1
00:00:15,110 --> 00:00:06,480
[Music]

2
00:00:20,070 --> 00:00:17,990
mars is unavoidably special we've landed

3
00:00:21,269 --> 00:00:20,080
and we've scooped we've roved we've

4
00:00:24,070 --> 00:00:21,279
orbited

5
00:00:26,230 --> 00:00:24,080
together we did it but the attitude was

6
00:00:28,630 --> 00:00:26,240
together we can do it

7
00:00:31,630 --> 00:00:28,640
the future is what you make out of it

8
00:00:33,990 --> 00:00:31,640
you can make it real

9
00:00:36,790 --> 00:00:34,000
[Music]

10
00:00:38,869 --> 00:00:36,800
and here we are with mars perseverance

11
00:00:41,670 --> 00:00:38,879
51 years later getting ready to do the

12
00:00:43,590 --> 00:00:41,680
first ever mars return mission

13
00:00:45,750 --> 00:00:43,600

eventually we can bring those samples

14
00:00:46,950 --> 00:00:45,760
back to earth and determine for the very

15
00:00:48,380 --> 00:00:46,960
first time

16
00:00:55,510 --> 00:00:48,390
did life exist on mars

17
00:00:59,430 --> 00:00:57,350
good afternoon everyone and welcome to

18
00:01:01,990 --> 00:00:59,440
the nasa kennedy space center for the

19
00:01:04,789 --> 00:01:02,000
mars 2020 mission tech and humans to

20
00:01:07,510 --> 00:01:04,799
mars briefing i'm tammy long of nasa

21
00:01:10,310 --> 00:01:07,520
communications and this afternoon we are

22
00:01:13,429 --> 00:01:10,320
going to unpack some truly

23
00:01:15,109 --> 00:01:13,439
spectacular technology on board the mars

24
00:01:16,950 --> 00:01:15,119
perseverance rover

25
00:01:19,510 --> 00:01:16,960
we encourage you to follow the mission

26
00:01:21,830 --> 00:01:19,520
at nasa persevere and we would love to

27
00:01:25,190 --> 00:01:21,840
have your questions for the panel please

28
00:01:27,830 --> 00:01:25,200
use the hashtag countdown to mars

29
00:01:30,950 --> 00:01:27,840
it is my distinct privilege and honor to

30
00:01:33,830 --> 00:01:30,960
introduce this amazing panel we begin at

31
00:01:36,789 --> 00:01:33,840
nasa headquarters in washington dc with

32
00:01:38,630 --> 00:01:36,799
jim watson the director of nasa's mars

33
00:01:41,429 --> 00:01:38,640
exploration program

34
00:01:44,469 --> 00:01:41,439
live with us in studio is dr jeffrey

35
00:01:46,789 --> 00:01:44,479
shihai chief engineer of nasa's space

36
00:01:48,870 --> 00:01:46,799
technology mission directorate

37
00:01:50,710 --> 00:01:48,880
then we're blasting west and going to

38
00:01:53,749 --> 00:01:50,720

the jet propulsion laboratory in

39
00:01:56,709 --> 00:01:53,759
pasadena california for mimi ong the

40
00:01:57,990 --> 00:01:56,719
project manager of the mars ingenuity

41
00:02:00,230 --> 00:01:58,000
helicopter

42
00:02:02,870 --> 00:02:00,240
then we're launching back to the east

43
00:02:04,950 --> 00:02:02,880
coast to cambridge massachusetts to

44
00:02:07,590 --> 00:02:04,960
michael hecht he's the principal

45
00:02:10,150 --> 00:02:07,600
investigator for moxie and the associate

46
00:02:12,070 --> 00:02:10,160
director for the mit haystack

47
00:02:14,390 --> 00:02:12,080
observatory and then of course we're

48
00:02:17,430 --> 00:02:14,400
coming back south to the johnson space

49
00:02:20,229 --> 00:02:17,440
center in houston texas for amy ross

50
00:02:22,470 --> 00:02:20,239
who's a planetary spacesuit engineer i

51
00:02:24,790 --> 00:02:22,480
want that on my business card and

52
00:02:27,190 --> 00:02:24,800
finishing off with michelle rucker she

53
00:02:30,070 --> 00:02:27,200
leads a cross-agency team for

54
00:02:33,430 --> 00:02:30,080
architecture and operational concepts

55
00:02:35,990 --> 00:02:33,440
for the first human mission to mars wow

56
00:02:37,750 --> 00:02:36,000
what a panel so let's get it kicked off

57
00:02:39,750 --> 00:02:37,760
with jim at nasa headquarters who's

58
00:02:41,990 --> 00:02:39,760
going to give us a quick mars 2020

59
00:02:42,710 --> 00:02:42,000
overview and tell us where it's leading

60
00:02:51,270 --> 00:02:42,720
us

61
00:02:53,270 --> 00:02:51,280
remark those videos that you uh teed up

62
00:02:54,070 --> 00:02:53,280
this whole event with you they never get

63
00:02:56,390 --> 00:02:54,080

old

64
00:02:58,390 --> 00:02:56,400
i have a chart here that i brought along

65
00:03:00,790 --> 00:02:58,400
that sort of summarizes some of our more

66
00:03:02,630 --> 00:03:00,800
recent history and what i wanted to do

67
00:03:04,390 --> 00:03:02,640
and address this afternoon with

68
00:03:06,790 --> 00:03:04,400
everybody is explain a little bit of how

69
00:03:09,750 --> 00:03:06,800
we were able to accomplish so much

70
00:03:10,790 --> 00:03:09,760
so if you look at the past 20 years nasa

71
00:03:13,030 --> 00:03:10,800
has been

72
00:03:16,869 --> 00:03:13,040
following a very

73
00:03:19,030 --> 00:03:16,879
focused and strategic plan to explore

74
00:03:21,110 --> 00:03:19,040
mars and it's been guided by setting a

75
00:03:22,149 --> 00:03:21,120
strategy of what we call follow the

76
00:03:23,910 --> 00:03:22,159
water

77
00:03:25,350 --> 00:03:23,920
and we did that because we know that

78
00:03:28,309 --> 00:03:25,360
water is key

79
00:03:30,789 --> 00:03:28,319
for life here on earth it's also key to

80
00:03:33,350 --> 00:03:30,799
how our how the climate behaves it's

81
00:03:35,750 --> 00:03:33,360
also key to understanding how the

82
00:03:38,149 --> 00:03:35,760
surface of a planet forms

83
00:03:40,350 --> 00:03:38,159
so starting back at the

84
00:03:42,789 --> 00:03:40,360
around 2000 actually the late

85
00:03:43,910 --> 00:03:42,799
1990s we started with a series of

86
00:03:48,789 --> 00:03:43,920
orbiters

87
00:03:50,309 --> 00:03:48,799
remote sensing to capture imagery so we

88
00:03:52,789 --> 00:03:50,319

could create the maps of what the

89
00:03:54,630 --> 00:03:52,799
surface looks like what the geology

90
00:03:56,550 --> 00:03:54,640
looks like to characterize it get a

91
00:03:57,509 --> 00:03:56,560
sense for the mineralogy that's on the

92
00:03:59,509 --> 00:03:57,519
surface

93
00:04:01,990 --> 00:03:59,519
and start to form our understanding of

94
00:04:04,470 --> 00:04:02,000
how that planet may have formed and how

95
00:04:06,550 --> 00:04:04,480
that surface has evolved over the time

96
00:04:08,630 --> 00:04:06,560
but we knew to do the real serious work

97
00:04:11,589 --> 00:04:08,640
we had to get down to the surface

98
00:04:13,990 --> 00:04:11,599
so we started in 1996 we sent a very

99
00:04:15,509 --> 00:04:14,000
small rover you'd hardly recognize it

100
00:04:17,830 --> 00:04:15,519
today when you compared it with the

101
00:04:19,349 --> 00:04:17,840
perseverance rover it's a tiny little

102
00:04:22,469 --> 00:04:19,359
thing but a little bit bigger than the

103
00:04:24,870 --> 00:04:22,479
shoebox and that we landed on mars and

104
00:04:27,670 --> 00:04:24,880
that's how we first learned how to

105
00:04:30,230 --> 00:04:27,680
survive on the surface of mars and how

106
00:04:31,990 --> 00:04:30,240
to operate on the surface of mars so

107
00:04:33,670 --> 00:04:32,000
that we could do work we could do

108
00:04:35,510 --> 00:04:33,680
exploration work

109
00:04:36,790 --> 00:04:35,520
we learned a lot from that

110
00:04:39,110 --> 00:04:36,800
and so we

111
00:04:41,189 --> 00:04:39,120
established a new program

112
00:04:43,830 --> 00:04:41,199
that had the spirit and opportunity

113
00:04:45,030 --> 00:04:43,840

rovers we sent those two together as a

114
00:04:47,990 --> 00:04:45,040
pair

115
00:04:50,950 --> 00:04:48,000
and very very successful program there

116
00:04:52,950 --> 00:04:50,960
so spirit and opportunity together

117
00:04:54,390 --> 00:04:52,960
established that mars truly was

118
00:04:56,230 --> 00:04:54,400
habitable

119
00:04:58,950 --> 00:04:56,240
that it had abundant water on the

120
00:05:02,469 --> 00:04:58,960
surface in many forms in the forms of

121
00:05:05,590 --> 00:05:02,479
large lakes small lakes flowing rivers

122
00:05:07,270 --> 00:05:05,600
even hot springs so with that knowledge

123
00:05:09,350 --> 00:05:07,280
in hand and the experience that we

124
00:05:11,430 --> 00:05:09,360
gained operating these spirit and

125
00:05:13,749 --> 00:05:11,440
opportunity rovers

126
00:05:15,510 --> 00:05:13,759
we went and developed our what has been

127
00:05:18,710 --> 00:05:15,520
our flagship to date and that's the

128
00:05:21,590 --> 00:05:18,720
curiosity rover almost a metric ton in

129
00:05:24,310 --> 00:05:21,600
weight and outfitted with a lot of very

130
00:05:26,870 --> 00:05:24,320
very precise instrumentation including a

131
00:05:29,510 --> 00:05:26,880
mass spectrometer to help tell us what

132
00:05:31,830 --> 00:05:29,520
the molecular structure was of of the

133
00:05:35,270 --> 00:05:31,840
samples that we were able to probe

134
00:05:37,350 --> 00:05:35,280
we've been exploring mars since 2011

135
00:05:39,350 --> 00:05:37,360
and from that success and from the data

136
00:05:41,270 --> 00:05:39,360
that's returned from that

137
00:05:44,230 --> 00:05:41,280
we have commissioned

138
00:05:46,150 --> 00:05:44,240

the perseverance rover on the mars 2020

139
00:05:47,670 --> 00:05:46,160
project and we're going to launch that

140
00:05:49,270 --> 00:05:47,680
on thursday

141
00:05:52,469 --> 00:05:49,280
and that rover is following in the

142
00:05:54,950 --> 00:05:52,479
footsteps of that legacy of rovers so

143
00:05:57,830 --> 00:05:54,960
we'd try something first we'd learn from

144
00:05:59,430 --> 00:05:57,840
it we'd evolve new technologies apply

145
00:06:01,909 --> 00:05:59,440
them and feed forward into the next

146
00:06:03,749 --> 00:06:01,919
rover we'd learn some more feed them

147
00:06:06,309 --> 00:06:03,759
forward into the next rover and

148
00:06:08,070 --> 00:06:06,319
perseverance is no exception

149
00:06:10,710 --> 00:06:08,080
perseverance is loaded with new

150
00:06:12,469 --> 00:06:10,720
technology new operational techniques

151
00:06:14,710 --> 00:06:12,479
that we're going to experiment so that

152
00:06:17,510 --> 00:06:14,720
we can explore mars in even greater

153
00:06:20,150 --> 00:06:17,520
detail and in fact we're setting up the

154
00:06:22,710 --> 00:06:20,160
next great campaign at mars marsh sample

155
00:06:25,350 --> 00:06:22,720
return in the sense that perseverance is

156
00:06:26,950 --> 00:06:25,360
going to take samples and cache them

157
00:06:28,550 --> 00:06:26,960
and they'll be retrieved by future

158
00:06:31,029 --> 00:06:28,560
missions and bring them home to be

159
00:06:34,550 --> 00:06:31,039
studied in laboratories here on earth

160
00:06:36,390 --> 00:06:34,560
so you might ask well perseverance

161
00:06:39,189 --> 00:06:36,400
looking at new technologies that will

162
00:06:41,029 --> 00:06:39,199
enable future exploration what possibly

163
00:06:43,830 --> 00:06:41,039

do we have yet to learn

164
00:06:46,550 --> 00:06:43,840
well we still have a lot okay we still

165
00:06:48,710 --> 00:06:46,560
can't land exactly where we want to be

166
00:06:50,550 --> 00:06:48,720
the error circle for

167
00:06:53,270 --> 00:06:50,560
perseverance is on the order of 10

168
00:06:55,110 --> 00:06:53,280
kilometers when we send humans to mars

169
00:06:57,510 --> 00:06:55,120
and when we pursue

170
00:07:00,150 --> 00:06:57,520
sample return we need to land even

171
00:07:01,990 --> 00:07:00,160
closer to where we want to be than that

172
00:07:03,830 --> 00:07:02,000
so we hope to improve that yet another

173
00:07:05,909 --> 00:07:03,840
order of magnitude and so there's

174
00:07:08,150 --> 00:07:05,919
technologies that we're going to use in

175
00:07:10,070 --> 00:07:08,160
the perseverance landing we're going to

176
00:07:12,870 --> 00:07:10,080
experiment with how we can get even

177
00:07:15,189 --> 00:07:12,880
closer we've improved our algorithms for

178
00:07:16,950 --> 00:07:15,199
how we deploy our parachutes and we've

179
00:07:19,350 --> 00:07:16,960
added a new sensor

180
00:07:21,830 --> 00:07:19,360
that can view the terrain on the final

181
00:07:24,070 --> 00:07:21,840
descent and from that we can determine

182
00:07:25,589 --> 00:07:24,080
if we're flying towards hazard and take

183
00:07:27,510 --> 00:07:25,599
corrective action

184
00:07:29,589 --> 00:07:27,520
we also when we explore mars in the

185
00:07:31,510 --> 00:07:29,599
future we want to be able to live off

186
00:07:34,150 --> 00:07:31,520
the land in some respects we don't want

187
00:07:35,909 --> 00:07:34,160
to have to carry everything that we need

188
00:07:37,670 --> 00:07:35,919

and so it's going to be very important

189
00:07:41,510 --> 00:07:37,680
for future explorers

190
00:07:44,309 --> 00:07:41,520
both robotic and human to be able to get

191
00:07:46,629 --> 00:07:44,319
some substance from the planet so we

192
00:07:48,710 --> 00:07:46,639
have an experiment on board a technology

193
00:07:50,629 --> 00:07:48,720
demonstration you'll hear about today

194
00:07:52,710 --> 00:07:50,639
called moxie and it's going to extract

195
00:07:56,150 --> 00:07:52,720
oxygen from the atmosphere

196
00:07:58,469 --> 00:07:56,160
we also have an instrument on mars 2020

197
00:08:00,309 --> 00:07:58,479
as a ground penetrating radar and we're

198
00:08:03,189 --> 00:08:00,319
going to start to probe the upper 10

199
00:08:05,029 --> 00:08:03,199
meters or so of the surface of mars

200
00:08:07,029 --> 00:08:05,039
understand the soil structure and the

201
00:08:09,909 --> 00:08:07,039
rock structure and start to do the

202
00:08:11,430 --> 00:08:09,919
necessary civil engineering then we will

203
00:08:13,909 --> 00:08:11,440
have to know

204
00:08:15,990 --> 00:08:13,919
whether that soil can support the larger

205
00:08:18,390 --> 00:08:16,000
landers that humans will take in the

206
00:08:20,309 --> 00:08:18,400
future that go to mars we also need to

207
00:08:22,070 --> 00:08:20,319
forecast the weather better

208
00:08:24,469 --> 00:08:22,080
okay if you recall

209
00:08:26,869 --> 00:08:24,479
not too long ago we lost the opportunity

210
00:08:29,110 --> 00:08:26,879
rover and we lost it because there was a

211
00:08:31,189 --> 00:08:29,120
planet enveloping dust storm that

212
00:08:33,350 --> 00:08:31,199
obscured the sunlight that can no longer

213
00:08:35,350 --> 00:08:33,360

charges battery when we have human

214
00:08:38,149 --> 00:08:35,360
explorers on mars we want to be able to

215
00:08:40,230 --> 00:08:38,159
forecast these before they happen so we

216
00:08:41,269 --> 00:08:40,240
can take precautions for the safety of

217
00:08:42,870 --> 00:08:41,279
the crew

218
00:08:45,590 --> 00:08:42,880
and lastly

219
00:08:47,829 --> 00:08:45,600
we need to be able to come home

220
00:08:50,870 --> 00:08:47,839
from our sample return the first round

221
00:08:53,829 --> 00:08:50,880
trip to another planet that will be the

222
00:08:55,190 --> 00:08:53,839
first time using robotic systems that we

223
00:08:57,509 --> 00:08:55,200
land

224
00:08:59,350 --> 00:08:57,519
get samples from another mission get the

225
00:09:00,550 --> 00:08:59,360
treasure that we're that we find in

226
00:09:02,870 --> 00:09:00,560
exploring

227
00:09:05,030 --> 00:09:02,880
and launch them back into mars orbit and

228
00:09:07,350 --> 00:09:05,040
then ultimately bring them home to earth

229
00:09:09,750 --> 00:09:07,360
we want to run those trap lines if you

230
00:09:11,910 --> 00:09:09,760
will with robotic systems before we

231
00:09:14,230 --> 00:09:11,920
develop the larger and more expensive

232
00:09:15,269 --> 00:09:14,240
and more capable human systems so you're

233
00:09:17,590 --> 00:09:15,279
going to hear about some of these

234
00:09:19,430 --> 00:09:17,600
technologies this afternoon they're very

235
00:09:23,110 --> 00:09:19,440
exciting and they all contribute to the

236
00:09:28,070 --> 00:09:25,269
thank you jim for setting up our mission

237
00:09:29,910 --> 00:09:28,080
2020 for the overview and now we would

238
00:09:31,509 --> 00:09:29,920

like to ask jeff

239
00:09:33,269 --> 00:09:31,519
to talk about some of the new

240
00:09:35,509 --> 00:09:33,279
technologies that are being featured in

241
00:09:37,590 --> 00:09:35,519
the mars 2020 mission

242
00:09:40,230 --> 00:09:37,600
well the agency understands that

243
00:09:42,870 --> 00:09:40,240
technology drives exploration and in the

244
00:09:46,310 --> 00:09:42,880
space technology mission director we're

245
00:09:49,030 --> 00:09:46,320
super excited to have some technologies

246
00:09:50,710 --> 00:09:49,040
on board the mars 2020 mission and the

247
00:09:53,430 --> 00:09:50,720
perseverance rover

248
00:09:55,750 --> 00:09:53,440
jim laid out the the uh

249
00:09:57,430 --> 00:09:55,760
the plan for this mission and and uh

250
00:09:59,990 --> 00:09:57,440
highlighted some of these technologies

251
00:10:01,829 --> 00:10:00,000
that are being included on the on the

252
00:10:04,150 --> 00:10:01,839
mission and and and will go to the

253
00:10:05,590 --> 00:10:04,160
surface with the rover this mission will

254
00:10:08,310 --> 00:10:05,600
contribute to

255
00:10:10,389 --> 00:10:08,320
enabling human exploration by

256
00:10:13,030 --> 00:10:10,399
giving us technology that can help us

257
00:10:14,790 --> 00:10:13,040
land more precisely and more hazardous

258
00:10:17,110 --> 00:10:14,800
locations a lot of the interesting

259
00:10:19,190 --> 00:10:17,120
places you want to explore on mars are

260
00:10:21,829 --> 00:10:19,200
also hazardous places to land your

261
00:10:23,670 --> 00:10:21,839
spacecraft and so having uh precise

262
00:10:26,150 --> 00:10:23,680
landing technology is really important

263
00:10:29,269 --> 00:10:26,160

it'll provide technologies that will

264
00:10:31,590 --> 00:10:29,279
allow us to live off the land to utilize

265
00:10:33,509 --> 00:10:31,600
resources that we find on mars

266
00:10:35,829 --> 00:10:33,519
to make commodities that we need to do

267
00:10:38,310 --> 00:10:35,839
exploration missions and even as jim

268
00:10:40,949 --> 00:10:38,320
mentioned to forecast the weather

269
00:10:42,550 --> 00:10:40,959
we've worked with a variety of partners

270
00:10:44,150 --> 00:10:42,560
science mission directorate human

271
00:10:45,269 --> 00:10:44,160
exploration operations mission

272
00:10:48,069 --> 00:10:45,279
directorate

273
00:10:51,350 --> 00:10:48,079
several the nasa field centers even the

274
00:10:53,990 --> 00:10:51,360
spanish national research council on

275
00:10:55,509 --> 00:10:54,000
these technologies and there are four

276
00:10:57,350 --> 00:10:55,519
particular items that i'd like to

277
00:10:59,910 --> 00:10:57,360
highlight for you today

278
00:11:02,630 --> 00:10:59,920
two of these will be utilized during the

279
00:11:04,630 --> 00:11:02,640
entry descent and landing phase of the

280
00:11:07,030 --> 00:11:04,640
mission those seven minutes of terror

281
00:11:09,190 --> 00:11:07,040
when the spacecraft first enters the

282
00:11:10,790 --> 00:11:09,200
atmosphere and then is descending all

283
00:11:12,550 --> 00:11:10,800
the way to the surface

284
00:11:15,030 --> 00:11:12,560
and then the other two technologies will

285
00:11:17,110 --> 00:11:15,040
be utilized when we reach the surface

286
00:11:18,389 --> 00:11:17,120
during the surface operations of the

287
00:11:20,150 --> 00:11:18,399
rover

288
00:11:21,910 --> 00:11:20,160

the first of the technologies i want to

289
00:11:23,350 --> 00:11:21,920
highlight is called

290
00:11:25,269 --> 00:11:23,360
medley ii

291
00:11:27,350 --> 00:11:25,279
that stands for mars

292
00:11:29,269 --> 00:11:27,360
entry descent and landing

293
00:11:31,750 --> 00:11:29,279
instrumentation and it's the second

294
00:11:32,949 --> 00:11:31,760
round for this we have an image that i'd

295
00:11:35,990 --> 00:11:32,959
like to show

296
00:11:38,230 --> 00:11:36,000
that shows the spacecraft you can see

297
00:11:39,910 --> 00:11:38,240
there the heat shield on the bottom and

298
00:11:42,150 --> 00:11:39,920
the back what they call the back shell

299
00:11:43,910 --> 00:11:42,160
on the top and embedded in the heat

300
00:11:45,910 --> 00:11:43,920
shield and the back shell

301
00:11:48,790 --> 00:11:45,920
are a number of instruments there's

302
00:11:50,470 --> 00:11:48,800
thermocouples there's heat flux sensors

303
00:11:52,230 --> 00:11:50,480
and there's pressure transducers and

304
00:11:53,829 --> 00:11:52,240
they collect data

305
00:11:56,230 --> 00:11:53,839
at the various locations on the heat

306
00:11:58,069 --> 00:11:56,240
shield during the descent and the back

307
00:11:59,470 --> 00:11:58,079
show during the descent through the

308
00:12:00,629 --> 00:11:59,480
atmosphere

309
00:12:03,190 --> 00:12:00,639
[Music]

310
00:12:06,230 --> 00:12:03,200
on those last seven minutes of flight

311
00:12:09,190 --> 00:12:06,240
when we take measurements of this nature

312
00:12:11,350 --> 00:12:09,200
we answer a lot of questions and when we

313
00:12:13,750 --> 00:12:11,360

look at the data we realize that we have

314
00:12:15,990 --> 00:12:13,760
new questions and so medley ii

315
00:12:19,190 --> 00:12:16,000
builds on the heritage of the

316
00:12:21,110 --> 00:12:19,200
2012 landing of curiosity where we had

317
00:12:23,190 --> 00:12:21,120
similar types of in

318
00:12:24,949 --> 00:12:23,200
instrumentation not in all the same

319
00:12:27,829 --> 00:12:24,959
locations

320
00:12:29,670 --> 00:12:27,839
on that flight and we learned a lot and

321
00:12:31,590 --> 00:12:29,680
we raised some new questions and some of

322
00:12:34,629 --> 00:12:31,600
those questions we're going to answer

323
00:12:36,710 --> 00:12:34,639
on this flight the way we use the data

324
00:12:39,110 --> 00:12:36,720
is to validate models

325
00:12:41,430 --> 00:12:39,120
that that we use when we develop new

326
00:12:43,670 --> 00:12:41,440
spacecraft that we want to land on mars

327
00:12:46,230 --> 00:12:43,680
jim showed the progression of rovers

328
00:12:48,949 --> 00:12:46,240
from small little rovers to

329
00:12:51,430 --> 00:12:48,959
things like perseverance that the size

330
00:12:53,750 --> 00:12:51,440
maybe of a small suv

331
00:12:55,430 --> 00:12:53,760
well for human exploration

332
00:12:58,150 --> 00:12:55,440
we're going to have to land something

333
00:13:00,710 --> 00:12:58,160
the size of a two-story condominium on

334
00:13:01,509 --> 00:13:00,720
mars something that weighs 20 tons or

335
00:13:04,069 --> 00:13:01,519
more

336
00:13:06,710 --> 00:13:04,079
not just a ton and so i mean it's

337
00:13:09,030 --> 00:13:06,720
amazing to be able to land a ton

338
00:13:12,150 --> 00:13:09,040

on mars but eventually we're gonna have

339
00:13:14,069 --> 00:13:12,160
to land 20 tons on mars and so

340
00:13:15,990 --> 00:13:14,079
as we design the new

341
00:13:17,670 --> 00:13:16,000
landing systems and the new spacecraft

342
00:13:19,030 --> 00:13:17,680
that we have on mars it's important to

343
00:13:23,190 --> 00:13:19,040
be able to model

344
00:13:26,470 --> 00:13:24,470
portion of the

345
00:13:28,470 --> 00:13:26,480
of the mission and make sure that we can

346
00:13:30,550 --> 00:13:28,480
land those systems safely so the data we

347
00:13:32,790 --> 00:13:30,560
get from medley ii will be able to

348
00:13:35,350 --> 00:13:32,800
provide that validation for entry

349
00:13:36,870 --> 00:13:35,360
descent and landing models

350
00:13:39,030 --> 00:13:36,880
another technology that i want to

351
00:13:41,750 --> 00:13:39,040
highlight is called terrain

352
00:13:44,870 --> 00:13:41,760
relative navigation it allows us to

353
00:13:46,550 --> 00:13:44,880
pinpoint the landing zone on mars and

354
00:13:49,189 --> 00:13:46,560
this is a technology that will allow us

355
00:13:51,750 --> 00:13:49,199
to land more accurately in the locations

356
00:13:54,150 --> 00:13:51,760
we want and in more hazardous locations

357
00:13:55,990 --> 00:13:54,160
you know in apollo 11

358
00:13:58,069 --> 00:13:56,000
neil armstrong looked out the window and

359
00:13:59,590 --> 00:13:58,079
said i don't really like where we're

360
00:14:01,910 --> 00:13:59,600
headed here

361
00:14:03,790 --> 00:14:01,920
or something very close to that and and

362
00:14:06,870 --> 00:14:03,800
so he took over control from the

363
00:14:09,670 --> 00:14:06,880

automated guidance system of the lunar

364
00:14:11,509 --> 00:14:09,680
lander and guided it past the crater

365
00:14:13,750 --> 00:14:11,519
guided it past some large boulders so

366
00:14:16,069 --> 00:14:13,760
that he could land safely at the sea of

367
00:14:18,150 --> 00:14:16,079
tranquility well we don't have neil

368
00:14:20,870 --> 00:14:18,160
armstrong or any other astronaut on

369
00:14:23,269 --> 00:14:20,880
board the perseverance landing but we do

370
00:14:25,750 --> 00:14:23,279
have terrain relative navigation and it

371
00:14:29,110 --> 00:14:25,760
provides us with two very important

372
00:14:32,550 --> 00:14:29,120
things one is better knowledge of where

373
00:14:34,949 --> 00:14:32,560
is perseverance over the surface of the

374
00:14:37,430 --> 00:14:34,959
of the landing zone and then the ability

375
00:14:39,430 --> 00:14:37,440
to divert if we see that we're headed

376
00:14:41,269 --> 00:14:39,440
toward

377
00:14:44,069 --> 00:14:41,279
an unfavorable landing area just like

378
00:14:46,310 --> 00:14:44,079
neil armstrong did on apollo 11. it has

379
00:14:48,550 --> 00:14:46,320
a lander vision system that compares

380
00:14:50,150 --> 00:14:48,560
images and actually we have an animation

381
00:14:53,350 --> 00:14:50,160
of this that we can show

382
00:14:56,230 --> 00:14:53,360
it compares images of the landing site

383
00:14:57,509 --> 00:14:56,240
that that's that are being taken as the

384
00:14:59,829 --> 00:14:57,519
spacecraft descends through the

385
00:15:03,030 --> 00:14:59,839
atmosphere with maps that have been

386
00:15:05,670 --> 00:15:03,040
prepared from orbital missions and and

387
00:15:08,629 --> 00:15:05,680
so it can get some information on where

388
00:15:11,350 --> 00:15:08,639

it is over the surface of mars then that

389
00:15:13,509 --> 00:15:11,360
information is fed into a safe target

390
00:15:15,590 --> 00:15:13,519
selection system that calculates where

391
00:15:18,310 --> 00:15:15,600
the rover is going to touch down

392
00:15:20,949 --> 00:15:18,320
and then compares images with different

393
00:15:23,590 --> 00:15:20,959
maps that have

394
00:15:26,310 --> 00:15:23,600
identified in the maps the safe landing

395
00:15:28,230 --> 00:15:26,320
zones and also especially bad landing

396
00:15:30,790 --> 00:15:28,240
zones and so if it sees that

397
00:15:31,910 --> 00:15:30,800
perseverance is headed toward a bad site

398
00:15:33,509 --> 00:15:31,920
it can

399
00:15:34,389 --> 00:15:33,519
institute a divert

400
00:15:36,629 --> 00:15:34,399
the

401
00:15:39,030 --> 00:15:36,639
landing system thrusters will fire and

402
00:15:40,470 --> 00:15:39,040
move the spacecraft toward a more safe

403
00:15:42,550 --> 00:15:40,480
landing site

404
00:15:44,710 --> 00:15:42,560
this is uh the kind of technology that

405
00:15:47,749 --> 00:15:44,720
we'll need as jim mentioned to

406
00:15:50,069 --> 00:15:47,759
land several assets in close proximity

407
00:15:53,509 --> 00:15:50,079
to each other in order to enable human

408
00:15:55,350 --> 00:15:53,519
exploration at some future day so i've

409
00:15:57,350 --> 00:15:55,360
talked about two technologies that will

410
00:15:59,590 --> 00:15:57,360
be used during the entry descent and

411
00:16:01,910 --> 00:15:59,600
landing portion of the mission during

412
00:16:03,829 --> 00:16:01,920
operations on the surface there are two

413
00:16:05,269 --> 00:16:03,839

additional key technologies that i want

414
00:16:08,470 --> 00:16:05,279
to highlight

415
00:16:11,110 --> 00:16:08,480
the first of these is called meta meda

416
00:16:13,749 --> 00:16:11,120
it stands for mars environmental

417
00:16:15,990 --> 00:16:13,759
dynamics analyzer it's a contribution

418
00:16:18,629 --> 00:16:16,000
from the spanish national research

419
00:16:20,949 --> 00:16:18,639
council with funding from

420
00:16:23,030 --> 00:16:20,959
nasa particularly the space technology

421
00:16:24,150 --> 00:16:23,040
mission directorate it's a collection of

422
00:16:26,629 --> 00:16:24,160
sensors

423
00:16:29,189 --> 00:16:26,639
that are designed to detect the

424
00:16:31,670 --> 00:16:29,199
amount and the size of dust particles in

425
00:16:34,150 --> 00:16:31,680
the atmosphere on mars as well as make a

426
00:16:36,150 --> 00:16:34,160
bunch of weather

427
00:16:37,509 --> 00:16:36,160
measurements kind of similar to what you

428
00:16:40,310 --> 00:16:37,519
might make with your

429
00:16:42,389 --> 00:16:40,320
uh weather system in the backyard it'll

430
00:16:43,350 --> 00:16:42,399
it'll measure the temperature both the

431
00:16:45,509 --> 00:16:43,360
air temperature and the ground

432
00:16:47,430 --> 00:16:45,519
temperature it'll measure the humidity

433
00:16:50,710 --> 00:16:47,440
it'll measure the atmospheric pressure

434
00:16:52,069 --> 00:16:50,720
it'll measure the solar radiation and

435
00:16:53,910 --> 00:16:52,079
and then it will accumulate all that

436
00:16:56,310 --> 00:16:53,920
data and it'll

437
00:16:58,629 --> 00:16:56,320
will be able to determine how

438
00:17:00,870 --> 00:16:58,639

the environment the weather environment

439
00:17:04,150 --> 00:17:00,880
the environment that we find on mars

440
00:17:07,189 --> 00:17:04,160
affects the performance of systems on

441
00:17:09,510 --> 00:17:07,199
perseverance and then ultimately when we

442
00:17:11,270 --> 00:17:09,520
land astronauts on mars and one of them

443
00:17:13,110 --> 00:17:11,280
turns to another and says hey what's the

444
00:17:15,189 --> 00:17:13,120
weather like today they'll be able to

445
00:17:16,949 --> 00:17:15,199
have a weather forecast of what the

446
00:17:19,590 --> 00:17:16,959
weather's like on mars

447
00:17:21,110 --> 00:17:19,600
the last technology

448
00:17:23,029 --> 00:17:21,120
it's i didn't leave it for last because

449
00:17:25,029 --> 00:17:23,039
it's the least

450
00:17:27,590 --> 00:17:25,039
i left it for last because

451
00:17:29,029 --> 00:17:27,600
mike hecht the principal investigator

452
00:17:30,789 --> 00:17:29,039
will be talking about it in just a

453
00:17:32,150 --> 00:17:30,799
little bit and so i don't want to steal

454
00:17:34,710 --> 00:17:32,160
too much of his thunder but i'll just

455
00:17:36,390 --> 00:17:34,720
mention it jim watson mentioned it also

456
00:17:38,710 --> 00:17:36,400
it's called moxie

457
00:17:40,310 --> 00:17:38,720
the name of it uh kind of invokes a

458
00:17:42,950 --> 00:17:40,320
certain kind of attitude that i think is

459
00:17:45,590 --> 00:17:42,960
appropriate for this kind of ambitious

460
00:17:46,710 --> 00:17:45,600
mission it's the first

461
00:17:50,230 --> 00:17:46,720
ever

462
00:17:51,909 --> 00:17:50,240
in-situ resource utilization experiment

463
00:17:53,669 --> 00:17:51,919

on another planet

464
00:17:56,789 --> 00:17:53,679
it's going to suck in the atmosphere of

465
00:17:58,549 --> 00:17:56,799
mars and turn it into oxygen i saved it

466
00:17:59,510 --> 00:17:58,559
for last because mike will talk about it

467
00:18:01,029 --> 00:17:59,520
and and

468
00:18:03,669 --> 00:18:01,039
i'm sure he's eager to tell you about it

469
00:18:06,070 --> 00:18:03,679
so i won't say any more about moxie but

470
00:18:07,270 --> 00:18:06,080
i'll just close by saying that space

471
00:18:09,590 --> 00:18:07,280
technology

472
00:18:11,669 --> 00:18:09,600
mission directorate is excited to be

473
00:18:14,230 --> 00:18:11,679
part of this fabulous mission i want to

474
00:18:15,750 --> 00:18:14,240
thank jim and his colleagues at science

475
00:18:17,909 --> 00:18:15,760
mission director for letting our

476
00:18:19,270 --> 00:18:17,919
technologies ride along with them and

477
00:18:21,110 --> 00:18:19,280
thank you all for letting me describe

478
00:18:23,110 --> 00:18:21,120
them to you

479
00:18:25,110 --> 00:18:23,120
thank you jim for a non-technical mere

480
00:18:26,950 --> 00:18:25,120
mortal like myself

481
00:18:28,630 --> 00:18:26,960
it is absolutely mind-blowing the

482
00:18:31,110 --> 00:18:28,640
technology we're sending on the mars

483
00:18:32,630 --> 00:18:31,120
perseverance rover and on that note

484
00:18:34,950 --> 00:18:32,640
we're going to the jet propulsion

485
00:18:38,070 --> 00:18:34,960
laboratory to speak with mimi who's

486
00:18:40,630 --> 00:18:38,080
going to take us to an introduction

487
00:18:46,789 --> 00:18:40,640
for the mars ingenuity helicopter

488
00:18:50,230 --> 00:18:48,470

thank you tammy

489
00:18:53,110 --> 00:18:50,240
hi so this is

490
00:18:54,950 --> 00:18:53,120
full-scale model of the mars helicopter

491
00:18:56,789 --> 00:18:54,960
ingenuity

492
00:18:58,230 --> 00:18:56,799
so the mars helicopter technology

493
00:19:01,350 --> 00:18:58,240
demonstration

494
00:19:03,669 --> 00:19:01,360
on mars 2020 will attempt the very first

495
00:19:05,669 --> 00:19:03,679
rotograph flight at mars

496
00:19:07,830 --> 00:19:05,679
in fact we as human beings have never

497
00:19:09,990 --> 00:19:07,840
flown a rotograph outside of our own

498
00:19:12,390 --> 00:19:10,000
earth's atmosphere so this will actually

499
00:19:14,870 --> 00:19:12,400
be a very much a wright brothers moment

500
00:19:17,590 --> 00:19:14,880
except on another planet

501
00:19:19,350 --> 00:19:17,600
well flying a rotograph at mars is

502
00:19:21,430 --> 00:19:19,360
very difficult

503
00:19:22,870 --> 00:19:21,440
first and foremost the atmosphere there

504
00:19:24,470 --> 00:19:22,880
is very thin

505
00:19:27,110 --> 00:19:24,480
about one percent compared to the

506
00:19:29,909 --> 00:19:27,120
earth's atmospheric density here

507
00:19:31,909 --> 00:19:29,919
and so to build a vehicle that can fly

508
00:19:34,390 --> 00:19:31,919
at mars it has to be very light and be

509
00:19:37,029 --> 00:19:34,400
able to spin very fast

510
00:19:39,669 --> 00:19:37,039
so going on to the model here of our

511
00:19:41,830 --> 00:19:39,679
solution okay there is a

512
00:19:44,150 --> 00:19:41,840
solar panel that will garner

513
00:19:45,990 --> 00:19:44,160

solar energy from the sun

514
00:19:47,590 --> 00:19:46,000
there is an antenna for wireless

515
00:19:49,430 --> 00:19:47,600
communication

516
00:19:52,310 --> 00:19:49,440
it has a rotor system

517
00:19:54,710 --> 00:19:52,320
ingenuity has a 1.2 meter diameter rotor

518
00:19:56,789 --> 00:19:54,720
system two pairs of counter rotating

519
00:20:00,310 --> 00:19:56,799
blades they'll spin

520
00:20:02,870 --> 00:20:00,320
about 2400 revolutions per minute

521
00:20:04,710 --> 00:20:02,880
and under here is a fuselage that

522
00:20:08,149 --> 00:20:04,720
contains a battery that will store the

523
00:20:10,789 --> 00:20:08,159
energy gathered by the solar cells and

524
00:20:13,590 --> 00:20:10,799
it's surrounded by custom lightweight

525
00:20:16,710 --> 00:20:13,600
circuit boards that will perform onboard

526
00:20:18,710 --> 00:20:16,720
autonomous flight and landing on boards

527
00:20:20,390 --> 00:20:18,720
management of the thermal the

528
00:20:22,310 --> 00:20:20,400
temperature based on the temperature

529
00:20:23,669 --> 00:20:22,320
sensors it will manage the onboard

530
00:20:25,350 --> 00:20:23,679
energy it will perform the

531
00:20:27,350 --> 00:20:25,360
telecommunication

532
00:20:29,510 --> 00:20:27,360
and the fuse at large is also equipped

533
00:20:30,950 --> 00:20:29,520
with on-board sensors

534
00:20:33,990 --> 00:20:30,960
cameras

535
00:20:35,510 --> 00:20:34,000
accelerometer gyros inclinometer

536
00:20:38,549 --> 00:20:35,520
and an altimeter

537
00:20:40,630 --> 00:20:38,559
to for the vehicle to use on with an

538
00:20:42,470 --> 00:20:40,640

onboard estimation of the state for the

539
00:20:44,149 --> 00:20:42,480
onboard autonomous flight

540
00:20:45,029 --> 00:20:44,159
and then the vehicle has the landing

541
00:20:47,590 --> 00:20:45,039
gear

542
00:20:51,669 --> 00:20:47,600
the entire vehicle that you see here

543
00:20:54,310 --> 00:20:51,679
weighs in just under 1.8 kilogram that's

544
00:20:56,710 --> 00:20:54,320
just about four pounds and that's been

545
00:20:58,070 --> 00:20:56,720
the very beginning fundamental challenge

546
00:21:01,669 --> 00:20:58,080
of building

547
00:21:03,590 --> 00:21:01,679
a rotorcraft that can fly at mars so

548
00:21:06,230 --> 00:21:03,600
there is a significant team behind

549
00:21:08,070 --> 00:21:06,240
making this happen i'm very happy to be

550
00:21:08,950 --> 00:21:08,080
here on behalf of the team

551
00:21:11,750 --> 00:21:08,960
and

552
00:21:13,510 --> 00:21:11,760
this 1.8 kilogram challenge

553
00:21:16,310 --> 00:21:13,520
you know is tackled by this large team

554
00:21:18,789 --> 00:21:16,320
across from jpl multiple sensors at

555
00:21:20,870 --> 00:21:18,799
multiple centers across nasa and

556
00:21:22,789 --> 00:21:20,880
critical industrial partners

557
00:21:24,950 --> 00:21:22,799
and we worked very tightly together

558
00:21:27,590 --> 00:21:24,960
rolled up our sleeps we had to set aside

559
00:21:29,110 --> 00:21:27,600
our traditional technical boundaries

560
00:21:31,510 --> 00:21:29,120
that we have from our individual

561
00:21:32,310 --> 00:21:31,520
disciplines of engineering to really

562
00:21:35,430 --> 00:21:32,320
come

563
00:21:38,070 --> 00:21:35,440

forward with this tight-knit solution to

564
00:21:40,710 --> 00:21:38,080
meet this ultimate 1.8 kilogram limit

565
00:21:43,029 --> 00:21:40,720
and we are very happy it weighed in just

566
00:21:44,390 --> 00:21:43,039
a hair under 1.8 kilogram

567
00:21:46,710 --> 00:21:44,400
so since then

568
00:21:50,070 --> 00:21:46,720
the mars helicopter ingenuity has been

569
00:21:51,430 --> 00:21:50,080
tested in mars-like uh environments and

570
00:21:53,510 --> 00:21:51,440
we have flown it in mars like

571
00:21:55,750 --> 00:21:53,520
atmospheric density here at jpl the

572
00:21:58,470 --> 00:21:55,760
space simulator chamber

573
00:22:01,990 --> 00:21:58,480
and so with the tests all tests possible

574
00:22:04,470 --> 00:22:02,000
done at mars the next thing to do is to

575
00:22:07,270 --> 00:22:04,480
test the mods ingenuity in the real

576
00:22:09,669 --> 00:22:07,280
environment that is being designed and

577
00:22:10,950 --> 00:22:09,679
done testing for on earth the next

578
00:22:14,230 --> 00:22:10,960
destination

579
00:22:16,390 --> 00:22:14,240
launch in space and at mars so at this

580
00:22:18,870 --> 00:22:16,400
very moment helicopter ingenuity is

581
00:22:21,270 --> 00:22:18,880
accommodated on perseverance rover

582
00:22:25,510 --> 00:22:21,280
waiting for launch and if we could play

583
00:22:30,549 --> 00:22:28,230
after perseverance rover lands and

584
00:22:31,669 --> 00:22:30,559
deploys the helicopter to the surface of

585
00:22:34,390 --> 00:22:31,679
mars

586
00:22:35,510 --> 00:22:34,400
we have 30 martian days planned to

587
00:22:37,270 --> 00:22:35,520
perform

588
00:22:40,070 --> 00:22:37,280

our flight experiments

589
00:22:43,830 --> 00:22:40,080
these will be the very first rotograph

590
00:22:47,110 --> 00:22:43,840
test flight on another planet so

591
00:22:50,070 --> 00:22:47,120
very exciting days ahead for our team

592
00:22:52,549 --> 00:22:50,080
and in fact this is truly the highest

593
00:22:55,190 --> 00:22:52,559
high reward phase of our project we've

594
00:22:58,390 --> 00:22:55,200
tested everything we can on earth and

595
00:23:01,270 --> 00:22:58,400
from launch forward every event we have

596
00:23:05,669 --> 00:23:01,280
will be the very first

597
00:23:07,590 --> 00:23:05,679
remotely operated activities in space

598
00:23:08,470 --> 00:23:07,600
during cruise and all the way to the

599
00:23:09,909 --> 00:23:08,480
surface

600
00:23:12,870 --> 00:23:09,919
and so

601
00:23:15,110 --> 00:23:12,880
that's a very high risk but very high

602
00:23:17,510 --> 00:23:15,120
reward because all our mathematical

603
00:23:20,390 --> 00:23:17,520
algorithms the tests that we have done

604
00:23:22,549 --> 00:23:20,400
and the actual hands-on experience and

605
00:23:25,590 --> 00:23:22,559
learning from operating this very first

606
00:23:29,029 --> 00:23:25,600
aerial vehicle in space they will feed

607
00:23:31,110 --> 00:23:29,039
directly into future generations of

608
00:23:32,470 --> 00:23:31,120
rotor crafts of much more sophisticated

609
00:23:34,710 --> 00:23:32,480
series as

610
00:23:36,310 --> 00:23:34,720
jim and jeff describe just as a little

611
00:23:39,510 --> 00:23:36,320
sojourner

612
00:23:41,350 --> 00:23:39,520
rover was a tech demo that showed how a

613
00:23:43,830 --> 00:23:41,360

rover could work and followed by

614
00:23:46,950 --> 00:23:43,840
generations of much more sophisticated

615
00:23:49,350 --> 00:23:46,960
generations of rovers this mars

616
00:23:52,230 --> 00:23:49,360
helicopter ingenuity

617
00:23:54,149 --> 00:23:52,240
could lead to the opening up a whole new

618
00:23:56,710 --> 00:23:54,159
way to explore

619
00:23:58,950 --> 00:23:56,720
space exploration missions to the aerial

620
00:23:59,669 --> 00:23:58,960
dimension so we're very excited about it

621
00:24:02,630 --> 00:23:59,679
and

622
00:24:04,070 --> 00:24:02,640
thank you for having our team i'm glad

623
00:24:08,310 --> 00:24:04,080
to be here to represent our team and i'm

624
00:24:12,149 --> 00:24:10,390
thank you mimi you can be sure that

625
00:24:14,230 --> 00:24:12,159
we've all got our fingers crossed that

626
00:24:16,470 --> 00:24:14,240
ingenuity is going to fly what an

627
00:24:18,630 --> 00:24:16,480
amazing experiment

628
00:24:21,110 --> 00:24:18,640
and so now we're going to fly across the

629
00:24:23,669 --> 00:24:21,120
states from jpl to cambridge

630
00:24:26,710 --> 00:24:23,679
massachusetts where michael hecht is

631
00:24:28,870 --> 00:24:26,720
going to explain what the moxie is what

632
00:24:30,549 --> 00:24:28,880
it does and why it's so important hello

633
00:24:32,630 --> 00:24:30,559
michael

634
00:24:35,590 --> 00:24:32,640
hello tammy thank you very much uh

635
00:24:37,110 --> 00:24:35,600
thanks all of you who are listening and

636
00:24:38,549 --> 00:24:37,120
uh a shout out to the media in

637
00:24:39,590 --> 00:24:38,559
particular we couldn't do this without

638
00:24:40,950 --> 00:24:39,600

you

639
00:24:42,870 --> 00:24:40,960
somewhere out there

640
00:24:44,630 --> 00:24:42,880
i'm at home obviously many of you are at

641
00:24:47,029 --> 00:24:44,640
home and some are out there maybe among

642
00:24:51,190 --> 00:24:47,039
the younger folks uh there's someone who

643
00:24:53,029 --> 00:24:51,200
will someday go to mars okay um 15 20 25

644
00:24:54,870 --> 00:24:53,039
years it's going to happen

645
00:24:56,230 --> 00:24:54,880
and when you go you know think about it

646
00:24:57,750 --> 00:24:56,240
you'll need things you'll need a place

647
00:24:59,269 --> 00:24:57,760
to live you'll need

648
00:25:01,590 --> 00:24:59,279
a way to breathe you need a way to get

649
00:25:03,350 --> 00:25:01,600
around and you'll need a way to get home

650
00:25:04,230 --> 00:25:03,360
and the first leg of getting home is

651
00:25:06,470 --> 00:25:04,240
getting

652
00:25:09,750 --> 00:25:06,480
on a rocket and being lifted from the

653
00:25:12,310 --> 00:25:09,760
ground to orbit so all those things it

654
00:25:14,390 --> 00:25:12,320
turns out the single heaviest thing

655
00:25:15,510 --> 00:25:14,400
you'll need

656
00:25:19,029 --> 00:25:15,520
is a

657
00:25:22,149 --> 00:25:19,039
great big tank of liquid oxygen

658
00:25:23,510 --> 00:25:22,159
so that the rocket can breathe not so

659
00:25:25,350 --> 00:25:23,520
you can breathe you need to breathe but

660
00:25:27,990 --> 00:25:25,360
you don't breathe very much compared to

661
00:25:30,149 --> 00:25:28,000
a rocket okay a rocket breathes a lot

662
00:25:33,269 --> 00:25:30,159
and what do i mean by that

663
00:25:34,630 --> 00:25:33,279

anything that burns fuel breathes

664
00:25:36,549 --> 00:25:34,640
whether it's you

665
00:25:39,029 --> 00:25:36,559
a fire you know if you shut off the air

666
00:25:41,510 --> 00:25:39,039
the fire goes out a jet plane or a

667
00:25:43,990 --> 00:25:41,520
rocket but when you go to space or to

668
00:25:47,350 --> 00:25:44,000
mars you need to bring

669
00:25:49,830 --> 00:25:47,360
that oxygen and it weighs way way more

670
00:25:51,350 --> 00:25:49,840
than the fuel that's burning so wouldn't

671
00:25:54,870 --> 00:25:51,360
it be great

672
00:25:56,310 --> 00:25:54,880
if we can make that oxygen on mars

673
00:26:00,470 --> 00:25:56,320
instead of having to bring it all the

674
00:26:03,110 --> 00:26:00,480
way with us so let me get the model here

675
00:26:06,630 --> 00:26:03,120
this is moxie okay this is a

676
00:26:08,950 --> 00:26:06,640
solid model uh 3d model of moxie

677
00:26:11,909 --> 00:26:08,960
and this indeed does what i just

678
00:26:13,750 --> 00:26:11,919
described it makes oxygen on mars

679
00:26:15,990 --> 00:26:13,760
out of resources it finds there well

680
00:26:18,390 --> 00:26:16,000
what resources am i talking about

681
00:26:20,710 --> 00:26:18,400
now mimi already mentioned how thin the

682
00:26:23,269 --> 00:26:20,720
air is at mars there's not a lot of it

683
00:26:24,390 --> 00:26:23,279
but what's there is almost entirely

684
00:26:29,990 --> 00:26:24,400
co2

685
00:26:31,990 --> 00:26:30,000
well trees do it every day okay we

686
00:26:33,909 --> 00:26:32,000
wouldn't be able to breathe if it wasn't

687
00:26:36,470 --> 00:26:33,919
for the flora and fauna

688
00:26:37,510 --> 00:26:36,480

of this planet that turned co2 into

689
00:26:39,269 --> 00:26:37,520
oxygen

690
00:26:41,830 --> 00:26:39,279
so we want to bring a little tree to

691
00:26:43,110 --> 00:26:41,840
mars as a demonstration this is in fact

692
00:26:45,269 --> 00:26:43,120
a little tree

693
00:26:48,070 --> 00:26:45,279
it puts out about as much oxygen from

694
00:26:49,990 --> 00:26:48,080
co2 as a small tree does

695
00:26:50,789 --> 00:26:50,000
how does it do okay

696
00:26:52,870 --> 00:26:50,799
um

697
00:26:55,190 --> 00:26:52,880
first thing you have to do is collect

698
00:26:58,070 --> 00:26:55,200
all of that thin air

699
00:27:00,630 --> 00:26:58,080
that and compress it we have of course

700
00:27:02,310 --> 00:27:00,640
the compressor this was developed by a

701
00:27:04,390 --> 00:27:02,320
company

702
00:27:07,190 --> 00:27:04,400
in colorado air squared

703
00:27:10,230 --> 00:27:07,200
to work particularly on mars in that

704
00:27:12,630 --> 00:27:10,240
special thin air harsh environment

705
00:27:14,870 --> 00:27:12,640
once it's collected it feeds it to this

706
00:27:18,070 --> 00:27:14,880
red device this is called a solid oxide

707
00:27:20,630 --> 00:27:18,080
electrolysis system or a sox in from

708
00:27:21,590 --> 00:27:20,640
boston i insisted on a red sox for the

709
00:27:23,269 --> 00:27:21,600
model

710
00:27:25,350 --> 00:27:23,279
um

711
00:27:27,510 --> 00:27:25,360
and that's where the magic happens so

712
00:27:29,990 --> 00:27:27,520
why is it we even know how to build this

713
00:27:32,630 --> 00:27:30,000

how to build something that will turn

714
00:27:35,990 --> 00:27:32,640
co2 into oxygen we don't often need to

715
00:27:38,549 --> 00:27:36,000
make oxygen on earth we have all we need

716
00:27:41,269 --> 00:27:38,559
well it's because the process that goes

717
00:27:42,950 --> 00:27:41,279
the other way is called a fuel cell when

718
00:27:45,909 --> 00:27:42,960
you start with

719
00:27:47,990 --> 00:27:45,919
with with a fuel and oxygen and turn it

720
00:27:50,710 --> 00:27:48,000
into a stable gas and get out

721
00:27:52,070 --> 00:27:50,720
electricity we call it a fuel cell in

722
00:27:54,710 --> 00:27:52,080
this case we're going to go the other

723
00:27:57,830 --> 00:27:54,720
way so what way are we going well we

724
00:28:00,710 --> 00:27:57,840
start with co2 which is carbon dioxide

725
00:28:02,789 --> 00:28:00,720
obviously carbon dioxide has oxide has

726
00:28:05,430 --> 00:28:02,799
oxygen in it what we want to do is

727
00:28:07,909 --> 00:28:05,440
borrow one of those oxygen atoms

728
00:28:10,470 --> 00:28:07,919
from the co2 why just one

729
00:28:12,310 --> 00:28:10,480
well because that way what comes out is

730
00:28:15,269 --> 00:28:12,320
co a gas

731
00:28:17,430 --> 00:28:15,279
and oxygen a gas and gases are easy you

732
00:28:19,029 --> 00:28:17,440
breathe them in they go out you have no

733
00:28:21,830 --> 00:28:19,039
mess to clean up

734
00:28:23,830 --> 00:28:21,840
so what comes out of out of moxie in

735
00:28:24,549 --> 00:28:23,840
this case out of the soxy

736
00:28:32,549 --> 00:28:24,559
is

737
00:28:33,590 --> 00:28:32,559
used and then a stream of totally pure

738
00:28:35,510 --> 00:28:33,600

oxygen

739
00:28:37,350 --> 00:28:35,520
that goes into a sensor system which

740
00:28:38,789 --> 00:28:37,360
measures it and tells us what's going on

741
00:28:40,310 --> 00:28:38,799
back on earth

742
00:28:41,990 --> 00:28:40,320
and

743
00:28:44,789 --> 00:28:42,000
that's basically how it works i'd be

744
00:28:47,110 --> 00:28:44,799
happy to answer more technical questions

745
00:28:49,669 --> 00:28:47,120
in the discussion later thank you very

746
00:28:54,389 --> 00:28:51,510
thank you michael

747
00:28:56,830 --> 00:28:54,399
moxie what an incredible little machine

748
00:29:00,230 --> 00:28:56,840
the little engine machine i tell you

749
00:29:02,549 --> 00:29:00,240
oxygen yes well now we're going to go

750
00:29:06,149 --> 00:29:02,559
from cambridge massachusetts down to

751
00:29:09,029 --> 00:29:06,159
johnson space center in houston texas

752
00:29:10,389 --> 00:29:09,039
for amy ross our planetary spacesuit

753
00:29:13,269 --> 00:29:10,399
engineer

754
00:29:15,269 --> 00:29:13,279
hello amy

755
00:29:18,389 --> 00:29:15,279
hi tammy

756
00:29:21,029 --> 00:29:18,399
yeah i was so excited when mark freeze

757
00:29:21,750 --> 00:29:21,039
and trevor graff the project lead for

758
00:29:23,990 --> 00:29:21,760
the

759
00:29:25,430 --> 00:29:24,000
sherlock instrument calibration target

760
00:29:27,590 --> 00:29:25,440
approached me and offered us the

761
00:29:30,470 --> 00:29:27,600
opportunity to put spacey materials on

762
00:29:33,350 --> 00:29:30,480
the calibration target i'll tell you why

763
00:29:36,310 --> 00:29:33,360

as a planetary spacesuit engineer i have

764
00:29:38,230 --> 00:29:36,320
two primary jobs the first is to keep

765
00:29:39,909 --> 00:29:38,240
the astronauts alive

766
00:29:42,950 --> 00:29:39,919
the second is to give them a good tool

767
00:29:44,389 --> 00:29:42,960
to do the work they need to do in

768
00:29:46,149 --> 00:29:44,399
and

769
00:29:48,230 --> 00:29:46,159
then the mars missions that will

770
00:29:49,750 --> 00:29:48,240
eventually send humans on

771
00:29:51,350 --> 00:29:49,760
are going to be more challenging than

772
00:29:54,310 --> 00:29:51,360
any we've tried before

773
00:29:56,310 --> 00:29:54,320
humans will be on the surface up to 500

774
00:29:58,470 --> 00:29:56,320
days and then we'll be doing routine

775
00:29:59,430 --> 00:29:58,480
evas throughout that time

776
00:30:01,750 --> 00:29:59,440
and so

777
00:30:03,830 --> 00:30:01,760
when i send somebody to mars in my

778
00:30:05,269 --> 00:30:03,840
spacesuit i want to make sure that they

779
00:30:07,990 --> 00:30:05,279
stay alive that whole time i need a

780
00:30:10,070 --> 00:30:08,000
durable reliable spacesuit

781
00:30:12,789 --> 00:30:10,080
to do that i need to understand how my

782
00:30:15,269 --> 00:30:12,799
materials of the spacesuit hold up over

783
00:30:18,870 --> 00:30:15,279
that duration of use so if we can show

784
00:30:23,669 --> 00:30:21,430
you can see the perseverance rover up in

785
00:30:25,669 --> 00:30:23,679
the upper right hand corner and then the

786
00:30:27,430 --> 00:30:25,679
calibration target is located on the

787
00:30:29,190 --> 00:30:27,440
sherlock instrument

788
00:30:30,630 --> 00:30:29,200

and the calibration target is shown on

789
00:30:33,510 --> 00:30:30,640
the lower right

790
00:30:36,070 --> 00:30:33,520
and so there are round circles above and

791
00:30:38,149 --> 00:30:36,080
then the colors with the round circle

792
00:30:40,870 --> 00:30:38,159
and then the squares below it are my

793
00:30:43,029 --> 00:30:40,880
spacesuit materials a calibration target

794
00:30:46,470 --> 00:30:43,039
is basically how you can check your

795
00:30:47,590 --> 00:30:46,480
focus on a camera as an example um it

796
00:30:48,870 --> 00:30:47,600
gives you a chance to make sure that

797
00:30:52,789 --> 00:30:48,880
your instrument is still working

798
00:30:54,950 --> 00:30:52,799
properly and so in addition to those

799
00:30:57,269 --> 00:30:54,960
test articles we have my spacesuit

800
00:31:00,070 --> 00:30:57,279
materials these space materials are key

801
00:31:02,549 --> 00:31:00,080
to the spacesuits function polycarbonate

802
00:31:04,149 --> 00:31:02,559
vectran orthofabric teflon and then

803
00:31:05,909 --> 00:31:04,159
we're doing an experimental fabric

804
00:31:08,789 --> 00:31:05,919
that's one that we haven't used before

805
00:31:11,190 --> 00:31:08,799
called a coated teflon so if you can

806
00:31:13,190 --> 00:31:11,200
come back and look at the materials here

807
00:31:14,310 --> 00:31:13,200
i have examples of those

808
00:31:16,549 --> 00:31:14,320
with me

809
00:31:18,789 --> 00:31:16,559
this is a spacesuit helmet this material

810
00:31:20,549 --> 00:31:18,799
here is polycarbonate

811
00:31:22,950 --> 00:31:20,559
on the space of glove the material on

812
00:31:24,630 --> 00:31:22,960
the palm is vectran

813
00:31:26,389 --> 00:31:24,640

then the ortho fabric is a material

814
00:31:28,630 --> 00:31:26,399
that's the white that you see on most of

815
00:31:30,710 --> 00:31:28,640
the rest of the outside of the suit

816
00:31:32,389 --> 00:31:30,720
and then the teflon is the

817
00:31:33,350 --> 00:31:32,399
gauntlet and the back of the hand of the

818
00:31:36,389 --> 00:31:33,360
glove

819
00:31:39,830 --> 00:31:36,399
and then we have a coated teflon that's

820
00:31:42,230 --> 00:31:39,840
going to be a dust mitigating material

821
00:31:44,070 --> 00:31:42,240
we want to do tests on

822
00:31:46,149 --> 00:31:44,080
in the mars atmosphere so we can

823
00:31:48,870 --> 00:31:46,159
understand how our materials hold up or

824
00:31:51,190 --> 00:31:48,880
don't in that environment and then we're

825
00:31:54,389 --> 00:31:51,200
doing tests on the ground that give us a

826
00:31:55,990 --> 00:31:54,399
data to compare to that on mars data so

827
00:31:57,430 --> 00:31:56,000
we can have confidence when we design a

828
00:31:59,350 --> 00:31:57,440
spacesuit that we are designing the

829
00:32:00,710 --> 00:31:59,360
spacesuit to last for the entire

830
00:32:02,710 --> 00:32:00,720
duration of missions and keep our

831
00:32:03,830 --> 00:32:02,720
astronauts alive

832
00:32:05,269 --> 00:32:03,840
this is a

833
00:32:07,990 --> 00:32:05,279
something my mentor and i had talked

834
00:32:09,669 --> 00:32:08,000
about for years he tried to do it had to

835
00:32:11,669 --> 00:32:09,679
retire after 50 years of spacesuit

836
00:32:13,350 --> 00:32:11,679
experience without getting this done so

837
00:32:15,909 --> 00:32:13,360
this is a major career goal for me to

838
00:32:17,590 --> 00:32:15,919

have what i think is to the best of my

839
00:32:20,230 --> 00:32:17,600
knowledge as the first human space

840
00:32:21,190 --> 00:32:20,240
flight hardware to go to mars

841
00:32:23,909 --> 00:32:21,200
and then

842
00:32:26,070 --> 00:32:23,919
that feeds my next career goal which is

843
00:32:28,389 --> 00:32:26,080
sending a spacesuit to mars so our

844
00:32:30,630 --> 00:32:28,399
future astronauts can use it there

845
00:32:32,230 --> 00:32:30,640
so i'm really glad to be here too i'm

846
00:32:34,070 --> 00:32:32,240
super excited to be included in the

847
00:32:35,750 --> 00:32:34,080
perseverance mission and i want to thank

848
00:32:37,669 --> 00:32:35,760
my colleague christine davis who did

849
00:32:41,590 --> 00:32:37,679
most of the work to get this realized

850
00:32:45,269 --> 00:32:42,990
thank you amy

851
00:32:47,430 --> 00:32:45,279
extraordinary technology with those

852
00:32:50,710 --> 00:32:47,440
fabrics i can't wait to see how they do

853
00:32:52,310 --> 00:32:50,720
on mars and sitting next to amy in the

854
00:32:54,870 --> 00:32:52,320
studio at johnson space center we're

855
00:32:56,789 --> 00:32:54,880
joined by michelle rucker she oversees

856
00:32:59,110 --> 00:32:56,799
across cross-agency team

857
00:33:01,509 --> 00:32:59,120
looking at architecture and operational

858
00:33:03,750 --> 00:33:01,519
concepts for the first human mission to

859
00:33:07,669 --> 00:33:03,760
mars so michelle tell us about what the

860
00:33:12,870 --> 00:33:09,350
thanks tammy

861
00:33:14,630 --> 00:33:12,880
so we know more about mars today than we

862
00:33:16,710 --> 00:33:14,640
knew about the moon when apollo 11

863
00:33:18,870 --> 00:33:16,720

touched down and the reason we know so

864
00:33:20,549 --> 00:33:18,880
much about mars is thanks to all of the

865
00:33:22,070 --> 00:33:20,559
robotic science missions that jim

866
00:33:24,630 --> 00:33:22,080
mentioned earlier

867
00:33:26,630 --> 00:33:24,640
those those robotic missions have done

868
00:33:28,630 --> 00:33:26,640
important science on mars they've taught

869
00:33:30,310 --> 00:33:28,640
us about the environment on mars and

870
00:33:32,310 --> 00:33:30,320
that is helping us to design the

871
00:33:35,590 --> 00:33:32,320
equipment that the humans will need to

872
00:33:37,669 --> 00:33:35,600
be able to live and work on mars someday

873
00:33:40,630 --> 00:33:37,679
the science is very important for

874
00:33:42,549 --> 00:33:40,640
helping us to design our systems but the

875
00:33:44,310 --> 00:33:42,559
technology demonstration opportunities

876
00:33:46,789 --> 00:33:44,320
that these missions give us is also

877
00:33:49,509 --> 00:33:46,799
important so jeff and and michael have

878
00:33:52,230 --> 00:33:49,519
talked about some of the technology

879
00:33:53,990 --> 00:33:52,240
those technologies will help us uh make

880
00:33:56,149 --> 00:33:54,000
the missions that that we're going to

881
00:33:58,149 --> 00:33:56,159
send humans on much safer

882
00:34:00,149 --> 00:33:58,159
so for example

883
00:34:03,430 --> 00:34:00,159
moxie that offers the promise that we'll

884
00:34:06,230 --> 00:34:03,440
never run out of oxygen on mars

885
00:34:07,990 --> 00:34:06,240
i know all eyes are on mars this month

886
00:34:09,669 --> 00:34:08,000
this happens to be a big big month with

887
00:34:11,829 --> 00:34:09,679
three missions uh international

888
00:34:14,069 --> 00:34:11,839

emissions going to to mars uh but don't

889
00:34:14,869 --> 00:34:14,079
forget we're also going back to the moon

890
00:34:16,149 --> 00:34:14,879
um

891
00:34:18,310 --> 00:34:16,159
some of the technologies that will be

892
00:34:20,389 --> 00:34:18,320
demonstrated on perseverance will also

893
00:34:22,710 --> 00:34:20,399
have applicability to the moon so the

894
00:34:24,230 --> 00:34:22,720
terrain relative navigation system that

895
00:34:26,149 --> 00:34:24,240
jeff talked about

896
00:34:28,790 --> 00:34:26,159
that could just as easily make landings

897
00:34:31,190 --> 00:34:28,800
on the moon uh safer than they were back

898
00:34:32,550 --> 00:34:31,200
in the apollo days

899
00:34:34,790 --> 00:34:32,560
as an engineer

900
00:34:37,030 --> 00:34:34,800
i have been i have to admit i've been

901
00:34:39,270 --> 00:34:37,040
smitten with the the mars helicopter

902
00:34:41,909 --> 00:34:39,280
ever since i first saw test footage of

903
00:34:43,909 --> 00:34:41,919
it about two years ago um

904
00:34:45,750 --> 00:34:43,919
my colleagues and i have been

905
00:34:47,510 --> 00:34:45,760
like kids in a candy store trying to

906
00:34:49,750 --> 00:34:47,520
think of the different ways we could use

907
00:34:52,069 --> 00:34:49,760
that technology for a human mars mission

908
00:34:53,589 --> 00:34:52,079
i think we have an image we can show

909
00:34:54,629 --> 00:34:53,599
the artists have been going a little bit

910
00:34:57,270 --> 00:34:54,639
crazy

911
00:34:59,750 --> 00:34:57,280
uh it's hard to see there but this this

912
00:35:01,910 --> 00:34:59,760
is just an artist's depiction of what it

913
00:35:03,430 --> 00:35:01,920

might look like having a human mission

914
00:35:04,550 --> 00:35:03,440
on mars you see a couple of astronauts

915
00:35:05,829 --> 00:35:04,560
there

916
00:35:07,030 --> 00:35:05,839
they've got a pressurized rover in the

917
00:35:09,349 --> 00:35:07,040
background

918
00:35:11,589 --> 00:35:09,359
that helicopter

919
00:35:14,470 --> 00:35:11,599
we have just all kinds of ideas for how

920
00:35:16,230 --> 00:35:14,480
to use that for a human mars mission

921
00:35:18,790 --> 00:35:16,240
i know poor mimi is trying to get ready

922
00:35:21,910 --> 00:35:18,800
for a launch and i've been pestering her

923
00:35:23,829 --> 00:35:21,920
with questions uh for example can we use

924
00:35:25,829 --> 00:35:23,839
that helicopter as an aerial

925
00:35:27,670 --> 00:35:25,839
communications relay in case an

926
00:35:29,990 --> 00:35:27,680
astronaut loses line-of-sight

927
00:35:31,589 --> 00:35:30,000
communication back to the rover say they

928
00:35:33,430 --> 00:35:31,599
go behind a hill or something and don't

929
00:35:35,750 --> 00:35:33,440
and they lose their communications could

930
00:35:38,630 --> 00:35:35,760
we use that helicopter to get an aerial

931
00:35:40,950 --> 00:35:38,640
view of the first human lander

932
00:35:43,510 --> 00:35:40,960
our landers as jeff mentioned will be

933
00:35:45,670 --> 00:35:43,520
perhaps 20 times bigger than than the

934
00:35:47,349 --> 00:35:45,680
robotic landers we expect those big

935
00:35:50,069 --> 00:35:47,359
powerful descent engines to kick up a

936
00:35:52,150 --> 00:35:50,079
lot of dust during landing if you had a

937
00:35:53,589 --> 00:35:52,160
camera up on a helicopter with an aerial

938
00:35:56,150 --> 00:35:53,599

point of view you might get a much

939
00:35:58,950 --> 00:35:56,160
better image of the first uh human mars

940
00:35:59,829 --> 00:35:58,960
mission landing so we're super excited

941
00:36:01,990 --> 00:35:59,839
um

942
00:36:04,230 --> 00:36:02,000
that and i apologize to mimi for

943
00:36:06,790 --> 00:36:04,240
pestering you with questions

944
00:36:10,790 --> 00:36:06,800
those questions can wait till next week

945
00:36:14,069 --> 00:36:12,550
today though is about the robotic

946
00:36:16,630 --> 00:36:14,079
science missions and the technology

947
00:36:19,349 --> 00:36:16,640
demonstrations um for my colleagues at

948
00:36:22,150 --> 00:36:19,359
jpl just know that those of us on the

949
00:36:23,750 --> 00:36:22,160
the human exploration side of the family

950
00:36:25,910 --> 00:36:23,760
will all be getting up early next

951
00:36:28,470 --> 00:36:25,920
thursday i will be cheering you on as

952
00:36:30,470 --> 00:36:28,480
you help lay the groundwork for for us

953
00:36:36,710 --> 00:36:30,480
to follow and we're just happy to be

954
00:36:40,870 --> 00:36:38,550
thank you michelle

955
00:36:42,950 --> 00:36:40,880
it sounds amazing we're all going to be

956
00:36:45,190 --> 00:36:42,960
cheering thursday morning but in the

957
00:36:47,829 --> 00:36:45,200
meantime we do have some media joining

958
00:36:50,550 --> 00:36:47,839
us and we do have a question from leo

959
00:36:58,790 --> 00:36:50,560
enright from irish television please go

960
00:37:02,870 --> 00:37:01,510
do we have leo

961
00:37:07,510 --> 00:37:02,880
hello

962
00:37:11,670 --> 00:37:09,430
we're not able to hear leo right at the

963
00:37:15,030 --> 00:37:11,680

moment but we also do have some social

964
00:37:17,829 --> 00:37:15,040
media questions that we have um received

965
00:37:19,190 --> 00:37:17,839
today and so let's throw one out there

966
00:37:20,630 --> 00:37:19,200
for michelle

967
00:37:22,550 --> 00:37:20,640
at johnson

968
00:37:24,470 --> 00:37:22,560
from darla jackson

969
00:37:26,790 --> 00:37:24,480
from facebook

970
00:37:31,910 --> 00:37:26,800
will perseverance start building a base

971
00:37:36,150 --> 00:37:33,829
and that is a great question

972
00:37:38,310 --> 00:37:36,160
so perseverance is a is a it's a pretty

973
00:37:40,470 --> 00:37:38,320
big robot but it's not quite big enough

974
00:37:42,790 --> 00:37:40,480
uh to be building the base camp uh

975
00:37:44,310 --> 00:37:42,800
perseverance is one of uh several

976
00:37:47,270 --> 00:37:44,320
robotic missions that we've got on the

977
00:37:49,190 --> 00:37:47,280
horizon now um we think of these

978
00:37:52,230 --> 00:37:49,200
missions these robotic missions as more

979
00:37:54,550 --> 00:37:52,240
more like scouts

980
00:37:56,710 --> 00:37:54,560
they they sort of help us

981
00:37:58,230 --> 00:37:56,720
learn about the new environment uh

982
00:38:01,109 --> 00:37:58,240
figure out if that's where we would like

983
00:38:04,230 --> 00:38:01,119
to build a base camp

984
00:38:05,750 --> 00:38:04,240
so yeah perseverance is er they won't be

985
00:38:07,750 --> 00:38:05,760
building the base camp for us but it

986
00:38:09,990 --> 00:38:07,760
might be very instrumental in helping us

987
00:38:11,910 --> 00:38:10,000
decide if we if we want to build a base

988
00:38:16,710 --> 00:38:11,920

count whether this is an area that we

989
00:38:19,589 --> 00:38:18,710
all right let's try our media question

990
00:38:22,069 --> 00:38:19,599
again

991
00:38:23,829 --> 00:38:22,079
leo enright of irish television can you

992
00:38:25,829 --> 00:38:23,839
hear us sir

993
00:38:28,310 --> 00:38:25,839
yes i hope you're hearing me this time

994
00:38:30,950 --> 00:38:28,320
yes sir we can please go ahead

995
00:38:34,150 --> 00:38:30,960
i i have a helicopter question i i was

996
00:38:36,950 --> 00:38:34,160
wondering uh what's the experience like

997
00:38:39,910 --> 00:38:36,960
going to be for us uh back here on earth

998
00:38:42,150 --> 00:38:39,920
uh in that first uh wright brothers

999
00:38:44,230 --> 00:38:42,160
moment are we going to see this

1000
00:38:47,589 --> 00:38:44,240
helicopter taking off

1001
00:38:51,910 --> 00:38:47,599
with cameras from the main rover uh are

1002
00:38:53,990 --> 00:38:51,920
we going to have a live commentary uh or

1003
00:38:57,510 --> 00:38:54,000
is this going to be a much more low-key

1004
00:39:02,310 --> 00:39:00,390
mimi all right uh i'll take that all

1005
00:39:05,109 --> 00:39:02,320
right tim but thank you for the question

1006
00:39:07,829 --> 00:39:05,119
uh leo it's a good question uh the

1007
00:39:11,109 --> 00:39:07,839
operation of the helicopter it is done

1008
00:39:13,349 --> 00:39:11,119
remotely right so the long answer here

1009
00:39:16,310 --> 00:39:13,359
uh we set up the commands prepare them a

1010
00:39:18,069 --> 00:39:16,320
few days ahead of time send them up and

1011
00:39:20,310 --> 00:39:18,079
then the helicopter

1012
00:39:23,349 --> 00:39:20,320
operates autonomously right at a given

1013
00:39:26,310 --> 00:39:23,359

time it'll take off fly you know take a

1014
00:39:29,430 --> 00:39:26,320
few images come back and land okay and

1015
00:39:30,630 --> 00:39:29,440
then we will have some images that we

1016
00:39:32,470 --> 00:39:30,640
send back

1017
00:39:34,790 --> 00:39:32,480
the first day

1018
00:39:37,510 --> 00:39:34,800
after the flight and landing and then

1019
00:39:39,990 --> 00:39:37,520
over the next few days we'll be sending

1020
00:39:42,550 --> 00:39:40,000
more data related to the flight so

1021
00:39:44,310 --> 00:39:42,560
that's the data from the helicopter

1022
00:39:46,230 --> 00:39:44,320
and they'll be primarily how did the

1023
00:39:48,950 --> 00:39:46,240
helicopter perform you know what were

1024
00:39:51,190 --> 00:39:48,960
the onboard voltages currents and what

1025
00:39:53,510 --> 00:39:51,200
were the vehicle state as it was flying

1026
00:39:57,030 --> 00:39:53,520
how well did it follow the trajectory

1027
00:39:59,510 --> 00:39:57,040
and also we have as icing on the cake a

1028
00:40:00,550 --> 00:39:59,520
few pictures uh colored pictures that we

1029
00:40:02,550 --> 00:40:00,560
will take

1030
00:40:04,630 --> 00:40:02,560
again that's for additional function so

1031
00:40:07,349 --> 00:40:04,640
from the helicopter centric we'll start

1032
00:40:09,109 --> 00:40:07,359
getting data back a few hours on the

1033
00:40:10,630 --> 00:40:09,119
first afterwards on the first day and

1034
00:40:12,069 --> 00:40:10,640
then the next two day we'll be getting

1035
00:40:14,390 --> 00:40:12,079
streams of data

1036
00:40:16,150 --> 00:40:14,400
on the perseverance rover side the

1037
00:40:18,870 --> 00:40:16,160
person knowing that where we have

1038
00:40:20,550 --> 00:40:18,880

commanded the helicopter to fly you know

1039
00:40:22,390 --> 00:40:20,560
the waypoints that we've given

1040
00:40:24,470 --> 00:40:22,400
perseverance rover will be pointing

1041
00:40:27,349 --> 00:40:24,480
their cameras also

1042
00:40:29,589 --> 00:40:27,359
along the path trajectory to take images

1043
00:40:32,390 --> 00:40:29,599
and will be sending data back so it

1044
00:40:34,710 --> 00:40:32,400
won't be instantaneously within minutes

1045
00:40:37,430 --> 00:40:34,720
but within the same day we'll start to

1046
00:40:39,430 --> 00:40:37,440
see both visual and

1047
00:40:41,589 --> 00:40:39,440
i'm very biased towards the engineering

1048
00:40:44,309 --> 00:40:41,599
data the engineering telemetry on how

1049
00:40:46,550 --> 00:40:44,319
well the uh the flight went and then

1050
00:40:49,750 --> 00:40:46,560
over the next couple days we'll get more

1051
00:40:53,349 --> 00:40:51,109
thank you mimi you're allowed to be

1052
00:40:56,309 --> 00:40:53,359
biased the ingenuity experiment is

1053
00:40:58,870 --> 00:40:56,319
extraordinary so our next media question

1054
00:41:00,630 --> 00:40:58,880
is jake robbins and he must have been

1055
00:41:03,430 --> 00:41:00,640
preparing for this day because he's

1056
00:41:05,349 --> 00:41:03,440
calling from we martians podcast

1057
00:41:07,190 --> 00:41:05,359
go ahead jake

1058
00:41:09,190 --> 00:41:07,200
all right thank you yeah uh there's

1059
00:41:11,349 --> 00:41:09,200
questions for uh from michael about the

1060
00:41:13,349 --> 00:41:11,359
moxie instrument uh assuming everything

1061
00:41:16,150 --> 00:41:13,359
goes real well with this and it's

1062
00:41:18,230 --> 00:41:16,160
turning out oxygen like crazy um how

1063
00:41:20,550 --> 00:41:18,240

scalable is it is it as simple as just

1064
00:41:22,630 --> 00:41:20,560
making one you know 100 times the size

1065
00:41:24,309 --> 00:41:22,640
or are there new technical challenges

1066
00:41:26,790 --> 00:41:24,319
that will come after that and making it

1067
00:41:29,910 --> 00:41:29,109
a great question and i'm really pleased

1068
00:41:31,750 --> 00:41:29,920
to

1069
00:41:33,430 --> 00:41:31,760
report that it's a question we're making

1070
00:41:35,910 --> 00:41:33,440
a lot of progress on there's a

1071
00:41:38,870 --> 00:41:35,920
development going on right now

1072
00:41:41,349 --> 00:41:38,880
in the laboratory testing out

1073
00:41:42,309 --> 00:41:41,359
these electrolysis systems the sox

1074
00:41:46,950 --> 00:41:42,319
system

1075
00:41:49,670 --> 00:41:46,960
that produces uh you know 100 times more

1076
00:41:51,510 --> 00:41:49,680
oxygen than what our little one does and

1077
00:41:53,750 --> 00:41:51,520
there's a separate project going on

1078
00:41:56,790 --> 00:41:53,760
developing a full-size compressor it

1079
00:41:58,950 --> 00:41:56,800
scales extremely well

1080
00:42:01,510 --> 00:41:58,960
and that said that does not mean the

1081
00:42:03,910 --> 00:42:01,520
full-scale system is 100 times heavier

1082
00:42:06,870 --> 00:42:03,920
or 100 times bigger we expect a

1083
00:42:09,670 --> 00:42:06,880
full-scale system that can produce two

1084
00:42:12,550 --> 00:42:09,680
to three kilograms an hour to be about a

1085
00:42:15,030 --> 00:42:12,560
cubic meter and to weigh about a metric

1086
00:42:17,670 --> 00:42:15,040
ton about a thousand kilograms

1087
00:42:19,190 --> 00:42:17,680
um of course we will learn a lot from

1088
00:42:21,990 --> 00:42:19,200

this mission that what may cause us to

1089
00:42:24,069 --> 00:42:22,000
redesign we have to remember that the

1090
00:42:26,069 --> 00:42:24,079
full-scale system will not only have to

1091
00:42:27,510 --> 00:42:26,079
put out more oxygen but do it for a

1092
00:42:28,309 --> 00:42:27,520
solid year

1093
00:42:30,950 --> 00:42:28,319
so

1094
00:42:33,349 --> 00:42:30,960
that implies changes in things like dust

1095
00:42:35,430 --> 00:42:33,359
filtering technology so it's well

1096
00:42:38,230 --> 00:42:35,440
underway it's basically

1097
00:42:41,109 --> 00:42:38,240
retaining the same design principles and

1098
00:42:46,069 --> 00:42:43,190
thank you michael our next media

1099
00:42:47,589 --> 00:42:46,079
question comes from haneka wietering of

1100
00:42:50,790 --> 00:42:47,599
ace media

1101
00:42:52,790 --> 00:42:50,800
haneka can you hear us

1102
00:42:55,990 --> 00:42:52,800
hi this is hanukkah

1103
00:43:04,150 --> 00:42:58,630
chin is for mimi and perhaps anyone else

1104
00:43:13,270 --> 00:43:07,190
mars and in what ways can rotate be

1105
00:43:13,280 --> 00:43:16,069
okay

1106
00:43:16,079 --> 00:43:19,670
mimi did you hear that

1107
00:43:22,550 --> 00:43:21,030
uh i didn't hear the whole question

1108
00:43:25,030 --> 00:43:22,560
what's the question in what ways will

1109
00:43:27,510 --> 00:43:25,040
helicopters be used in the future was

1110
00:43:30,870 --> 00:43:27,520
that the question

1111
00:43:36,790 --> 00:43:30,880
i i vote for human missions in addition

1112
00:43:40,790 --> 00:43:38,870
sorry tammy can you translate uh most of

1113
00:43:45,430 --> 00:43:40,800

the questions will you please repeat the

1114
00:43:53,510 --> 00:43:48,069
in what ways can rotarcraft be useful

1115
00:43:58,710 --> 00:43:56,630
i'm sorry haneka we're having trouble

1116
00:44:01,030 --> 00:43:58,720
hearing you maybe we'll try to get you

1117
00:44:03,190 --> 00:44:01,040
back on a better line

1118
00:44:05,349 --> 00:44:03,200
in the meantime let's go to some more

1119
00:44:09,190 --> 00:44:05,359
social media questions

1120
00:44:11,910 --> 00:44:09,200
this is for jeff

1121
00:44:15,589 --> 00:44:11,920
is nasa preparing 3d printers that will

1122
00:44:18,390 --> 00:44:15,599
utilize martian soil or material

1123
00:44:20,309 --> 00:44:18,400
we send so that we can build

1124
00:44:22,630 --> 00:44:20,319
storage and living quarters in the

1125
00:44:24,550 --> 00:44:22,640
foreseeable future do we have any plans

1126
00:44:27,270 --> 00:44:24,560
jeff to go building

1127
00:44:29,430 --> 00:44:27,280
we do actually um

1128
00:44:32,710 --> 00:44:29,440
space technology mission directorate and

1129
00:44:37,430 --> 00:44:32,720
others have been investing in 3d

1130
00:44:40,069 --> 00:44:37,440
printing technology we've actually flown

1131
00:44:42,470 --> 00:44:40,079
devices to the space station so we can

1132
00:44:44,870 --> 00:44:42,480
test it out in microgravity we've been

1133
00:44:46,630 --> 00:44:44,880
able to produce small implements with

1134
00:44:48,550 --> 00:44:46,640
those devices that

1135
00:44:51,109 --> 00:44:48,560
on the iss

1136
00:44:53,990 --> 00:44:51,119
we started out printing with plastics

1137
00:44:56,150 --> 00:44:54,000
progressed to metals

1138
00:44:57,910 --> 00:44:56,160

a lot of liquid rocket engine parts are

1139
00:45:00,309 --> 00:44:57,920
being printed with

1140
00:45:01,510 --> 00:45:00,319
additive manufacturing these days or 3d

1141
00:45:04,630 --> 00:45:01,520
printers

1142
00:45:06,630 --> 00:45:04,640
and we do actually have projects

1143
00:45:09,190 --> 00:45:06,640
in place

1144
00:45:12,309 --> 00:45:09,200
that have been looking at using regolith

1145
00:45:14,950 --> 00:45:12,319
or the soil that you find on planetary

1146
00:45:16,870 --> 00:45:14,960
bodies that's typically called regolith

1147
00:45:21,190 --> 00:45:16,880
on the moon

1148
00:45:23,589 --> 00:45:21,200
to uh as a as a a binder or as

1149
00:45:26,309 --> 00:45:23,599
as as a component

1150
00:45:27,990 --> 00:45:26,319
with a binding some system to bind it

1151
00:45:29,910 --> 00:45:28,000
together

1152
00:45:31,030 --> 00:45:29,920
of structures

1153
00:45:33,510 --> 00:45:31,040
and so

1154
00:45:35,670 --> 00:45:33,520
we've been working with caterpillar

1155
00:45:37,589 --> 00:45:35,680
and other terrestrial organ

1156
00:45:38,870 --> 00:45:37,599
organizations

1157
00:45:40,150 --> 00:45:38,880
on developing these sorts of

1158
00:45:42,790 --> 00:45:40,160
technologies

1159
00:45:43,589 --> 00:45:42,800
with the goal of being able to implement

1160
00:45:44,829 --> 00:45:43,599
them

1161
00:45:50,470 --> 00:45:44,839
to build

1162
00:45:53,349 --> 00:45:50,480
those types of structures on the moon

1163
00:45:55,190 --> 00:45:53,359

and and ultimately maybe on mars so yes

1164
00:45:57,829 --> 00:45:55,200
we do have that kind of technology

1165
00:45:59,510 --> 00:45:57,839
development underway these

1166
00:46:00,390 --> 00:45:59,520
these kind of projects tend to develop

1167
00:46:02,150 --> 00:46:00,400
over

1168
00:46:03,589 --> 00:46:02,160
a long period of time

1169
00:46:05,589 --> 00:46:03,599
i was thinking earlier

1170
00:46:07,510 --> 00:46:05,599
about the new technologies that we

1171
00:46:09,510 --> 00:46:07,520
discussed for this mission and we call

1172
00:46:10,630 --> 00:46:09,520
them new technologies because they're

1173
00:46:12,550 --> 00:46:10,640
new

1174
00:46:15,030 --> 00:46:12,560
being implemented on a flight system and

1175
00:46:17,589 --> 00:46:15,040
actually flying to another planet but

1176
00:46:21,030 --> 00:46:17,599
some of those technologies took

1177
00:46:23,750 --> 00:46:21,040
15 years of development to mature to the

1178
00:46:25,670 --> 00:46:23,760
point and to get an opportunity to be

1179
00:46:28,230 --> 00:46:25,680
included on a mission so that we can

1180
00:46:30,710 --> 00:46:28,240
demonstrate them so it's a long pipeline

1181
00:46:32,390 --> 00:46:30,720
sometimes where you do technology

1182
00:46:34,630 --> 00:46:32,400
development and then eventually out the

1183
00:46:36,790 --> 00:46:34,640
other end comes a technology you can use

1184
00:46:38,069 --> 00:46:36,800
on a mission but we have 3d printing

1185
00:46:41,510 --> 00:46:38,079
technology

1186
00:46:42,470 --> 00:46:41,520
for planetary bodies in that

1187
00:46:44,630 --> 00:46:42,480
thank you pipeline

1188
00:46:46,790 --> 00:46:44,640

i know we have a lot of tiny home folks

1189
00:46:48,390 --> 00:46:46,800
in america who probably would love the

1190
00:46:51,829 --> 00:46:48,400
opportunity to go to mars and build some

1191
00:46:56,390 --> 00:46:53,430
one of the organizations we partnered

1192
00:46:58,470 --> 00:46:56,400
with is army corps of engineers and they

1193
00:47:01,270 --> 00:46:58,480
have an interest in building

1194
00:47:03,190 --> 00:47:01,280
structures in forward operating areas

1195
00:47:04,470 --> 00:47:03,200
out of materials that they don't have to

1196
00:47:05,910 --> 00:47:04,480
truck in there

1197
00:47:08,309 --> 00:47:05,920
and

1198
00:47:09,829 --> 00:47:08,319
even organizations like fema have been

1199
00:47:11,349 --> 00:47:09,839
looking at it for how can we build

1200
00:47:14,309 --> 00:47:11,359
something really quick

1201
00:47:15,589 --> 00:47:14,319
uh in a disaster area right um you

1202
00:47:17,990 --> 00:47:15,599
wouldn't want to live there the rest of

1203
00:47:19,990 --> 00:47:18,000
your life but it could be a temporary

1204
00:47:21,349 --> 00:47:20,000
shelter to get you through a tough

1205
00:47:22,470 --> 00:47:21,359
period so

1206
00:47:24,710 --> 00:47:22,480
there are a lot of ways we could use

1207
00:47:26,870 --> 00:47:24,720
this technology even on earth as as we

1208
00:47:28,870 --> 00:47:26,880
find with a lot of space technologies we

1209
00:47:30,549 --> 00:47:28,880
develop i was going to say once again

1210
00:47:32,790 --> 00:47:30,559
nasa is leading the way in many

1211
00:47:34,390 --> 00:47:32,800
technologies that benefit our our

1212
00:47:35,589 --> 00:47:34,400
society in so many ways that we don't

1213
00:47:37,430 --> 00:47:35,599

even realize

1214
00:47:39,589 --> 00:47:37,440
so thank you

1215
00:47:41,910 --> 00:47:39,599
continuing on with more social media

1216
00:47:44,150 --> 00:47:41,920
questions we have one for amy our

1217
00:47:46,950 --> 00:47:44,160
spacesuit engineer at johnson

1218
00:47:49,349 --> 00:47:46,960
amy heidi younovic from twitter

1219
00:47:54,470 --> 00:47:49,359
asks how are humans going to keep warm

1220
00:47:59,190 --> 00:47:56,710
well heidi i know the most about how

1221
00:48:01,910 --> 00:47:59,200
we're gonna do that with spacesuits uh

1222
00:48:03,829 --> 00:48:01,920
we have extra layers on the outside of

1223
00:48:06,470 --> 00:48:03,839
the spacesuit that basically prevent uh

1224
00:48:10,870 --> 00:48:06,480
protect it from the environment that

1225
00:48:14,950 --> 00:48:10,880
they are exposed to and so because mars

1226
00:48:16,549 --> 00:48:14,960
has seasons very much like earth does

1227
00:48:18,950 --> 00:48:16,559
we think that we may need like a winter

1228
00:48:20,710 --> 00:48:18,960
coat so you may need insulation that

1229
00:48:22,710 --> 00:48:20,720
gives you a little more protection we're

1230
00:48:24,549 --> 00:48:22,720
going to think about using materials

1231
00:48:27,190 --> 00:48:24,559
like flexible air gels to help us do

1232
00:48:30,710 --> 00:48:27,200
that because of the slight

1233
00:48:33,349 --> 00:48:30,720
uh environment atmosphere on this on

1234
00:48:35,510 --> 00:48:33,359
mars we can't use what we use today in

1235
00:48:37,829 --> 00:48:35,520
the spacesuits for microgravity so it

1236
00:48:39,990 --> 00:48:37,839
has to be different

1237
00:48:40,950 --> 00:48:40,000
also when you're in your habitat you

1238
00:48:42,390 --> 00:48:40,960

need to

1239
00:48:43,670 --> 00:48:42,400
be able to trust your life support

1240
00:48:45,030 --> 00:48:43,680
systems and one of the things that the

1241
00:48:47,510 --> 00:48:45,040
international space station has been

1242
00:48:49,910 --> 00:48:47,520
able to do for us is really help us

1243
00:48:52,710 --> 00:48:49,920
explore and develop new

1244
00:48:55,990 --> 00:48:52,720
regenerable and durable life support

1245
00:48:58,630 --> 00:48:56,000
systems that can also control your

1246
00:49:01,030 --> 00:48:58,640
habitable volume your your cabin your

1247
00:49:02,069 --> 00:49:01,040
your house so that it's comfortable just

1248
00:49:04,549 --> 00:49:02,079
like we have air conditioning and

1249
00:49:06,470 --> 00:49:04,559
heaters here on earth so we're getting

1250
00:49:08,790 --> 00:49:06,480
benefits from the international space

1251
00:49:11,510 --> 00:49:08,800
station and also these future lunar

1252
00:49:14,790 --> 00:49:11,520
missions for both life sport and space

1253
00:49:17,430 --> 00:49:14,800
suits to be able to apply to mars

1254
00:49:20,230 --> 00:49:17,440
all right amy thank you

1255
00:49:23,670 --> 00:49:20,240
and we have one for michelle here

1256
00:49:25,829 --> 00:49:23,680
here sitting next to you from also from

1257
00:49:27,750 --> 00:49:25,839
heidi yunovic on twitter

1258
00:49:30,309 --> 00:49:27,760
what do we need to know more about to

1259
00:49:34,549 --> 00:49:30,319
colonize mars and how close are we to

1260
00:49:37,829 --> 00:49:36,630
that's a great question heidi so i i

1261
00:49:39,750 --> 00:49:37,839
don't know if you caught the nasa

1262
00:49:42,950 --> 00:49:39,760
administrator's blog

1263
00:49:45,990 --> 00:49:42,960

post uh last week uh he had a an event

1264
00:49:47,589 --> 00:49:46,000
with uh on social media and uh he

1265
00:49:49,829 --> 00:49:47,599
mentioned that the first team in mars

1266
00:49:52,790 --> 00:49:49,839
mission would probably be fairly modest

1267
00:49:53,750 --> 00:49:52,800
it would probably be um maybe a 30-day

1268
00:49:54,950 --> 00:49:53,760
mission

1269
00:49:59,589 --> 00:49:54,960
um

1270
00:50:01,349 --> 00:49:59,599
things right when we go to explore some

1271
00:50:03,750 --> 00:50:01,359
place new we don't show up and build a

1272
00:50:05,670 --> 00:50:03,760
city immediately we like to scout around

1273
00:50:09,349 --> 00:50:05,680
a little bit see whether that's a place

1274
00:50:11,910 --> 00:50:09,359
that we would like to to set up a

1275
00:50:14,309 --> 00:50:11,920
some sort of a settlement

1276
00:50:16,390 --> 00:50:14,319
we understand the challenges

1277
00:50:18,390 --> 00:50:16,400
we think we know what pieces we would

1278
00:50:19,910 --> 00:50:18,400
need to be able to

1279
00:50:23,510 --> 00:50:19,920
stay on mars

1280
00:50:25,990 --> 00:50:23,520
for 30 days or perhaps longer

1281
00:50:30,150 --> 00:50:26,000
we think it's technically doable in the

1282
00:50:32,470 --> 00:50:30,160
in the 2030s as early as the 2030s

1283
00:50:34,549 --> 00:50:32,480
especially if we're able to use the the

1284
00:50:36,549 --> 00:50:34,559
artemis program on the moon and test

1285
00:50:38,710 --> 00:50:36,559
some of our technologies there we'll be

1286
00:50:40,150 --> 00:50:38,720
able to practice some of our processes

1287
00:50:41,829 --> 00:50:40,160
and procedures and make sure that we've

1288
00:50:45,349 --> 00:50:41,839

gotten everything just exactly right

1289
00:50:49,510 --> 00:50:47,030
thanks michelle

1290
00:50:51,270 --> 00:50:49,520
mike in cambridge did you have some

1291
00:50:52,829 --> 00:50:51,280
thoughts on how humans are going to stay

1292
00:50:55,670 --> 00:50:52,839
warm on

1293
00:50:57,430 --> 00:50:55,680
mars i did thank you for bringing that

1294
00:50:59,190 --> 00:50:57,440
back around to me you know

1295
00:51:00,630 --> 00:50:59,200
i'd like to bring the perspective of a

1296
00:51:02,150 --> 00:51:00,640
mars scientist

1297
00:51:03,510 --> 00:51:02,160
to this um

1298
00:51:06,710 --> 00:51:03,520
because this is really one of those

1299
00:51:08,710 --> 00:51:06,720
mind-bending questions that force you to

1300
00:51:10,390 --> 00:51:08,720
escape from your earth preconceptions

1301
00:51:11,670 --> 00:51:10,400
and intuitions from being being an

1302
00:51:13,670 --> 00:51:11,680
earthling okay

1303
00:51:16,309 --> 00:51:13,680
uh on earth we have the idea that if we

1304
00:51:18,630 --> 00:51:16,319
go somewhere cold we will be cold that's

1305
00:51:20,950 --> 00:51:18,640
because we live in this thick soup of an

1306
00:51:22,790 --> 00:51:20,960
atmosphere you know to a martian we

1307
00:51:25,349 --> 00:51:22,800
would look like fish swimming around in

1308
00:51:27,910 --> 00:51:25,359
warm water now if you asked an astronaut

1309
00:51:30,230 --> 00:51:27,920
such as you know my colleague in moxie

1310
00:51:33,349 --> 00:51:30,240
jeff hoffman who did four

1311
00:51:35,829 --> 00:51:33,359
uh spacewalks in the shuttle dates

1312
00:51:37,910 --> 00:51:35,839
space is really really cold but when you

1313
00:51:39,990 --> 00:51:37,920

as an astronaut as a human being go into

1314
00:51:42,309 --> 00:51:40,000
space in the space suit you are really

1315
00:51:44,069 --> 00:51:42,319
really warm and you're sweating you know

1316
00:51:47,030 --> 00:51:44,079
sweating like a pig

1317
00:51:48,390 --> 00:51:47,040
so the issue then is to stay

1318
00:51:50,870 --> 00:51:48,400
to stay cool

1319
00:51:52,470 --> 00:51:50,880
not to stay warm because you're kind of

1320
00:51:55,430 --> 00:51:52,480
in a thermospot

1321
00:51:58,950 --> 00:51:55,440
now mars is not space but it's not earth

1322
00:52:01,030 --> 00:51:58,960
either so for the most part on mars

1323
00:52:02,390 --> 00:52:01,040
despite the fact the air is cold you're

1324
00:52:04,710 --> 00:52:02,400
going to be warm because you're

1325
00:52:07,030 --> 00:52:04,720
generating heat and it's hard to shed

1326
00:52:10,150 --> 00:52:07,040
all that heat in such thin air

1327
00:52:11,910 --> 00:52:10,160
so that makes amy's job even harder

1328
00:52:14,390 --> 00:52:11,920
because she's going to have to keep you

1329
00:52:15,750 --> 00:52:14,400
cold as an astronaut and sometimes keep

1330
00:52:18,790 --> 00:52:15,760
you warm

1331
00:52:21,270 --> 00:52:18,800
fortunately one of the pillars of having

1332
00:52:23,109 --> 00:52:21,280
being able to survive on mars is to have

1333
00:52:24,870 --> 00:52:23,119
lots and lots of power to have a big

1334
00:52:28,390 --> 00:52:24,880
capable power system

1335
00:52:29,910 --> 00:52:28,400
and as amy said we know how to cool and

1336
00:52:32,309 --> 00:52:29,920
we know how to heat and we'll have to do

1337
00:52:34,390 --> 00:52:32,319
both thank you

1338
00:52:37,510 --> 00:52:34,400

well mike stay with us because our last

1339
00:52:40,950 --> 00:52:37,520
question is also for you on moxie it's

1340
00:52:44,390 --> 00:52:40,960
from amal cebu he tweeted at us in what

1341
00:52:46,870 --> 00:52:44,400
quantity will moxie produce oxygen and

1342
00:52:50,390 --> 00:52:46,880
how will it be analyzed and confirmed

1343
00:52:52,230 --> 00:52:50,400
that it is producing oxygen

1344
00:52:53,829 --> 00:52:52,240
uh thanks a lot for asking that the

1345
00:52:55,109 --> 00:52:53,839
actual numbers

1346
00:52:58,150 --> 00:52:55,119
will be

1347
00:53:00,710 --> 00:52:58,160
6 to 10 grams per hour that's compared

1348
00:53:03,349 --> 00:53:00,720
to an eventual goal and a full scale

1349
00:53:04,150 --> 00:53:03,359
system to do two to three kilograms an

1350
00:53:05,990 --> 00:53:04,160
hour

1351
00:53:07,990 --> 00:53:06,000
six to ten grams

1352
00:53:09,910 --> 00:53:08,000
is limited to some extent by how thin

1353
00:53:11,670 --> 00:53:09,920
the air is up in jezreel where we're

1354
00:53:14,390 --> 00:53:11,680
landing it's like we're landing on top

1355
00:53:16,309 --> 00:53:14,400
of everest if we humans are likely to

1356
00:53:18,309 --> 00:53:16,319
land in a much lower altitude where the

1357
00:53:20,549 --> 00:53:18,319
air is thicker and there we can make

1358
00:53:22,390 --> 00:53:20,559
maybe 20 grams with the same system

1359
00:53:24,790 --> 00:53:22,400
every hour and that's enough for you to

1360
00:53:26,870 --> 00:53:24,800
live if you don't run around too much

1361
00:53:28,630 --> 00:53:26,880
so that's what moxie will make

1362
00:53:31,109 --> 00:53:28,640
and

1363
00:53:32,549 --> 00:53:31,119

again it will make it for about an hour

1364
00:53:35,190 --> 00:53:32,559
or two at a time

1365
00:53:37,270 --> 00:53:35,200
it'll do this maybe 10 or so times

1366
00:53:41,670 --> 00:53:37,280
through the first year

1367
00:53:44,390 --> 00:53:42,870
thank you

1368
00:53:46,549 --> 00:53:44,400
jim i'd like to come back to you at

1369
00:53:48,710 --> 00:53:46,559
headquarters you've heard some of the

1370
00:53:51,270 --> 00:53:48,720
questions this afternoon

1371
00:53:53,990 --> 00:53:51,280
what thoughts do you have how far along

1372
00:53:55,589 --> 00:53:54,000
do you think we are into colonizing mars

1373
00:53:57,510 --> 00:53:55,599
and sending folks there it's what

1374
00:54:01,589 --> 00:53:57,520
everyone wants to know

1375
00:54:05,670 --> 00:54:03,910
sure so uh

1376
00:54:07,829 --> 00:54:05,680
having shepherd along these robotic

1377
00:54:09,829 --> 00:54:07,839
missions uh have a sense of just how

1378
00:54:12,630 --> 00:54:09,839
difficult it is for the robots to do

1379
00:54:14,870 --> 00:54:12,640
their job and how many people it takes

1380
00:54:17,270 --> 00:54:14,880
back at the control centers to to guide

1381
00:54:19,349 --> 00:54:17,280
the robots in their tasks so i think we

1382
00:54:21,190 --> 00:54:19,359
still have a lot to learn

1383
00:54:22,950 --> 00:54:21,200
to develop these systems that not only

1384
00:54:26,390 --> 00:54:22,960
can support

1385
00:54:28,790 --> 00:54:26,400
a human and take care of a safe

1386
00:54:30,230 --> 00:54:28,800
environment for them to live and to take

1387
00:54:33,190 --> 00:54:30,240
care of all their many needs for

1388
00:54:35,990 --> 00:54:33,200

survival but also to move them around i

1389
00:54:38,390 --> 00:54:36,000
think it was mentioned that the uh

1390
00:54:40,470 --> 00:54:38,400
the human system scale in size by

1391
00:54:42,630 --> 00:54:40,480
perhaps a factor of 20

1392
00:54:45,910 --> 00:54:42,640
over the size of the rovers that we've

1393
00:54:48,710 --> 00:54:45,920
been sending here so we still have to uh

1394
00:54:50,870 --> 00:54:48,720
to learn how to master all of the tasks

1395
00:54:53,270 --> 00:54:50,880
in going back and forth from earth as

1396
00:54:55,589 --> 00:54:53,280
well as doing work safely on the surface

1397
00:54:57,349 --> 00:54:55,599
of mars before we can send humans and

1398
00:54:59,430 --> 00:54:57,359
that's one of the exciting

1399
00:55:01,670 --> 00:54:59,440
things about where we are in a robotic

1400
00:55:04,470 --> 00:55:01,680
program right now as we move ahead with

1401
00:55:05,990 --> 00:55:04,480
perseverance and we collect the let's

1402
00:55:08,309 --> 00:55:06,000
call them the souvenirs that we want to

1403
00:55:10,870 --> 00:55:08,319
bring home the samples and then we

1404
00:55:12,390 --> 00:55:10,880
through the sample return campaign we

1405
00:55:13,910 --> 00:55:12,400
figure out and learn how to bring

1406
00:55:15,990 --> 00:55:13,920
samples home

1407
00:55:17,990 --> 00:55:16,000
back to earth we'll have solved a lot of

1408
00:55:20,309 --> 00:55:18,000
the same system engineering problems

1409
00:55:23,190 --> 00:55:20,319
that the human crew designers have to

1410
00:55:25,430 --> 00:55:23,200
solve for the larger systems there

1411
00:55:27,990 --> 00:55:25,440
but then we have to add the complexity

1412
00:55:29,670 --> 00:55:28,000
of all of the additional life support

1413
00:55:31,589 --> 00:55:29,680

and other equipment that we have to

1414
00:55:33,990 --> 00:55:31,599
bring with the humans that's being

1415
00:55:36,150 --> 00:55:34,000
worked on through the the uh the human

1416
00:55:38,390 --> 00:55:36,160
program and the artemis program going

1417
00:55:40,549 --> 00:55:38,400
back to the moon trying to get those

1418
00:55:42,870 --> 00:55:40,559
systems down so the everything that it

1419
00:55:44,549 --> 00:55:42,880
takes to support the crew and on a

1420
00:55:47,030 --> 00:55:44,559
robotic side we're trying to get the

1421
00:55:48,950 --> 00:55:47,040
understanding of the planet and and act

1422
00:55:50,630 --> 00:55:48,960
as precursors if you will to figure out

1423
00:55:53,430 --> 00:55:50,640
the next set of problems that will have

1424
00:55:54,950 --> 00:55:53,440
to be addressed by the human system so

1425
00:55:57,270 --> 00:55:54,960
you know we're looking at hoping that

1426
00:55:59,430 --> 00:55:57,280
you know sometime in the 2030s we'll be

1427
00:56:01,589 --> 00:55:59,440
able to attempt a first trip there we'll

1428
00:56:03,990 --> 00:56:01,599
have bring all the system engineering

1429
00:56:05,589 --> 00:56:04,000
together that we've done in the robotics

1430
00:56:07,349 --> 00:56:05,599
program and all the lessons that we'll

1431
00:56:09,349 --> 00:56:07,359
have learned with our return to the moon

1432
00:56:10,549 --> 00:56:09,359
and put it together so it looks like

1433
00:56:11,750 --> 00:56:10,559
it's going to be a very bright and

1434
00:56:15,109 --> 00:56:11,760
exciting

1435
00:56:19,430 --> 00:56:17,349
thank you jim you did a beautiful job

1436
00:56:22,150 --> 00:56:19,440
weaving everything back together again

1437
00:56:24,950 --> 00:56:22,160
as a bookend to our briefing this hour

1438
00:56:27,430 --> 00:56:24,960

has flown by we are so grateful to the

1439
00:56:28,870 --> 00:56:27,440
media the ones that we could understand

1440
00:56:31,030 --> 00:56:28,880
your questions i'm sorry that we had

1441
00:56:32,870 --> 00:56:31,040
technical problems at one point and

1442
00:56:35,510 --> 00:56:32,880
we're also very grateful for the social

1443
00:56:38,470 --> 00:56:35,520
media questions again we encourage you

1444
00:56:40,390 --> 00:56:38,480
to follow the mission at nasa persevere

1445
00:56:42,950 --> 00:56:40,400
and we would love to keep engaging with

1446
00:56:45,190 --> 00:56:42,960
all of you so please keep using

1447
00:56:48,230 --> 00:56:45,200
countdown to mars and keep sending us

1448
00:56:51,349 --> 00:56:48,240
your questions and your comments

1449
00:56:53,829 --> 00:56:51,359
how here we go mars 2020 thursday

1450
00:56:55,190 --> 00:56:53,839
morning our live launch coverage starts

1451
00:56:57,589 --> 00:56:55,200
at 7 a.m

1452
00:57:00,309 --> 00:56:57,599
we will see you back here

1453
00:57:02,630 --> 00:57:00,319
and we have a launch at 7 50 if all

1454
00:57:04,470 --> 00:57:02,640
things if everything goes to plan

1455
00:57:06,950 --> 00:57:04,480
and we appreciate you joining us this

1456
00:57:09,829 --> 00:57:06,960
afternoon thank you so much