

# SPACESUITS FOR THE NEXT EXPLORERS



1  
00:00:07,430 --> 00:00:04,550

[Music]

2  
00:00:09,750 --> 00:00:07,440

a new era of exploration is beginning

3  
00:00:11,910 --> 00:00:09,760

nasa is building on its experience in

4  
00:00:14,230 --> 00:00:11,920

low earth orbit and preparing to go

5  
00:00:16,710 --> 00:00:14,240

farther setting up a base camp in orbit

6  
00:00:18,870 --> 00:00:16,720

around the moon known as the gateway

7  
00:00:21,910 --> 00:00:18,880

exploring the surface of the moon like

8  
00:00:23,349 --> 00:00:21,920

never before and preparing to one day go

9  
00:00:25,830 --> 00:00:23,359

to mars

10  
00:00:28,710 --> 00:00:25,840

to accomplish all this nasa will need a

11  
00:00:31,269 --> 00:00:28,720

new space suit for its astronauts one

12  
00:00:34,150 --> 00:00:31,279

that's more flexible versatile and

13  
00:00:36,790 --> 00:00:34,160

durable than any made before

14

00:00:39,350 --> 00:00:36,800

engineers are now hard at work designing

15

00:00:41,750 --> 00:00:39,360

building and testing the new suit making

16

00:00:45,510 --> 00:00:41,760

sure it's up to the task for future

17

00:00:45,520 --> 00:00:52,630

[Music]

18

00:00:56,549 --> 00:00:54,069

some of the greatest moments in

19

00:00:58,950 --> 00:00:56,559

exploration have taken place with a

20

00:01:01,349 --> 00:00:58,960

human in a spacesuit whether it was a

21

00:01:03,750 --> 00:01:01,359

first journey outside the spacecraft or

22

00:01:06,230 --> 00:01:03,760

traversing mountainous moonscapes

23

00:01:08,310 --> 00:01:06,240

the spacesuit made it possible

24

00:01:11,750 --> 00:01:08,320

the act of sending a suited human

25

00:01:13,990 --> 00:01:11,760

outside the spacecraft is called eva

26

00:01:16,469 --> 00:01:14,000

what is an eva eva is an acronym that

27

00:01:18,149 --> 00:01:16,479

stands for extravehicular activity which

28

00:01:19,910 --> 00:01:18,159

is what most people know is a spacewalk

29

00:01:22,870 --> 00:01:19,920

it's whenever we take astronauts and we

30

00:01:24,550 --> 00:01:22,880

let them go outside to do useful work in

31

00:01:26,789 --> 00:01:24,560

the vacuum of space

32

00:01:29,910 --> 00:01:26,799

the spacesuits currently in use for nasa

33

00:01:31,670 --> 00:01:29,920

evas were designed in the 1970s for

34

00:01:33,429 --> 00:01:31,680

space shuttle missions

35

00:01:35,109 --> 00:01:33,439

they have been upgraded over the years

36

00:01:38,230 --> 00:01:35,119

for work on the international space

37

00:01:40,310 --> 00:01:38,240

station and have served nasa well

38

00:01:42,310 --> 00:01:40,320

in the past 20 years there are a handful

39

00:01:43,910 --> 00:01:42,320

of types of spacewalks that we've done

40

00:01:46,149 --> 00:01:43,920

we've done planned spacewalks for

41

00:01:47,910 --> 00:01:46,159

maintenance as hardware breaks we can do

42

00:01:49,590 --> 00:01:47,920

contingency spacewalks

43

00:01:51,749 --> 00:01:49,600

as technology improves we can upgrade

44

00:01:54,310 --> 00:01:51,759

hardware or like with the hubble space

45

00:01:55,910 --> 00:01:54,320

telescope we're actually repairing very

46

00:01:57,590 --> 00:01:55,920

sensitive scientific experiments in

47

00:02:00,149 --> 00:01:57,600

order to enable science

48

00:02:02,310 --> 00:02:00,159

those ebas took place in microgravity

49

00:02:05,190 --> 00:02:02,320

where astronauts float and need to use

50

00:02:07,910 --> 00:02:05,200

their hands to move from place to place

51  
00:02:09,910 --> 00:02:07,920  
but moonwalkers working in one-sixth

52  
00:02:12,550 --> 00:02:09,920  
earth's gravity will need spacesuits

53  
00:02:15,030 --> 00:02:12,560  
that let them use their hands and feet

54  
00:02:16,790 --> 00:02:15,040  
walking to destinations and bending and

55  
00:02:19,589 --> 00:02:16,800  
reaching as they explore

56  
00:02:22,229 --> 00:02:19,599  
for this new type of work nasa has been

57  
00:02:24,630 --> 00:02:22,239  
testing prototype planetary suits

58  
00:02:26,229 --> 00:02:24,640  
culminating in a new suit design the

59  
00:02:29,030 --> 00:02:26,239  
xemu

60  
00:02:31,830 --> 00:02:29,040  
the cmu is exploration extravehicular

61  
00:02:33,670 --> 00:02:31,840  
activity mobility unit so it's an

62  
00:02:35,910 --> 00:02:33,680  
exploration spacesuit so it's a

63  
00:02:38,229 --> 00:02:35,920

spacesuit that you're going to use as we

64

00:02:40,309 --> 00:02:38,239

move forward in on gateway missions and

65

00:02:43,110 --> 00:02:40,319

on the lunar missions with artemis and

66

00:02:44,869 --> 00:02:43,120

then we're using all that to test the

67

00:02:46,150 --> 00:02:44,879

suits you would want to use to go to

68

00:02:48,390 --> 00:02:46,160

mars in so eventually you're going to

69

00:02:50,309 --> 00:02:48,400

have to be very independent and very

70

00:02:52,790 --> 00:02:50,319

confident in your hardware when you go

71

00:02:54,710 --> 00:02:52,800

and do a mission that far away

72

00:02:57,110 --> 00:02:54,720

one of the most obvious changes in the

73

00:02:59,430 --> 00:02:57,120

new space suit is the way astronauts get

74

00:03:01,670 --> 00:02:59,440

in and out of it donning the current

75

00:03:03,830 --> 00:03:01,680

suit is a multi-step process of

76  
00:03:05,670 --> 00:03:03,840  
wriggling into the upper torso and then

77  
00:03:08,390 --> 00:03:05,680  
getting help attaching a pair of space

78  
00:03:10,710 --> 00:03:08,400  
pants the new generation spacesuit

79  
00:03:13,509 --> 00:03:10,720  
features a hatchback where astronauts

80  
00:03:17,589 --> 00:03:13,519  
simply slide in and out of the one-piece

81  
00:03:21,670 --> 00:03:19,589  
another big feature of the suit is the

82  
00:03:23,270 --> 00:03:21,680  
way the astronauts are able to move

83  
00:03:25,509 --> 00:03:23,280  
while wearing it

84  
00:03:28,149 --> 00:03:25,519  
apollo astronauts learned they had to

85  
00:03:30,229 --> 00:03:28,159  
hop to get around on the moon

86  
00:03:34,820 --> 00:03:30,239  
the suit design sometimes made it

87  
00:03:39,030 --> 00:03:36,710  
[Music]

88  
00:03:43,509 --> 00:03:39,040

okay

89

00:03:56,550 --> 00:03:45,390

not quite

90

00:04:01,429 --> 00:03:58,710

engineers learned valuable lessons from

91

00:04:03,589 --> 00:04:01,439

those apollo suits the improved design

92

00:04:06,149 --> 00:04:03,599

for the next generation spacesuit will

93

00:04:07,350 --> 00:04:06,159

allow astronauts to walk on the moon not

94

00:04:09,830 --> 00:04:07,360

hop

95

00:04:12,390 --> 00:04:09,840

additionally astronauts will experience

96

00:04:13,830 --> 00:04:12,400

an improved range of motion

97

00:04:15,830 --> 00:04:13,840

the new suits the planetary walking

98

00:04:18,870 --> 00:04:15,840

suits we're working now we really hope

99

00:04:21,430 --> 00:04:18,880

to provide improved mobility and comfort

100

00:04:23,590 --> 00:04:21,440

along with reduced injury potential and

101  
00:04:25,590 --> 00:04:23,600  
really like i said provide the best tool

102  
00:04:27,189 --> 00:04:25,600  
to the crew member that we can provide

103  
00:04:28,870 --> 00:04:27,199  
then we want to be able to provide them

104  
00:04:30,550 --> 00:04:28,880  
the ability to kneel down and pick up a

105  
00:04:32,629 --> 00:04:30,560  
rock like they're going to do in their

106  
00:04:34,469 --> 00:04:32,639  
geology science that they're working on

107  
00:04:35,990 --> 00:04:34,479  
we want this to be a very reliable and

108  
00:04:37,749 --> 00:04:36,000  
durable suit so they can use it day

109  
00:04:39,350 --> 00:04:37,759  
after day in a dusty environment and not

110  
00:04:40,469 --> 00:04:39,360  
have to do a lot of maintenance with it

111  
00:04:42,469 --> 00:04:40,479  
while they're needing to do their

112  
00:04:44,469 --> 00:04:42,479  
mission so there's a lot of those kinds

113  
00:04:46,230 --> 00:04:44,479

of aspects that go into improving the

114

00:04:47,909 --> 00:04:46,240

suit that we're going to provide for the

115

00:04:49,990 --> 00:04:47,919

lunar missions

116

00:04:52,150 --> 00:04:50,000

improved mobility is not the only

117

00:04:54,310 --> 00:04:52,160

feature engineers have been working on

118

00:04:57,189 --> 00:04:54,320

the astronauts will also be carrying a

119

00:04:58,950 --> 00:04:57,199

special backpack known as the pliss

120

00:05:00,629 --> 00:04:58,960

the plus is the portable life support

121

00:05:02,550 --> 00:05:00,639

system it's the backpack on the

122

00:05:03,990 --> 00:05:02,560

spacesuit and it has all of the

123

00:05:05,110 --> 00:05:04,000

interesting parts to keep the crew

124

00:05:06,310 --> 00:05:05,120

member alive while they're on their

125

00:05:08,310 --> 00:05:06,320

spacewalk

126

00:05:10,870 --> 00:05:08,320

so it has oxygen

127

00:05:12,550 --> 00:05:10,880

stored as pressurized gas for breathing

128

00:05:14,550 --> 00:05:12,560

pressure regulators that regulate the

129

00:05:16,790 --> 00:05:14,560

oxygen pressure inside the spacesuit and

130

00:05:18,310 --> 00:05:16,800

then a ventilation loop and a water loop

131

00:05:20,390 --> 00:05:18,320

that we call the thermal loop that

132

00:05:22,469 --> 00:05:20,400

provide trace contaminant and carbon

133

00:05:24,390 --> 00:05:22,479

dioxide removal from the breathing

134

00:05:26,710 --> 00:05:24,400

environment and also cooling for the

135

00:05:28,870 --> 00:05:26,720

crew member and the suit on board

136

00:05:30,870 --> 00:05:28,880

avionics and electronic systems

137

00:05:32,070 --> 00:05:30,880

while the pliss has been on previous

138

00:05:34,150 --> 00:05:32,080

spacesuits

139

00:05:36,390 --> 00:05:34,160

this improved version will offer new

140

00:05:38,710 --> 00:05:36,400

technology greater control of its

141

00:05:40,629 --> 00:05:38,720

systems for the astronaut and longer

142

00:05:43,430 --> 00:05:40,639

life for each eva

143

00:05:46,070 --> 00:05:43,440

allowing more exploration the plus labs

144

00:05:48,150 --> 00:05:46,080

are awesome super fun places and we

145

00:05:50,150 --> 00:05:48,160

physically assemble the parts to build

146

00:05:51,909 --> 00:05:50,160

the life support system and then we test

147

00:05:53,990 --> 00:05:51,919

it it's our opportunity to find things

148

00:05:55,909 --> 00:05:54,000

and fix things before we get it on orbit

149

00:05:58,469 --> 00:05:55,919

we love what we do we really want to see

150

00:06:00,870 --> 00:05:58,479

the system fly and be useful and help a

151  
00:06:02,390 --> 00:06:00,880  
person explore the moon in a more

152  
00:06:03,749 --> 00:06:02,400  
capable manner than they were able to do

153  
00:06:07,670 --> 00:06:03,759  
during apollo

154  
00:06:09,990 --> 00:06:07,680  
so it's a great job

155  
00:06:11,670 --> 00:06:10,000  
so i want you to perform some isolated

156  
00:06:15,350 --> 00:06:11,680  
joint movement to understand how the

157  
00:06:20,550 --> 00:06:17,590  
testing for the new spacesuit continues

158  
00:06:22,950 --> 00:06:20,560  
underwater in the neutral buoyancy lab

159  
00:06:25,189 --> 00:06:22,960  
here the weightless environment of space

160  
00:06:27,270 --> 00:06:25,199  
can be simulated to put the suit through

161  
00:06:30,070 --> 00:06:27,280  
its paces

162  
00:06:32,150 --> 00:06:30,080  
so being able to test the suit in the

163  
00:06:33,110 --> 00:06:32,160

pool in microgravity environments allows

164

00:06:35,270 --> 00:06:33,120

us to

165

00:06:37,110 --> 00:06:35,280

iterate on our design and make it better

166

00:06:39,830 --> 00:06:37,120

and get feedback from astronauts and

167

00:06:42,469 --> 00:06:39,840

from other instructors and trainers

168

00:06:44,950 --> 00:06:42,479

could you reach all the way across and

169

00:06:48,390 --> 00:06:44,960

do the cross switches with your opposite

170

00:06:51,270 --> 00:06:48,400

arm oh yeah it's really easy to get all

171

00:06:57,029 --> 00:06:51,280

the switches with my opposite arm

172

00:07:00,390 --> 00:06:58,870

come on i know i guess it's going to get

173

00:07:03,430 --> 00:07:00,400

lower and flatter

174

00:07:06,309 --> 00:07:03,440

yeah hold on

175

00:07:09,510 --> 00:07:08,390

very good so if this could happen in

176  
00:07:12,550 --> 00:07:09,520  
real life

177  
00:07:14,790 --> 00:07:12,560  
this is a spectacular translation

178  
00:07:17,749 --> 00:07:14,800  
rex and i are very lucky it is it is

179  
00:07:19,589 --> 00:07:17,759  
like a you know brand new spacecraft

180  
00:07:25,820 --> 00:07:19,599  
even even has the new smell and

181  
00:07:31,589 --> 00:07:29,029  
[Music]

182  
00:07:35,350 --> 00:07:31,599  
spacesuits are also tested in the active

183  
00:07:38,150 --> 00:07:35,360  
response gravity offload system or argos

184  
00:07:38,950 --> 00:07:38,160  
yes so the argos electronically is able

185  
00:07:43,189 --> 00:07:38,960  
to

186  
00:07:45,350 --> 00:07:43,199  
gravity it is that we're practicing that

187  
00:07:47,350 --> 00:07:45,360  
day whether that's microgravity lunar

188  
00:07:49,189 --> 00:07:47,360

gravity or martian gravity the other

189

00:07:50,790 --> 00:07:49,199

nice thing about argos is you're able to

190

00:07:52,230 --> 00:07:50,800

get the instructors and the engineers

191

00:07:53,830 --> 00:07:52,240

right next to the astronauts as they're

192

00:07:55,110 --> 00:07:53,840

working helping the astronaut figure out

193

00:07:57,350 --> 00:07:55,120

a problem as they work through the

194

00:07:59,110 --> 00:07:57,360

development of that test for the suit or

195

00:08:00,869 --> 00:07:59,120

for a piece of hardware and get that

196

00:08:03,510 --> 00:08:00,879

real-time feedback

197

00:08:06,150 --> 00:08:03,520

spacesuit hardware is not the only thing

198

00:08:08,869 --> 00:08:06,160

being tested on earth

199

00:08:11,189 --> 00:08:08,879

nasa is looking at human performance as

200

00:08:12,950 --> 00:08:11,199

an important factor in designing evas

201  
00:08:15,830 --> 00:08:12,960  
and space suits

202  
00:08:17,189 --> 00:08:15,840  
so related to a spacesuit a lot of times

203  
00:08:18,710 --> 00:08:17,199  
people think about the actual

204  
00:08:20,710 --> 00:08:18,720  
engineering the hardware the different

205  
00:08:22,469 --> 00:08:20,720  
pieces but i want to look at the eva

206  
00:08:24,070 --> 00:08:22,479  
scenario from the human really inside

207  
00:08:26,070 --> 00:08:24,080  
the suit make sure that

208  
00:08:28,390 --> 00:08:26,080  
their performance both physically

209  
00:08:30,469 --> 00:08:28,400  
cognitively is going well so we want to

210  
00:08:33,750 --> 00:08:30,479  
look at things like physical exertion

211  
00:08:35,509 --> 00:08:33,760  
cognitive workload injury risk and

212  
00:08:38,469 --> 00:08:35,519  
really just trying to make sure that

213  
00:08:40,870 --> 00:08:38,479

they're not impaired by the eva system

214

00:08:43,430 --> 00:08:40,880

any more than they have to be the nasa

215

00:08:45,990 --> 00:08:43,440

team uses virtual reality technology

216

00:08:48,150 --> 00:08:46,000

motion capture and other tools to study

217

00:08:51,190 --> 00:08:48,160

what it takes for a human to conduct an

218

00:08:54,630 --> 00:08:51,200

eva and what we're able to do is bring

219

00:08:57,030 --> 00:08:54,640

actual no kidding data to the table that

220

00:08:59,590 --> 00:08:57,040

really removes the opinions

221

00:09:01,590 --> 00:08:59,600

that's probably our primary benefit for

222

00:09:03,030 --> 00:09:01,600

how we kind of enhance the eba community

223

00:09:04,550 --> 00:09:03,040

is we take a look at this not from a

224

00:09:06,630 --> 00:09:04,560

hardware not from an operations

225

00:09:08,710 --> 00:09:06,640

standpoint first we look first at the

226  
00:09:10,150 --> 00:09:08,720  
human and then kind of say what do they

227  
00:09:11,590 --> 00:09:10,160  
need to be able to do to be ready for

228  
00:09:13,509 --> 00:09:11,600  
the job

229  
00:09:15,829 --> 00:09:13,519  
all the work on the spacesuit here on

230  
00:09:16,790 --> 00:09:15,839  
earth is building up to the ultimate

231  
00:09:19,590 --> 00:09:16,800  
test

232  
00:09:21,430 --> 00:09:19,600  
to fly it in space

233  
00:09:23,670 --> 00:09:21,440  
so we're actually building a flight unit

234  
00:09:25,430 --> 00:09:23,680  
of that xemu and we're going to launch

235  
00:09:28,310 --> 00:09:25,440  
it to the international space station

236  
00:09:30,230 --> 00:09:28,320  
and we will do an eva with a current

237  
00:09:32,070 --> 00:09:30,240  
spacesuit and emu that we use today and

238  
00:09:33,509 --> 00:09:32,080

the xcmu with it we'll go out in pairs

239

00:09:35,350 --> 00:09:33,519

and we'll have the astronauts working

240

00:09:36,790 --> 00:09:35,360

together one in the old suit and one in

241

00:09:39,430 --> 00:09:36,800

the new suit and we'll test its

242

00:09:41,269 --> 00:09:39,440

functionality in a microgravity or a low

243

00:09:43,350 --> 00:09:41,279

gravity environment out in the vacuum of

244

00:09:44,870 --> 00:09:43,360

space that will help us test a lot of

245

00:09:47,110 --> 00:09:44,880

its systems

246

00:09:49,590 --> 00:09:47,120

the eva on the space station will set

247

00:09:51,110 --> 00:09:49,600

the stage for the future when the suit

248

00:09:53,990 --> 00:09:51,120

will need to perform a variety of

249

00:09:56,310 --> 00:09:54,000

missions beyond low earth orbit

250

00:09:59,509 --> 00:09:56,320

yeah so a great example is uh nasa's

251  
00:10:01,509 --> 00:09:59,519  
gateway so even though it is in lunar

252  
00:10:03,269 --> 00:10:01,519  
orbit it's still a microgravity platform

253  
00:10:05,350 --> 00:10:03,279  
so astronauts would still be floating in

254  
00:10:06,310 --> 00:10:05,360  
space and so we can use a lot of the

255  
00:10:08,069 --> 00:10:06,320  
lessons we learned from the

256  
00:10:10,470 --> 00:10:08,079  
international space station to do

257  
00:10:13,350 --> 00:10:10,480  
spacewalks on the gateway it's actually

258  
00:10:15,509 --> 00:10:13,360  
really advantageous to use one spacesuit

259  
00:10:17,190 --> 00:10:15,519  
both at gateway and on the lunar surface

260  
00:10:18,010 --> 00:10:17,200  
so the exploration space you can do both

261  
00:10:19,350 --> 00:10:18,020  
of those things

262  
00:10:22,230 --> 00:10:19,360  
[Music]

263  
00:10:24,470 --> 00:10:22,240

for evas on the moon the new spacesuit

264

00:10:26,630 --> 00:10:24,480

will give astronauts unprecedented

265

00:10:27,910 --> 00:10:26,640

abilities as they explore the lunar

266

00:10:29,590 --> 00:10:27,920

surface

267

00:10:31,430 --> 00:10:29,600

really this is the first time we're

268

00:10:32,790 --> 00:10:31,440

trying to bring a

269

00:10:34,949 --> 00:10:32,800

suit that's optimized for human

270

00:10:36,470 --> 00:10:34,959

performance and optimize for lunar

271

00:10:38,150 --> 00:10:36,480

exploration so that you can actually

272

00:10:39,430 --> 00:10:38,160

bend down interact with the ground so

273

00:10:40,870 --> 00:10:39,440

that you're going to have the visibility

274

00:10:42,870 --> 00:10:40,880

that you need the mobility that you need

275

00:10:44,389 --> 00:10:42,880

to accomplish these tasks

276

00:10:47,430 --> 00:10:44,399

this new suit will allow us the

277

00:10:49,750 --> 00:10:47,440

flexibility to really do exploration get

278

00:10:51,509 --> 00:10:49,760

down on the surface and send geologists

279

00:10:53,509 --> 00:10:51,519

to the surface and really let them act

280

00:10:55,509 --> 00:10:53,519

like geologists in a spacesuit this is

281

00:10:57,030 --> 00:10:55,519

the first time in history that a suit

282

00:10:59,269 --> 00:10:57,040

like that will have been created and

283

00:11:00,949 --> 00:10:59,279

it's really exciting to be part of that

284

00:11:03,430 --> 00:11:00,959

to do what nasa was meant to do and that

285

00:11:05,670 --> 00:11:03,440

is to do exploration and this suit will

286

00:11:07,030 --> 00:11:05,680

really help enable the agency go do

287

00:11:08,630 --> 00:11:07,040

exploration

288

00:11:10,550 --> 00:11:08,640

well everyone in my generation wasn't

289

00:11:12,470 --> 00:11:10,560

alive the first time we went to the moon

290

00:11:14,389 --> 00:11:12,480

and we want to do it again and we want

291

00:11:16,389 --> 00:11:14,399

to do it better we want to go do more

292

00:11:18,069 --> 00:11:16,399

science we want to stay longer we want

293

00:11:20,550 --> 00:11:18,079

to get more out of it and we have the

294

00:11:22,389 --> 00:11:20,560

technology to do it now so

295

00:11:24,470 --> 00:11:22,399

we're really excited about it

296

00:11:25,910 --> 00:11:24,480

with its new technology

297

00:11:28,870 --> 00:11:25,920

new design

298

00:11:30,790 --> 00:11:28,880

greater mobility and greater versatility

299

00:11:33,910 --> 00:11:30,800

in how it can be used

300

00:11:36,710 --> 00:11:33,920

nasa's new space walking suit is truly

301

00:11:39,660 --> 00:11:36,720

tailored for the next generation of