnik.

37

00:02:20,799 --> 00:02:28,879

And we marshaled our resources and put together a winning program.

38

00:02:28,879 --> 00:02:33,599

One of the things that drove us into human space flight was fear, was the fear when Sputnik

39

00:02:33,599 --> 00:02:38,549

went overhead in 1957 and people began to realize that there was another nation in the

40

00:02:38,549 --> 00:02:42,549

world that had the capability of putting something into space that could actually pass over the

41

00:02:42,549 --> 00:02:43,549

United States.

42

00:02:43,549 --> 00:02:48,689

That's not a good way to do a  
Clearly our motivation was a race.

43

00:02:48,689 --> 00:02:50,790

It was to beat the Soviets.

44

00:02:50,790 --> 00:02:53,599

And we had to do that for international prestige.

45

00:02:53,599 --> 00:02:55,510

And so, that set us on a sprint to the moon.

46

00:02:55,510 --> 00:02:57,400

We will get to the moon within the decade.

47

00:02:57,400 --> 00:02:58,400

And we did.

48

00:02:58,400 --> 00:03:03,329

But, it didn't set us up for a long-term exploration program in space.

49

00:03:03,329 --> 00:03:13,810

Way back in what we called the Terrible '60s, when the country was awash in campus unrest,

50

00:03:13,810 --> 00:03:22,359

civil strife, the beginning of a very unpopular war, the Soviets literally owned space at

51

00:03:22,359 --> 00:03:23,419

that point in time.

52

00:03:23,419 --> 00:03:31,469

Yuri Gagarin back in the early 1961 made one orbit around the Earth.

53

00:03:31,469 --> 00:03:35,730

Alan Shepard became the hero that this country needed.

54

00:03:35,730 --> 00:03:40,230

America's initial and successfully crewed space missions, known as Project Mercury,

55

00:03:40,230 --> 00:03:44,569

were followed by Project Gemini, the proving ground that would lead to the Apollo missions

56

00:03:44,569 --> 00:03:46,549

and the landing on the moon.

57

00:03:46,549 --> 00:03:51,370

On the Soviet side, cosmonauts and engineers were doing similar work to extend space flight

58

00:03:51,370 --> 00:03:56,819

duration, improve rendezvous techniques, and to develop the capability to leave the spacecraft,

59

00:03:56,819 --> 00:04:02,889

in what was dubbed by NASA as an extravehicular activity, or EVA.

60

00:04:02,889 --> 00:04:13,999

In order for us to conquer the space, we need to learn how to

61

00:04:13,999 --> 00:04:18,700

The first successful egress from a spacecraft while in orbit was achieved by cosmonaut Alexey

62

00:04:18,700 --> 00:04:26,910

Leonov on March 18th, 1965, making him the first person to complete an EVA, or spacewalk.

63

00:04:26,910 --> 00:04:37,500

: And what I saw, and I just half of the world because we were 500 kilometers above the earth.

64

00:04:37,500 --> 00:04:44,550

And nobody, even up until now, nobody's flying that high.

65

00:04:44,550 --> 00:04:53,870

Alexey's, you know, task was to get out and get back in.

66

00:04:53,870 --> 00:05:02,690

And he had basically, as best I understand it, a fabric tunnel after he got out of an

67

00:05:02,690 --> 00:05:03,690

airlock.

68

00:05:03,690 --> 00:05:08,750

And he was literally out there in the vacuum of space.

69

00:05:08,750 --> 00:05:15,639

And once he got through that tunnel, his job was to turn around and get back in and had

70

00:05:15,639 --> 00:05:21,090

a great deal of difficulty getting back in because he had to turn around in that tunnel

71

00:05:21,090 --> 00:05:24,729

with a pressurized space suit.

72

00:05:24,729 --> 00:05:32,060

At that time, even for us, was like being inhibited by a suit of Plaster of Paris.

73

00:05:32,060 --> 00:05:33,539

I mean it's hard to move anything.

74

00:05:33,539 --> 00:05:41,750

And he literally had to deflate his spacesuit at that point in time to be able to reduce

75

00:05:41,750 --> 00:05:44,189

his size to get back in.

76

00:05:44,189 --> 00:05:49,210

Later that year, Gemini 4 stood ready to launch from Cape Canaveral, Florida, with the primary

77

00:05:49,210 --> 00:05:54,210

objective of gathering the results of an extended four-day mission on both crew and spacecraft.

78  
00:05:54,210 --> 00:05:59,900  
Gemini 4's original semiconservative mission was then expanded to include, amongst other

79  
00:05:59,900 --> 00:06:05,840  
things, a dramatic exit from the Gemini spacecraft in what would be America's first spacewalk.

80  
00:06:05,840 --> 00:06:14,289  
On June 3rd, 1965, the second crewed mission of the Gemini series carried James McDivitt

81  
00:06:14,289 --> 00:06:16,000  
and Edward White into space.

82  
00:06:16,000 --> 00:06:18,310  
At 2:46 P.M.

83  
00:06:18,310 --> 00:06:24,650  
Eastern Time, using a handheld gas gun, White stepped out of his spacecraft, leaving crewmate

84  
00:06:24,650 --> 00:06:31,310  
McDivitt behind to witness the vastness of space alone, becoming the first American astronaut

85  
00:06:31,310 --> 00:06:36,919  
to complete a spacewalk.

86  
00:06:36,919 --> 00:06:44,850  
It's very easy to maneuver the gun.

87  
00:06:44,850 --> 00:06:45,850  
The only problem I have is that I haven't got enough fuel.

88  
00:06:45,850 --> 00:06:46,850  
The only thing I wish is I had more.

89

00:06:46,850 --> 00:06:47,850

This is the greatest experience It's just tremendous.

90

00:06:47,850 --> 00:06:51,150

We had Ed White's magnificent 20-minute, quote, walk in space.

91

00:06:51,150 --> 00:06:55,770

I don't think you'll ever get any better film.

92

00:06:55,770 --> 00:07:05,580

It was space euphoria, I think, from everyone, from Ed and Jim McDivitt, to everyone on the

93

00:07:05,580 --> 00:07:07,159

ground at Mission Control, everybody.

94

00:07:07,159 --> 00:07:08,840

I mean it was spectacular.

95

00:07:08,840 --> 00:07:09,840

He had a little gun.

96

00:07:09,840 --> 00:07:10,840

He controlled his body.

97

00:07:10,840 --> 00:07:13,280

He could move where he wanted to go.

98

00:07:13,280 --> 00:07:14,310

It set us up.

99

00:07:14,310 --> 00:07:20,199

As time progressed, the Gemini program continued to refine and even extend EVA procedures as

100

00:07:20,199 --> 00:07:24,840

more astronauts followed with tethered spacewalks in Earth's orbit.

101

00:07:24,840 --> 00:07:32,550

Well, you know the difficulties that we had in the Gemini program doing spacewalks because

102

00:07:32,550 --> 00:07:35,360

the state of the art needs to improve.

103

00:07:35,360 --> 00:07:39,599

But, you saw the difficulties there, where you jump out and you try to get something

104

00:07:39,599 --> 00:07:40,599

done.

105

00:07:40,599 --> 00:07:44,560

Well, you haven't practiced in the free fall zero G condition.

106

00:07:44,560 --> 00:07:46,190

And so, it's Newton's Second Law.

107

00:07:46,190 --> 00:07:47,190

You push on something.

108

00:07:47,190 --> 00:07:49,699

It moves your body instead of getting work done.

109

00:07:49,699 --> 00:07:57,810

And so, that whole business, you see, we just evolved and we grew since Leonov and Gemini.

110

00:07:57,810 --> 00:08:04,120

Americans like Gene Cernan, Michael Collins, Richard Gordon, and Buzz Aldrin continued

111

00:08:04,120 --> 00:08:07,039

the competition with the Soviets.

112

00:08:07,039 --> 00:08:12,949

In the Gemini days, when they were trying to do the first spacewalks from a capsule,

113

00:08:12,949 --> 00:08:17,560

the first EVAs, the first spacewalks were not very productive.

114

00:08:17,560 --> 00:08:18,789

The crew members got outside.

115

00:08:18,789 --> 00:08:20,669

They didn't have anything to hold onto.

116

00:08:20,669 --> 00:08:22,360

They kind of flailed around.

117

00:08:22,360 --> 00:08:26,030

They couldn't do fairly simple tasks.

118

00:08:26,030 --> 00:08:30,729

And they learned from that that they had to have a better way to train.

119

00:08:30,729 --> 00:08:33,360

And they started to use water tanks at that time.

120

00:08:33,360 --> 00:08:45,120

Every progressive EVA had different little hang ups, frustration, overpowering, getting

121

00:08:45,120 --> 00:08:46,470

overheated.

122

00:08:46,470 --> 00:08:51,790

Next came the Apollo program, with one of its lofty goals to land Americans on the surface

123

00:08:51,790 --> 00:08:56,160

of the moon and then return them safely to Earth.

124

00:08:56,160 --> 00:08:58,220

We're going to moon.

125

00:08:58,220 --> 00:09:01,880

I mean, hey, we're going to the moon.

126

00:09:01,880 --> 00:09:06,330

The Gemini series, you could pretty much compare it to what the launch entry suit was like,

127

00:09:06,330 --> 00:09:07,330

you know.

128

00:09:07,330 --> 00:09:10,120

It was not custom made.

129

00:09:10,120 --> 00:09:16,150

But, you could--you know, the length in that stuff could be configured so that you did

130

00:09:16,150 --> 00:09:22,310

have a certain mobility in the arms and at the knees, the difference being the Apollo

131

00:09:22,310 --> 00:09:24,980

suits were all custom made for each crew member.

132

00:09:24,980 --> 00:09:28,180

Three, two, one, zero, all engine running.

133

00:09:28,180 --> 00:09:39,520

Lift off, we have a lift off, 32 minutes past the hour, liftoff on Apollo 11.

134

00:09:39,520 --> 00:09:44,180

The first steps on the lunar surface were performed by Neil Armstrong and Buzz Aldrin.

135

00:09:44,180 --> 00:09:47,130

It was July 21st, 1969.

136

00:09:47,130 --> 00:09:53,730

And the world irrevocably changed with the steps of men very far away from the Earth.

137

00:09:53,730 --> 00:10:01,390

That's one small step for a man, one giant leap for mankind.

138

00:10:01,390 --> 00:10:04,070

I do remember the first landing on the moon, Apollo 11.

139

00:10:04,070 --> 00:10:08,890

I remember I guess I was in high school and staying up and watching that and going out

140

00:10:08,890 --> 00:10:12,710

and looking at the moon and just marveling about there are people up there.

141

00:10:12,710 --> 00:10:17,540

I think we were all captivated when Neil Armstrong did the ultimate spacewalk, which was to actually

142

00:10:17,540 --> 00:10:24,070

go out of his vehicle and end up walking on the surface of another body in our solar system.

143

00:10:24,070 --> 00:10:31,860

You have a mass with the backpack and the

body and everything else.

144

00:10:31,860 --> 00:10:33,840

And you move around.

145

00:10:33,840 --> 00:10:39,620

And you kind of think that you can change direction.

146

00:10:39,620 --> 00:10:48,250

But, that's sort of why at the end of our two hour, two and a half hour EVA, I got in

147

00:10:48,250 --> 00:10:52,220

front of the camera and bounced around with different ways of moving.

148

00:10:52,220 --> 00:10:56,230

I was really personally impressed with the Apollo EVAs and spacewalks.

149

00:10:56,230 --> 00:11:02,000

Can you imagine the first humans to ever walk on another planetary body to the moon?

150

00:11:02,000 --> 00:11:05,950

So, just fantastic, and you kind of see that two-foot bunny hop.

151

00:11:05,950 --> 00:11:07,720

So, we had great spacesuits.

152

00:11:07,720 --> 00:11:09,140

We kept the Apollo astronauts alive.

153

00:11:09,140 --> 00:11:17,360

Once we got the Lunar Rover set up, we were ready to go be lunar explorers, if you will.

154

00:11:17,360 --> 00:11:26,630

And part of the lunar rover had plastic fenders that when it was folded up, we had to unfold

155

00:11:26,630 --> 00:11:27,630

them.

156

00:11:27,630 --> 00:11:28,810

And they slid down to cover the wheels.

157

00:11:28,810 --> 00:11:34,660

But, the reason we had fenders on these things were because the lunar dust was one of the

158

00:11:34,660 --> 00:11:37,830

biggest problems that we encountered on the surface of the moon.

159

00:11:37,830 --> 00:11:39,820

It was almost the texture of graphite.

160

00:11:39,820 --> 00:11:41,180

But, graphite's a lubricant.

161

00:11:41,180 --> 00:11:43,440

This was just the opposite.

162

00:11:43,440 --> 00:11:47,180

It would get in and on everything.

163

00:11:47,180 --> 00:11:50,520

So, I was walking, doing some work around the lunar rover.

164

00:11:50,520 --> 00:11:54,530

And I put my rock hammer in my pocket with the handle sticking out.

165

00:11:54,530 --> 00:12:00,440

And I caught it under one of those extensions of the fender and, boom, blew it off.

166

00:12:00,440 --> 00:12:04,740

The dust would have come right over the top and immersed us in all this dust.

167

00:12:04,740 --> 00:12:07,370

So, we had to figure out a way.

168

00:12:07,370 --> 00:12:12,480

We took four maps, four lunar geology maps, and taped them together and took a couple

169

00:12:12,480 --> 00:12:14,770

light clamps and clamped them.

170

00:12:14,770 --> 00:12:17,120

And it did the job.

171

00:12:17,120 --> 00:12:19,350

And what did we tape them with?

172

00:12:19,350 --> 00:12:20,720

Duct tape.

173

00:12:20,720 --> 00:12:23,170

: We went from there into the Skylab program.

174

00:12:23,170 --> 00:12:26,710

And we went to the A7LB at that time.

175

00:12:26,710 --> 00:12:32,420

So, Apollo, you know, so on the surface with A7L, a spacesuit.

176

00:12:32,420 --> 00:12:34,290

And we do 1/6 of the gravity.

177

00:12:34,290 --> 00:12:39,350

And we do have the life support system on the back, which is taking care of all our

178

00:12:39,350 --> 00:12:46,480

physiology, the cooling, the oxygen, removing the carbon dioxide, and all the rest of that.

179

00:12:46,480 --> 00:12:49,010

In the Skylab problem, we were on an umbilical.

180

00:12:49,010 --> 00:12:54,310

The umbilical provided all of the physiology, if you will.

181

00:12:54,310 --> 00:12:59,560

The umbilical between the spacewalker and the Skylab Space Station provided all the

182

00:12:59,560 --> 00:13:01,330

life support.

183

00:13:01,330 --> 00:13:05,070

When we went into the Shuttle program, we went back to riding a backpack.

184

00:13:05,070 --> 00:13:14,820

But, the big difference between the Shuttle and Apollo was that we did--we integrated

185

00:13:14,820 --> 00:13:17,140

the backpack with the suit itself.

186

00:13:17,140 --> 00:13:22,090

So, Apollo was you wear the backpack there, and you bring the hoses around and connect

187

00:13:22,090 --> 00:13:23,090

them.

188

00:13:23,090 --> 00:13:28,830

In the Shuttle program, we integrated the hard upper torso and the life support system.

189

00:13:28,830 --> 00:13:32,510

But, importantly too is that we did away with the zipper.

190

00:13:32,510 --> 00:13:35,750

Now the zipper worked.

191

00:13:35,750 --> 00:13:40,280

And I had taken a zipper through a vacuum many times.

192

00:13:40,280 --> 00:13:46,920

The zipper starts here, and it rolls around, and it rolls up the back.

193

00:13:46,920 --> 00:13:50,580

And the zipper is maybe three feet long.

194

00:13:50,580 --> 00:13:52,280

And it is a zipper.

195

00:13:52,280 --> 00:13:56,420

And a zipper is the only thing between you and eternity.

196

00:13:56,420 --> 00:13:58,850

Spacewalking has actually saved some of our programs.

197

00:13:58,850 --> 00:14:04,660

So, we can look at Skylab, which Skylab, the habitat was getting very, very hot.

198

00:14:04,660 --> 00:14:09,290

And the astronauts had to go outside in their spacesuits, perform the extravehicular activity,

199

00:14:09,290 --> 00:14:11,600

and they literally saved Skylab.

200

00:14:11,600 --> 00:14:13,660

Without EVA, Skylab would have not been habitable.

201

00:14:13,660 --> 00:14:15,630

You know, they had to deploy the solar array.

202

00:14:15,630 --> 00:14:20,870

They had to deploy the thermal canopy over the damaged area.

203

00:14:20,870 --> 00:14:25,190

So, EVA saved that mission completely.

204

00:14:25,190 --> 00:14:31,120

Another great example from the Gamma Ray Observatory Mission, Jerry Ross and Jay Apt went out and

205

00:14:31,120 --> 00:14:33,200

literally got an antenna deployed.

206

00:14:33,200 --> 00:14:38,070

And it saved, you know, a major observatory, so really important interactions when humans

207

00:14:38,070 --> 00:14:40,990

are suited and kind of saving very large missions.

208

00:14:40,990 --> 00:14:45,670

My first job in the astronaut office after my initial training program was completed

209

00:14:45,670 --> 00:14:48,550

was to start working on EVAs, or spacewalks,

and the equipment.

210

00:14:48,550 --> 00:14:57,940

And in fact, we worked with the early crews to design what their spacewalks would be like.

211

00:14:57,940 --> 00:15:00,530

STS-5 was the first planned spacewalk.

212

00:15:00,530 --> 00:15:02,730

And they had equipment malfunctions which prohibited them from going outside.

213

00:15:02,730 --> 00:15:08,040

And then STS-6 was the first one where we actually conducted some spacewalks.

214

00:15:08,040 --> 00:15:13,060

So, I worked with those crews, helping them to figure out what tools we had available

215

00:15:13,060 --> 00:15:17,240

to them that they could test out and operate in the vacuum of space, out in the payload

216

00:15:17,240 --> 00:15:18,370

bay of the orbiter.

217

00:15:18,370 --> 00:15:20,350

And then we progressed from there.

218

00:15:20,350 --> 00:15:23,410

The suit was not a brand-new suit anymore.

219

00:15:23,410 --> 00:15:27,920

I had run it through all the on the floor.

220

00:15:27,920 --> 00:15:28,930

It's the 1G tests.

221

00:15:28,930 --> 00:15:30,790

I had run it through vacuum testing.

222

00:15:30,790 --> 00:15:37,260

I had run it through certification, where the number of cycles you put on every--all

223

00:15:37,260 --> 00:15:38,260

the joints.

224

00:15:38,260 --> 00:15:39,260

I've been in the water with it.

225

00:15:39,260 --> 00:15:40,630

So, it was a friend.

226

00:15:40,630 --> 00:15:44,610

From that, then we started to develop things like the manned maneuvering unit, the little

227

00:15:44,610 --> 00:15:49,660

rocket backpack that we demonstrated on several flights and used in some cases.

228

00:15:49,660 --> 00:15:55,730

In dramatic fashion, doing the first fully untethered spacewalk, Bruce McCandless zoomed

229

00:15:55,730 --> 00:15:59,070

about in the manned maneuvering unit.

230

00:15:59,070 --> 00:16:03,340

This equipment test would lead to the retrieval of stranded satellites on subsequent missions

231

00:16:03,340 --> 00:16:04,340

year later.

232

00:16:04,340 --> 00:16:12,670

And I was really jealous of Bruce McCandless when he had a backpack and went out a ways

233

00:16:12,670 --> 00:16:16,480

without a tether and maneuvered around.

234

00:16:16,480 --> 00:16:22,160

Over the following years, extravehicular activity became one of the space traveler's most exciting

235

00:16:22,160 --> 00:16:26,640

and necessary tools in his or her tool belt.

236

00:16:26,640 --> 00:16:33,480

It was July 17th, 1984, as cosmonaut Svetlana Savitskaya broke the proverbial glass ceiling

237

00:16:33,480 --> 00:16:36,700

and became the first woman to walk in space.

238

00:16:36,700 --> 00:16:41,640

Kathryn Sullivan followed shortly after on October 11th, becoming the first female American

239

00:16:41,640 --> 00:16:45,980

astronaut to perform a spacewalk.

240

00:16:45,980 --> 00:16:51,510

This is the first chance I had to stick my head out the hatch on our EVA on day seven.

241

00:16:51,510 --> 00:16:56,670

As time progressed, so did the need for advanced technology and utilities.

242

00:16:56,670 --> 00:17:01,400

Complicated missions and space program saving maneuvers are the essence of NASA's extravehicular

243

00:17:01,400 --> 00:17:02,400

activity.

244

00:17:02,400 --> 00:17:05,260

There was one time when I was on the end of the mechanical arm.

245

00:17:05,260 --> 00:17:06,799

It was on the Hubble mission.

246

00:17:06,799 --> 00:17:09,030

And I was being moved from one place to another.

247

00:17:09,030 --> 00:17:11,850

And you really have no sensation of movement when you're on that arm.

248

00:17:11,850 --> 00:17:13,120

And it's just so smooth.

249

00:17:13,120 --> 00:17:14,120

There's nothing.

250

00:17:14,120 --> 00:17:16,309

There's no drag of the water pulling you back.

251

00:17:16,309 --> 00:17:18,760

And so, you don't really know you're moving.

252

00:17:18,760 --> 00:17:20,339

And I was just--I was working on the tools.

253

00:17:20,339 --> 00:17:23,850

I was putting the sockets on for the next whatever task I had to do next.

254

00:17:23,850 --> 00:17:25,200

And the guys stopped.

255

00:17:25,200 --> 00:17:26,440

And they said, "You have to look at this.

256

00:17:26,440 --> 00:17:27,630

You just have to stop and look."

257

00:17:27,630 --> 00:17:28,630

And so, I stopped and looked.

258

00:17:28,630 --> 00:17:30,120

And we were over the Gulf of Mexico.

259

00:17:30,120 --> 00:17:33,030

We could see the entire North America.

260

00:17:33,030 --> 00:17:35,030

And we could see an aurora up over Canada.

261

00:17:35,030 --> 00:17:37,750

And it was just an amazing view.

262

00:17:37,750 --> 00:17:41,170

We started to develop little power tools.

263

00:17:41,170 --> 00:17:45,730

We developed more wrenches and others kinds of tools that we could use for other types

264

00:17:45,730 --> 00:17:53,260

of failures that we identified in the payload bay door mechanisms to remove debris or to

265

00:17:53,260 --> 00:17:56,600

disconnect things should the not function properly.

266

00:17:56,600 --> 00:18:02,130

From the Apollo program's deep space missions around and to the moon, to the US Skylab,

267

00:18:02,130 --> 00:18:07,340

Shuttle, and International Space Station programs, spacewalkers have suited up.

268

00:18:07,340 --> 00:18:12,611

On board the spacecraft, you've got the today two spacewalk crew members who go out, work

269

00:18:12,611 --> 00:18:13,730

cooperatively together.

270

00:18:13,730 --> 00:18:17,240

They become brother and sister, brother and brother, sister and sister.

271

00:18:17,240 --> 00:18:21,040

They learn how to work as a very coherent team.

272

00:18:21,040 --> 00:18:23,470

They actually understand each other's moves.

273

00:18:23,470 --> 00:18:25,280

They know where they're supposed to be.

274

00:18:25,280 --> 00:18:31,130

You've got nowadays a robotic operator who's generally moving one--at least one of the

275

00:18:31,130 --> 00:18:33,700

crew members around on a robotic arm.

276

00:18:33,700 --> 00:18:37,350

You've got the IV crew member, the intravehicular crew member, who is, for all intents and purposes,

277

00:18:37,350 --> 00:18:38,350

the choreographer.

278

00:18:38,350 --> 00:18:39,350

If you can imagine a ballet, there is a choreographer offstage who's really taught everybody which

279

00:18:39,350 --> 00:18:40,350

moves to make and directing them on how to perfect their moves and everything.

280

00:18:40,350 --> 00:18:42,020

And that's what an IV crew member does, has the whole mission kind of committed to memory,

281

00:18:42,020 --> 00:18:46,720

knows when somebody's out of position, knows when somebody's about to get too far away

282

00:18:46,720 --> 00:18:48,680

where they can be safely tethered.

283

00:18:48,680 --> 00:18:53,280

Back on Earth in the Mission Control Center, you have the primary person on console that

284

00:18:53,280 --> 00:18:58,410

is the EV, or the extravehicular controller.

285

00:18:58,410 --> 00:19:05,130

In the back room, they probably have anywhere from 25 to 100 people who are looking at data

286

00:19:05,130 --> 00:19:08,240

from each of the spacewalking astronauts.

287

00:19:08,240 --> 00:19:11,870

They're looking at data from the spacewalk that's actually going on.

288

00:19:11,870 --> 00:19:17,861

And then somewhere in the world, like at a place that built the spacesuit, or somebody

289

00:19:17,861 --> 00:19:23,010

that designed the procedure that's being down, whether it's in Denver, Colorado, or Connecticut,

290

00:19:23,010 --> 00:19:24,640

they're also looking on.

291

00:19:24,640 --> 00:19:29,180

And they have their own data that they're evaluating and getting all that back into

292

00:19:29,180 --> 00:19:33,650

Mission Control in Houston, telling the flight control team, okay, we see this developing

293

00:19:33,650 --> 00:19:35,030

or we see this happening.

294

00:19:35,030 --> 00:19:40,860

You need to let the crew know, so probably thousands of people supporting the development

295

00:19:40,860 --> 00:19:46,110

of the types of spacewalks that we're going to do and then hundreds actually involved

296

00:19:46,110 --> 00:19:47,990

in the spacewalk on that particular day.

297

00:19:47,990 --> 00:19:53,110

It was part of our training to make sure that, you know, even though you might be nervous,

298

00:19:53,110 --> 00:19:55,680

try not to show them that you're nervous.

299

00:19:55,680 --> 00:19:57,610

Everything had to be laid out perfectly, you know.

300

00:19:57,610 --> 00:20:01,780

I mean from the start, you know, you had your check list.

301

00:20:01,780 --> 00:20:04,280

It was all laid out properly.

302

00:20:04,280 --> 00:20:10,730

You know which pocket every pen went in, you know, even down to where the pocket they wanted

303

00:20:10,730 --> 00:20:12,260

their sandwich put in.

304

00:20:12,260 --> 00:20:18,510

It has been the astronauts' mantra to train, test, and

305

00:20:18,510 --> 00:20:26,850

One of the things that astronauts learn to do, to look at a situation and don't panic

306

00:20:26,850 --> 00:20:28,000

about anything.

307

00:20:28,000 --> 00:20:30,460

You'll make it worse.

308

00:20:30,460 --> 00:20:32,210

But, think carefully.

309

00:20:32,210 --> 00:20:35,010

Did you do something wrong?

310

00:20:35,010 --> 00:20:36,420

And then fix it.

311

00:20:36,420 --> 00:20:39,480

Well, the astronaut prayer, which is please,  
God, don't let me screw this up.

312

00:20:39,480 --> 00:20:40,660

That's the first thing.

313

00:20:40,660 --> 00:20:44,790

I think the biggest fear that I had and maybe  
many astronauts as well is not that I was

314

00:20:44,790 --> 00:20:45,790

going to get hurt.

315

00:20:45,790 --> 00:20:48,810

It was that I was going to mess up because  
everybody's watching.

316

00:20:48,810 --> 00:20:52,320

You have such a limited time out there to  
get done what needs to be done.

317

00:20:52,320 --> 00:20:54,970

And you really, really don't want to make  
a mistake.

318

00:20:54,970 --> 00:20:56,350

It was cold.

319

00:20:56,350 --> 00:20:58,280

So, that was a little surprise.

320

00:20:58,280 --> 00:21:00,240

But, we should have anticipated cold.

321

00:21:00,240 --> 00:21:03,850

But, it turns out at that point, we had only done hot spacewalks.

322

00:21:03,850 --> 00:21:07,280

Until STS6, they had all been warm.

323

00:21:07,280 --> 00:21:15,360

The STS-125 crew, which was the final Hubble serving mission, that almost none of us thought

324

00:21:15,360 --> 00:21:20,470

they would be able to successfully complete five back-to-back-to-back-to-back-to-back

325

00:21:20,470 --> 00:21:23,650

EVAs and do all that they were supposed to do.

326

00:21:23,650 --> 00:21:27,960

And they not only completed them in spite of obstacles that almost on--at every turn

327

00:21:27,960 --> 00:21:29,550

on almost every single EVA.

328

00:21:29,550 --> 00:21:34,120

But, they did them superbly and left Hubble in incredible shape.

329

00:21:34,120 --> 00:21:40,500

And I think they a tremendous service to planetary science, astrophysics, and just the field

330

00:21:40,500 --> 00:21:45,560

of spacewalks in terms of showing people that if you really work hard at it and you plan

331

00:21:45,560 --> 00:21:49,820

it and you execute the way you plan, there's nothing we can't do.

332

00:21:49,820 --> 00:21:54,320

When you're doing a spacewalk on orbit, you're in your own spaceship.

333

00:21:54,320 --> 00:21:55,390

It's your spacesuit.

334

00:21:55,390 --> 00:22:01,210

But, it keeps you from the vacuum outside and your crewmates inside the space shuttle.

335

00:22:01,210 --> 00:22:06,130

I had one moment on the Hubble Space Telescope mission where Drew Feustel, my spacewalking

336

00:22:06,130 --> 00:22:08,559

partner, was on the other side of the telescope.

337

00:22:08,559 --> 00:22:13,620

And I was holding onto a handrail looking up at the Earth go by behind the Hubble.

338

00:22:13,620 --> 00:22:15,160

And it was a truly remarkable moment.

339

00:22:15,160 --> 00:22:20,400

But, I did realize, you know, how far away we were from the Earth's atmosphere, from

340

00:22:20,400 --> 00:22:24,410

our homes, from our companions inside the space shuttle.

341

00:22:24,410 --> 00:22:29,070

And I wouldn't say that I felt a sense of loneliness, but a sense of awe, you know,

342

00:22:29,070 --> 00:22:33,010

that we're doing these kind of things, that we're able to fix the Hubble to orbit the

343

00:22:33,010 --> 00:22:36,630

Earth.

344

00:22:36,630 --> 00:22:42,130

Through spacewalks, complex problems have been solved in extreme ways, such as fixing

345

00:22:42,130 --> 00:22:47,020

the Hubble Space Telescope's blurry vision, turning a possible billion dollar piece of

346

00:22:47,020 --> 00:22:54,540

space junk into one of the most revered scientific instruments of human history.

347

00:22:54,540 --> 00:22:59,420

Missions like Hubble tested the mettle of spacewalkers, an elite breed among an already

348

00:22:59,420 --> 00:23:00,840

out of this world group of adventurers.

349

00:23:00,840 --> 00:23:06,480

I'd say that on Hubble, it's a very fine motor skill tuned in very close in a lot of hands

350

00:23:06,480 --> 00:23:07,480

work.

351

00:23:07,480 --> 00:23:11,980

So, it's almost like doing surgery when you're in Hubble in a suit, versus being a longshoreman

352

00:23:11,980 --> 00:23:17,350

when you're on Space Station or you're just

hanging, moving big blivets around and you're

353

00:23:17,350 --> 00:23:18,350

changing stuff out.

354

00:23:18,350 --> 00:23:23,490

And that tradition continued with the wall of EVAs, which built the tremendously successful

355

00:23:23,490 --> 00:23:25,000

International Space Station.

356

00:23:25,000 --> 00:23:31,190

It's been 50 years since NASA's first EVA, when Ed White went out on Gemini 4.

357

00:23:31,190 --> 00:23:34,230

We've come a long way since that first one.

358

00:23:34,230 --> 00:23:37,940

Building the International Space Station, it was very, very EVA intensive.

359

00:23:37,940 --> 00:23:42,570

And when we were planning for it, everybody talked about the wall of EVA.

360

00:23:42,570 --> 00:23:43,570

We're never going to be able to accomplish all this.

361

00:23:43,570 --> 00:23:48,840

And when you look back on what we accomplished, it was pretty darned amazing.

362

00:23:48,840 --> 00:23:52,640

So, on my first flight, we were right in the middle of the construction of the space station.

363

00:23:52,640 --> 00:23:58,380

And so, of course, every shuttle flight that went up was full of spacewalks and just putting

364

00:23:58,380 --> 00:24:00,170

pieces together.

365

00:24:00,170 --> 00:24:05,520

Every single EVA was an important and necessary component of the assembly sequence.

366

00:24:05,520 --> 00:24:11,180

So, I think we all feel that, you know, we had a hand in laying the keystone or however

367

00:24:11,180 --> 00:24:12,302

you want to describe it.

368

00:24:12,302 --> 00:24:16,350

To see the ISS now and the spacewalks that they do to go out and do repairs, I mean it's

369

00:24:16,350 --> 00:24:18,620

just incredible.

370

00:24:18,620 --> 00:24:24,250

Station is more than 14 years old, built by spacewalkers, and continues to be maintained

371

00:24:24,250 --> 00:24:30,520

and upgraded through spacewalks in the most advanced spacesuits the world has ever seen.

372

00:24:30,520 --> 00:24:33,840

Spacewalks are not--they look like they're incredible fun.

373

00:24:33,840 --> 00:24:36,830

And they probably are for the crew member when you really get down to it.

374

00:24:36,830 --> 00:24:39,700

But, we much never forget how dangerous they are.

375

00:24:39,700 --> 00:24:42,900

I felt something that was not--unexpected.

376

00:24:42,900 --> 00:24:47,350

I felt cold water on the back of my head.

377

00:24:47,350 --> 00:24:54,360

And that surprised me.

378

00:24:54,360 --> 00:24:58,940

I contacted the ground, which is the first thing you would do when something that you're

379

00:24:58,940 --> 00:25:00,450

not expecting comes up.

380

00:25:00,450 --> 00:25:02,340

So, I asked Houston for advice.

381

00:25:02,340 --> 00:25:05,380

You know, I said I feel water in my helmet.

382

00:25:05,380 --> 00:25:07,370

But, it feels like a lot of water.

383

00:25:07,370 --> 00:25:11,840

The ground doesn't have a lot of information on the suit.

384

00:25:11,840 --> 00:25:13,370

They can monitor some things.

385

00:25:13,370 --> 00:25:16,970

They have telemetry about my status, my mental status.

386

00:25:16,970 --> 00:25:18,911

And they know how the suit is performing.

387

00:25:18,911 --> 00:25:24,040

But, a lot of things, we couldn't tell at that point.

388

00:25:24,040 --> 00:25:27,870

Is the water increasing in my helmet, in the back of my helmet?

389

00:25:27,870 --> 00:25:29,630

I couldn't tell.

390

00:25:29,630 --> 00:25:30,630

The ground couldn't tell.

391

00:25:30,630 --> 00:25:34,960

We were trying to come out with what could be the possible problem and the solution.

392

00:25:34,960 --> 00:25:43,220

Finally came the decision from the ground to take the safest option, which is we are

393

00:25:43,220 --> 00:25:44,580

going to terminate this EVA.

394

00:25:44,580 --> 00:25:49,151

Chris and Luca, just for you guys, based on what we heard with Luca saying that water

395

00:25:49,151 --> 00:25:55,080

is in his eyes now and it seems to be increasing, we think we're going to terminate EVA case

396

00:25:55,080 --> 00:25:56,790  
for EV2.

397

00:25:56,790 --> 00:26:01,570

And so, when they told me, okay, Luca, you're going to travel back to the airlock, and Chris

398

00:26:01,570 --> 00:26:04,670

is going to clean and then follow you, that's what we did.

399

00:26:04,670 --> 00:26:07,570

And I started translating back to the airlock.

400

00:26:07,570 --> 00:26:12,150

I had to go upside down and translating with my head towards the ground.

401

00:26:12,150 --> 00:26:13,150

It always happens.

402

00:26:13,150 --> 00:26:15,552

A lot of things happen at the same time.

403

00:26:15,552 --> 00:26:16,990

The sun went down at that point.

404

00:26:16,990 --> 00:26:23,330

You go to zero, darkness, no [unintelligible], and cold.

405

00:26:23,330 --> 00:26:27,660

And at the same time, the water sloshed around in my helmet.

406

00:26:27,660 --> 00:26:31,910

And it covered my eyes and my nose and my ears.

407

00:26:31,910 --> 00:26:39,450

So, all at once, I was isolated both being outside in my spacesuit, but I was also sensorially

408

00:26:39,450 --> 00:26:40,450

[ph] isolated.

409

00:26:40,450 --> 00:26:41,650

I couldn't see.

410

00:26:41,650 --> 00:26:44,020

And I couldn't hear.

411

00:26:44,020 --> 00:26:50,429

And I didn't quite know where I was, how to find my way back to the airlock.

412

00:26:50,429 --> 00:26:56,250

At that point, it was obvious to me that I needed to go back to the airlock by myself

413

00:26:56,250 --> 00:26:59,740

and do it as fast as I could because I could still breathe through my mouth.

414

00:26:59,740 --> 00:27:03,340

But, I didn't know how much water was in the helmet.

415

00:27:03,340 --> 00:27:06,710

And I didn't know if there would be more water in the helmet.

416

00:27:06,710 --> 00:27:11,730

Thankfully, we spent hundreds of hours under water on the neutral buoyant slab learning

417

00:27:11,730 --> 00:27:16,580

the configuration of the Space Station and learning how to use our spacesuit, learning

418

00:27:16,580 --> 00:27:18,220

how to navigate.

419

00:27:18,220 --> 00:27:23,410

And so, using that experience and using my knowledge of the suit and everything I had

420

00:27:23,410 --> 00:27:30,790

with me, I was able to find my way in the dark, in the blind back to the airlock.

421

00:27:30,790 --> 00:27:36,559

Once I found the airlock, though, everything became a little better because once I opened

422

00:27:36,559 --> 00:27:38,690

the terminal cover, the airlock is illuminated.

423

00:27:38,690 --> 00:27:43,299

And that made a huge difference because now I knew where I was.

424

00:27:43,299 --> 00:27:45,950

And I knew I could get inside by myself.

425

00:27:45,950 --> 00:27:50,240

And the end of it was that at that point, I had no communication whatsoever.

426

00:27:50,240 --> 00:27:51,240

I couldn't hear myself.

427

00:27:51,240 --> 00:27:52,240

I couldn't hear anything.

428

00:27:52,240 --> 00:27:53,440

I couldn't talk.

429

00:27:53,440 --> 00:27:55,990

My ears were filled with water.

430

00:27:55,990 --> 00:27:57,390

But, I was looking up.

431

00:27:57,390 --> 00:28:01,549

And as soon as they opened the hatch between the space station and the airlock, I saw my

432

00:28:01,549 --> 00:28:03,860

crewmates and the look on their faces.

433

00:28:03,860 --> 00:28:06,720

They were so worried and so relieved at the same time.

434

00:28:06,720 --> 00:28:08,330

And they pulled me out.

435

00:28:08,330 --> 00:28:14,670

And as soon as they could, they deflated the suit and unlocked the helmet.

436

00:28:14,670 --> 00:28:20,490

And the look on their faces and seeing their faces was a very happy moment for me.

437

00:28:20,490 --> 00:28:24,970

I felt so relieved and so happy that they were all around me.

438

00:28:24,970 --> 00:28:29,260

Today, the International Space Station is being used as a proving ground to conduct

439

00:28:29,260 --> 00:28:34,500

the research and test the technologies that will take humans beyond low Earth orbit and

440

00:28:34,500 --> 00:28:40,270

deeper into the solar system than ever before,  
to the area around the moon, to an asteroid,

441

00:28:40,270 --> 00:28:42,430

and on to Mars.

442

00:28:42,430 --> 00:28:47,770

We will pioneer space, not just to visit,  
but to stay.

443

00:28:47,770 --> 00:28:54,420

We're going to migrate out over the next five  
to 10 years into repositioning humanity in

444

00:28:54,420 --> 00:28:55,420

lunar orbit.

445

00:28:55,420 --> 00:29:01,720

So, we will spend most of our time orbiting  
the moon and doing more technology development,

446

00:29:01,720 --> 00:29:08,770

but learning basically how we operate in a  
low gravity or no gravity environment because

447

00:29:08,770 --> 00:29:11,549

that's the way it will be when we go to Mars.

448

00:29:11,549 --> 00:29:14,440

Mars's gravity is less than Earth's.

449

00:29:14,440 --> 00:29:18,600

Operating there will be significantly different  
than operating here in low Earth orbit.

450

00:29:18,600 --> 00:29:24,500

When we do the asteroid redirect mission and

we reposition an asteroid into a stable retrograde

451

00:29:24,500 --> 00:29:32,380

orbit around the moon, then the dominant gravity for that group of explorers, if you will,

452

00:29:32,380 --> 00:29:33,760

is going to be the asteroid itself.

453

00:29:33,760 --> 00:29:38,350

And that's going to be a very, very, very low gravity field if any at all.

454

00:29:38,350 --> 00:29:43,990

So, we've got a lot of development of tactics, techniques, and procedures.

455

00:29:43,990 --> 00:29:51,010

You never know when you build a piece of hardware, the guys back in the '70s and gals that built

456

00:29:51,010 --> 00:29:55,841

and designed and tested the original EMUs, which we're still flying today, by the way.

457

00:29:55,841 --> 00:30:00,929

The life support systems are still the original life support systems that we had 37 years

458

00:30:00,929 --> 00:30:01,929

ago.

459

00:30:01,929 --> 00:30:04,062

You never know where that hardware's going to end up.

460

00:30:04,062 --> 00:30:10,660

To see the suit, you know, to see it go on over the decades and into we never planned

461

00:30:10,660 --> 00:30:13,410

on hundreds of spacewalks.

462

00:30:13,410 --> 00:30:19,880

And the key thing there is in structural integrity is that you identify weakness before failure.

463

00:30:19,880 --> 00:30:25,980

From here, NASA engineers, technicians, and astronauts will figure out new ways to overcome

464

00:30:25,980 --> 00:30:29,370

the next set of challenges.

465

00:30:29,370 --> 00:30:32,780

We decided to orbit the Earth a lot instead of going deeper into space.

466

00:30:32,780 --> 00:30:36,380

And now I think it's time for us to take that step beyond orbiting the Earth and moving

467

00:30:36,380 --> 00:30:37,380

on.

468

00:30:37,380 --> 00:30:41,080

We don't have the same momentum we had when we had an enemy that we were afraid of.

469

00:30:41,080 --> 00:30:46,980

So, we are not in competition as much as I think we need to be in cooperation with other

470

00:30:46,980 --> 00:30:51,140

nations in order to move all of us forward and out into space.

471

00:30:51,140 --> 00:30:53,870

Mars is really extreme, which is the great

part about it.

472

00:30:53,870 --> 00:30:54,870

It's challenging.

473

00:30:54,870 --> 00:30:58,950

So, when we get to Mars, you're going to need to be provided your life support and pressure

474

00:30:58,950 --> 00:31:00,450

with the spacesuit.

475

00:31:00,450 --> 00:31:06,600

But, it'll have to be really something new in terms of to be very lightweight, be very

476

00:31:06,600 --> 00:31:07,600

mobile.

477

00:31:07,600 --> 00:31:08,760

We don't really have a locomotion suit.

478

00:31:08,760 --> 00:31:13,160

We have spacesuits for the vacuum of microgravity.

479

00:31:13,160 --> 00:31:15,220

So, you're weightless, which is great.

480

00:31:15,220 --> 00:31:16,560

But, that's a very different environment.

481

00:31:16,560 --> 00:31:19,330

Now when we get to Mars, we have gravity, [unintelligible] gravity.

482

00:31:19,330 --> 00:31:20,750

So, we're bipedal again.

483

00:31:20,750 --> 00:31:24,169

So, we're going to be walking, bending, or going there to search for life.

484

00:31:24,169 --> 00:31:25,960

We're looking for fossils and digging things up.

485

00:31:25,960 --> 00:31:27,280

So, you really are an explorer.

486

00:31:27,280 --> 00:31:30,130

So, it is akin to Lewis and Clark Expedition.

487

00:31:30,130 --> 00:31:32,929

And you're exploring and moving out into the West.

488

00:31:32,929 --> 00:31:34,470

It's really the next frontier.

489

00:31:34,470 --> 00:31:41,010

For anyone who goes on another EVA stroll back on the moon or on Mars, and we'll do

490

00:31:41,010 --> 00:31:42,620

both one day.

491

00:31:42,620 --> 00:31:44,720

I know that'll happen.

492

00:31:44,720 --> 00:31:46,030

Take duct tape.

493

00:31:46,030 --> 00:31:57,490

We are currently further along than ever before in human history on our journey to Mars.

494

00:31:57,490 --> 00:32:02,260

American engineers and scientists around the country are working hard to develop the technologies,