1
00:00:04,870 --> 00:00:02,389
welcome to nasa's jet propulsion

2
00:00:07,590 --> 00:00:04,880
laboratory in southern california

3
00:00:10,070 --> 00:00:07,600
i'm vacuum viennueva the ingenuity

4
00:00:12,549 --> 00:00:10,080
helicopter is now standing on its own

5
00:00:13,110 --> 00:00:12,559
on mars after hitching a ride to the red

6
00:00:16,150 --> 00:00:13,120
planet

7
00:00:18,630 --> 00:00:16,160
on the perseverance rover today we are

8
00:00:20,390 --> 00:00:18,640
looking ahead to ingenuity's takeoff

9
00:00:21,510 --> 00:00:20,400
with some of the members from the mars

10
00:00:24,070 --> 00:00:21,520
helicopter team

11
00:00:26,550 --> 00:00:24,080
who will be answering your questions

12
00:00:27,349 --> 00:00:26,560
ingenuity project manager mimi um will

13
00:00:30,870 --> 00:00:27,359

join us

14
00:00:34,709 --> 00:00:30,880
later with us now is ingenuity deputy

15
00:00:36,549 --> 00:00:34,719
deputy operations lead teddy sanetos

16
00:00:37,990 --> 00:00:36,559
teddy thanks for joining us thank you

17
00:00:41,430 --> 00:00:38,000
for having me remember

18
00:00:44,549 --> 00:00:41,440
to use the mars helicopter hashtag

19
00:00:47,510 --> 00:00:44,559
to ask a question so teddy

20
00:00:50,470 --> 00:00:47,520
can you walk us through how the mars

21
00:00:53,990 --> 00:00:50,480
helicopter was able to stand on its own

22
00:00:55,750 --> 00:00:54,000
sure so the whole team's super excited

23
00:00:57,590 --> 00:00:55,760
right now we

24
00:00:58,790 --> 00:00:57,600
just got through a lot of huge

25
00:01:00,389 --> 00:00:58,800
milestones

26
00:01:02,229 --> 00:01:00,399
now that we are in our official

27
00:01:03,590 --> 00:01:02,239
helicopter mission phase

28
00:01:05,429 --> 00:01:03,600
to get to the point where we're standing

29
00:01:07,190 --> 00:01:05,439
on all four feet required

30
00:01:09,750 --> 00:01:07,200
a lot of intricate deployments from the

31
00:01:11,830 --> 00:01:09,760
rover perseverance

32
00:01:13,350 --> 00:01:11,840
since launch we've been in the belly

33
00:01:16,950 --> 00:01:13,360
compartment of perseverance

34
00:01:19,590 --> 00:01:16,960
so underneath the deck and

35
00:01:21,109 --> 00:01:19,600
after we went through edl last you know

36
00:01:22,550 --> 00:01:21,119
since arriving on mars

37
00:01:25,350 --> 00:01:22,560
we've been staying there getting charged

38
00:01:27,270 --> 00:01:25,360

periodically kept warm from from the

39
00:01:30,390 --> 00:01:27,280
energy from perseverance

40
00:01:31,910 --> 00:01:30,400
um but we just completed uh recently our

41
00:01:32,950 --> 00:01:31,920
deployment sequence where we've been

42
00:01:35,190 --> 00:01:32,960
unfolded

43
00:01:36,149 --> 00:01:35,200
uh our legs have been deployed we went

44
00:01:37,830 --> 00:01:36,159
vertical

45
00:01:39,350 --> 00:01:37,840
and very recently we were just dropped

46
00:01:40,310 --> 00:01:39,360
onto the surface for the first time and

47
00:01:42,550 --> 00:01:40,320
now

48
00:01:44,469 --> 00:01:42,560
we're on our own we're we're a separate

49
00:01:47,429 --> 00:01:44,479
uh spacecraft on mars uh

50
00:01:51,590 --> 00:01:47,439
on our own energy uh and and the team

51
00:01:57,910 --> 00:01:55,109
oh it was uh it was a dream come true uh

52
00:01:59,190 --> 00:01:57,920
it it to to see the culmination of the

53
00:02:02,310 --> 00:01:59,200
entire team's hard work

54
00:02:04,789 --> 00:02:02,320
really pay off um being dropped

55
00:02:06,389 --> 00:02:04,799
right that's one huge milestone but the

56
00:02:08,389 --> 00:02:06,399
massive one for us

57
00:02:10,229 --> 00:02:08,399
uh over the last two days has been

58
00:02:12,390 --> 00:02:10,239
realizing not only did we

59
00:02:13,270 --> 00:02:12,400
drop um but we actually survived the

60
00:02:16,390 --> 00:02:13,280
first night

61
00:02:18,869 --> 00:02:16,400
that is huge that is that was one of the

62
00:02:20,390 --> 00:02:18,879
huge huge achievements that we've been

63
00:02:22,309 --> 00:02:20,400

looking forward to

64
00:02:24,710 --> 00:02:22,319
and now we can move on to the rest of

65
00:02:26,869 --> 00:02:24,720
the mission but being able to drop

66
00:02:28,390 --> 00:02:26,879
uh under our own energy sustain

67
00:02:29,830 --> 00:02:28,400
ourselves keep ourselves warm throughout

68
00:02:31,990 --> 00:02:29,840
the night and then wake up

69
00:02:33,750 --> 00:02:32,000
and talk with perseverance and say yep

70
00:02:35,830 --> 00:02:33,760
we're here we're alive and healthy

71
00:02:37,430 --> 00:02:35,840
uh the team couldn't be happier now you

72
00:02:39,670 --> 00:02:37,440
said this was a dream come true could

73
00:02:42,070 --> 00:02:39,680
you kind of talk us through your career

74
00:02:43,350 --> 00:02:42,080
which led you to eventually be on the

75
00:02:46,229 --> 00:02:43,360
mayor's helicopter team

76
00:02:47,910 --> 00:02:46,239
sure uh ever since i was a little kid

77
00:02:52,070 --> 00:02:47,920
i've been infatuated with

78
00:02:54,550 --> 00:02:52,080
computers electronics robotics my dad

79
00:02:55,509 --> 00:02:54,560
got me started at about eight to nine

80
00:02:58,470 --> 00:02:55,519
years old

81
00:02:59,430 --> 00:02:58,480
uh playing with robotic components

82
00:03:01,910 --> 00:02:59,440
playing with

83
00:03:03,589 --> 00:03:01,920
with some sewing machine parts and

84
00:03:04,949 --> 00:03:03,599
eventually taught me how to build my own

85
00:03:07,589 --> 00:03:04,959
first computer

86
00:03:08,790 --> 00:03:07,599
from there it kind of snowballed and i

87
00:03:09,990 --> 00:03:08,800
went to study computer science

88
00:03:12,790 --> 00:03:10,000

electrical engineering

89
00:03:14,229 --> 00:03:12,800
for undergrad and graduate school and

90
00:03:16,070 --> 00:03:14,239
from there on i was hooked

91
00:03:18,070 --> 00:03:16,080
any time that i saw something doing

92
00:03:19,830 --> 00:03:18,080
anything on its own autonomously

93
00:03:22,550 --> 00:03:19,840
i want to know how does it work i want

94
00:03:25,110 --> 00:03:22,560
to take it apart i want to figure it out

95
00:03:26,390 --> 00:03:25,120
and after graduate school i worked a

96
00:03:27,910 --> 00:03:26,400
couple years in the field

97
00:03:29,350 --> 00:03:27,920
and then was eventually lucky enough to

98
00:03:30,949 --> 00:03:29,360
land a job here at the jet propulsion

99
00:03:33,030 --> 00:03:30,959
laboratory to work on

100
00:03:34,229 --> 00:03:33,040
once in a lifetime kind of project like

101
00:03:37,830 --> 00:03:34,239
ingenuity

102
00:03:38,390 --> 00:03:37,840
that's great all the questions i have

103
00:03:41,670 --> 00:03:38,400
for you

104
00:03:42,149 --> 00:03:41,680
can we now go to our social media

105
00:03:45,430 --> 00:03:42,159
questions

106
00:03:48,550 --> 00:03:45,440
please all right let's head over

107
00:03:52,710 --> 00:03:48,560
to the first question

108
00:03:57,589 --> 00:03:55,670
deja soo on twitter asks are all

109
00:03:58,390 --> 00:03:57,599
ingenuity rotor blades basically

110
00:04:01,589 --> 00:03:58,400
identical

111
00:04:04,309 --> 00:04:01,599
and is it best to say it has two blades

112
00:04:05,990 --> 00:04:04,319
or four so there are four separate

113
00:04:08,070 --> 00:04:06,000

blades on ingenuity

114
00:04:09,750 --> 00:04:08,080
uh and there are two comprising the two

115
00:04:10,470 --> 00:04:09,760
rotors so each rotor has two blades one

116
00:04:12,229 --> 00:04:10,480
on the top

117
00:04:13,750 --> 00:04:12,239
one on the bottom and they spin counter

118
00:04:16,629 --> 00:04:13,760
to each other

119
00:04:17,509 --> 00:04:16,639
so in terms of are they different the

120
00:04:19,030 --> 00:04:17,519
the the two

121
00:04:21,509 --> 00:04:19,040
directionalities of the blades are

122
00:04:22,710 --> 00:04:21,519
different but the aerodynamic designs of

123
00:04:24,790 --> 00:04:22,720
them are similar

124
00:04:26,469 --> 00:04:24,800
you'll also note that there are counter

125
00:04:28,629 --> 00:04:26,479
there are pitch weights

126
00:04:29,830 --> 00:04:28,639
those little pointy things at the root

127
00:04:31,270 --> 00:04:29,840
of the blades

128
00:04:32,629 --> 00:04:31,280
those obviously between the upper and

129
00:04:33,189 --> 00:04:32,639
the lower are different but aside from

130
00:04:34,469 --> 00:04:33,199
that

131
00:04:35,990 --> 00:04:34,479
the direction in which they're designed

132
00:04:37,110 --> 00:04:36,000
to spin and the direction that the pitch

133
00:04:40,390 --> 00:04:37,120
weights go

134
00:04:43,189 --> 00:04:40,400
they're effectively the same now transit

135
00:04:44,950 --> 00:04:43,199
signal on twitter notes it appears that

136
00:04:47,270 --> 00:04:44,960
the mars helicopter ingenuity

137
00:04:48,150 --> 00:04:47,280
has a bit of dust on its solar panels

138
00:04:51,590 --> 00:04:48,160

already

139
00:04:53,670 --> 00:04:51,600
is that a problem uh no we saw some

140
00:04:56,629 --> 00:04:53,680
initial images from the rover

141
00:04:57,749 --> 00:04:56,639
we got some high resolution uh haz cam

142
00:04:59,670 --> 00:04:57,759
images

143
00:05:00,790 --> 00:04:59,680
looking down at a kind of upward angle

144
00:05:02,230 --> 00:05:00,800
onto the solar panel

145
00:05:04,390 --> 00:05:02,240
which is great it's fantastic to see

146
00:05:05,909 --> 00:05:04,400
that that new imagery

147
00:05:07,749 --> 00:05:05,919
and you can see there there looks like

148
00:05:08,710 --> 00:05:07,759
there's some dust accumulation but in

149
00:05:11,029 --> 00:05:08,720
fact yesterday

150
00:05:12,070 --> 00:05:11,039
was the first time that we got our noon

151
00:05:14,390 --> 00:05:12,080
time mars

152
00:05:15,510 --> 00:05:14,400
uh solar ray characterization a huge

153
00:05:17,590 --> 00:05:15,520
step for us

154
00:05:18,950 --> 00:05:17,600
and the solar array is working perfectly

155
00:05:21,189 --> 00:05:18,960
uh

156
00:05:22,310 --> 00:05:21,199
it lined up right where we had expected

157
00:05:24,310 --> 00:05:22,320
it to

158
00:05:25,590 --> 00:05:24,320
and as a result of that we know that it

159
00:05:27,110 --> 00:05:25,600
charged our batteries up

160
00:05:29,110 --> 00:05:27,120
right before we communicated with it so

161
00:05:30,950 --> 00:05:29,120
the system energetically

162
00:05:32,230 --> 00:05:30,960
it's working fantastic uh we couldn't be

163
00:05:34,150 --> 00:05:32,240

happier

164
00:05:35,430 --> 00:05:34,160
that's good news and now henry on

165
00:05:37,430 --> 00:05:35,440
twitter asks

166
00:05:39,110 --> 00:05:37,440
how is the mars helicopter protected

167
00:05:41,830 --> 00:05:39,120
from a harsh environment

168
00:05:42,629 --> 00:05:41,840
storms etc can the helicopter be

169
00:05:47,029 --> 00:05:42,639
protected

170
00:05:49,350 --> 00:05:47,039
by perseverance no uh so so

171
00:05:51,029 --> 00:05:49,360
the the mission is designed so that once

172
00:05:52,150 --> 00:05:51,039
we get to our flight phase

173
00:05:54,550 --> 00:05:52,160
perseverance is going to be at a

174
00:05:56,070 --> 00:05:54,560
standoff distance uh

175
00:05:57,749 --> 00:05:56,080
a safe distance away so that we could

176
00:06:00,230 --> 00:05:57,759
fly in our flight zone

177
00:06:00,950 --> 00:06:00,240
uh and execute our five flights coming

178
00:06:03,909 --> 00:06:00,960
up

179
00:06:04,390 --> 00:06:03,919
um so there's no notion of guarding

180
00:06:07,110 --> 00:06:04,400
against

181
00:06:08,150 --> 00:06:07,120
wind or any other uh effect or dust or

182
00:06:09,990 --> 00:06:08,160
something like that

183
00:06:11,590 --> 00:06:10,000
we're on our own right and and that's

184
00:06:13,029 --> 00:06:11,600
that's part of the challenge that's part

185
00:06:16,469 --> 00:06:13,039
of the excitement

186
00:06:17,990 --> 00:06:16,479
of what's to come here um we just uh

187
00:06:20,070 --> 00:06:18,000
like i said we just got through our noon

188
00:06:23,029 --> 00:06:20,080

time wake up yesterday

189
00:06:24,870 --> 00:06:23,039
but there are important steps up ahead

190
00:06:26,629 --> 00:06:24,880
the next two soles on mars will be doing

191
00:06:28,150 --> 00:06:26,639
energy evaluation

192
00:06:30,309 --> 00:06:28,160
wanting to make sure that our thermal

193
00:06:31,909 --> 00:06:30,319
models are tuned our thermal set points

194
00:06:34,469 --> 00:06:31,919
are tuned correctly

195
00:06:36,390 --> 00:06:34,479
inside the gold box here is where all of

196
00:06:39,110 --> 00:06:36,400
our precious electronics are and our

197
00:06:40,469 --> 00:06:39,120
lithium ion batteries and we're going to

198
00:06:41,430 --> 00:06:40,479
look at the data from the next two days

199
00:06:43,270 --> 00:06:41,440
to make sure that

200
00:06:45,510 --> 00:06:43,280
they're staying warm well throughout the

201
00:06:47,430 --> 00:06:45,520
night and that by the time the sun rises

202
00:06:48,550 --> 00:06:47,440
and we get more photons on the solar

203
00:06:50,629 --> 00:06:48,560
panel

204
00:06:52,790 --> 00:06:50,639
we still have enough energy to make it

205
00:06:55,830 --> 00:06:52,800
there speaking of the batteries

206
00:06:57,749 --> 00:06:55,840
valentine on youtube asks how long can

207
00:07:01,029 --> 00:06:57,759
it fly on full batteries

208
00:07:04,070 --> 00:07:01,039
sure 90 seconds is what we're targeting

209
00:07:06,629 --> 00:07:04,080
for the average of our flights uh

210
00:07:08,390 --> 00:07:06,639
the first flight though right that's

211
00:07:10,629 --> 00:07:08,400
going to be the most critical

212
00:07:12,710 --> 00:07:10,639
and right now that's a simple take off

213
00:07:15,110 --> 00:07:12,720

hover and land back down

214
00:07:17,270 --> 00:07:15,120
but 90 seconds is is kind of the average

215
00:07:18,950 --> 00:07:17,280
uh flight length that we're looking for

216
00:07:20,150 --> 00:07:18,960
everything after that first flight not

217
00:07:21,909 --> 00:07:20,160
as critical that first one's the

218
00:07:23,270 --> 00:07:21,919
important one we are a tech demo and we

219
00:07:23,830 --> 00:07:23,280
want to make sure that first light works

220
00:07:27,029 --> 00:07:23,840
out

221
00:07:30,070 --> 00:07:27,039
coming in sure here

222
00:07:32,469 --> 00:07:30,080
on youtube asks what is the voltage

223
00:07:33,270 --> 00:07:32,479
and amperage of the battery of the

224
00:07:36,390 --> 00:07:33,280
helicopter

225
00:07:36,950 --> 00:07:36,400
sure at 100 state of charge it's 25.2

226
00:07:39,749 --> 00:07:36,960
volts

227
00:07:40,629 --> 00:07:39,759
so there we have six lithium ion cells

228
00:07:43,830 --> 00:07:40,639
uh each one

229
00:07:45,830 --> 00:07:43,840
at 100 is 4.2 volts so you multiply that

230
00:07:48,230 --> 00:07:45,840
out you get 25.2

231
00:07:49,909 --> 00:07:48,240
and again that's at 100 state of charge

232
00:07:53,589 --> 00:07:49,919
that fluctuates throughout the day

233
00:07:56,309 --> 00:07:53,599
as we use energy to power electronics

234
00:07:56,950 --> 00:07:56,319
talk back with perseverance and then the

235
00:07:58,469 --> 00:07:56,960
big

236
00:08:01,189 --> 00:07:58,479
chunk of energy goes into heating

237
00:08:03,909 --> 00:08:01,199
ourselves overnight

238
00:08:04,950 --> 00:08:03,919

and that kind of leads us into celebi on

239
00:08:08,230 --> 00:08:04,960
youtube

240
00:08:11,110 --> 00:08:08,240
asks what extent do cold nights on the

241
00:08:12,790 --> 00:08:11,120
surface of mars affect the ingenuity

242
00:08:15,670 --> 00:08:12,800
helicopter i assume they're saying does

243
00:08:19,029 --> 00:08:15,680
it affect its lifespan

244
00:08:19,510 --> 00:08:19,039
so from uh let me break that question up

245
00:08:21,270 --> 00:08:19,520
into

246
00:08:22,629 --> 00:08:21,280
the separate part so okay uh to what

247
00:08:25,589 --> 00:08:22,639
extent does it affect us

248
00:08:26,950 --> 00:08:25,599
massively right temperatures are huge

249
00:08:28,469 --> 00:08:26,960
and that's what we're spending the next

250
00:08:30,710 --> 00:08:28,479
two soles on mars doing

251
00:08:31,510 --> 00:08:30,720
is is proving out our models making sure

252
00:08:34,310 --> 00:08:31,520
that that

253
00:08:34,709 --> 00:08:34,320
we have enough margin to to to to like i

254
00:08:36,550 --> 00:08:34,719
said

255
00:08:38,149 --> 00:08:36,560
come out in the morning with enough

256
00:08:39,670 --> 00:08:38,159
juice in the tank so to speak

257
00:08:41,190 --> 00:08:39,680
uh to communicate to perseverance when

258
00:08:43,990 --> 00:08:41,200
it's time um

259
00:08:45,509 --> 00:08:44,000
so it's a huge focus for the team uh

260
00:08:46,790 --> 00:08:45,519
yesterday was a massive success and

261
00:08:48,230 --> 00:08:46,800
again the next two souls are really

262
00:08:51,190 --> 00:08:48,240
going to be tuning that in

263
00:08:53,030 --> 00:08:51,200

in terms of the uh lifetime the mission

264
00:08:57,509 --> 00:08:53,040
lifetime is only 30 souls

265
00:08:59,590 --> 00:08:57,519
so uh while examples of other

266
00:09:00,630 --> 00:08:59,600
uh robotic platforms that we've sent to

267
00:09:02,630 --> 00:09:00,640
mars right

268
00:09:04,150 --> 00:09:02,640
have definitely lasted longer than the

269
00:09:07,269 --> 00:09:04,160
initial lifetime

270
00:09:09,750 --> 00:09:07,279
our mission is is to knock out a

271
00:09:11,030 --> 00:09:09,760
one flight and then four additional

272
00:09:13,430 --> 00:09:11,040
flights after that

273
00:09:15,110 --> 00:09:13,440
within those 30 salts you mentioned it's

274
00:09:16,630 --> 00:09:15,120
similar to sojourner exactly

275
00:09:19,110 --> 00:09:16,640
yeah just like sojourner was a

276
00:09:21,509 --> 00:09:19,120
technology demonstration for

277
00:09:23,190 --> 00:09:21,519
what we have now for rovers right we

278
00:09:25,110 --> 00:09:23,200
didn't always have large

279
00:09:26,470 --> 00:09:25,120
very capable rovers on mars it started

280
00:09:28,150 --> 00:09:26,480
off as a technology demonstration that

281
00:09:30,550 --> 00:09:28,160
we see here

282
00:09:31,910 --> 00:09:30,560
we hope that ingenuity will do the same

283
00:09:33,990 --> 00:09:31,920
for the future of martian aerial

284
00:09:36,310 --> 00:09:34,000
exploration

285
00:09:37,430 --> 00:09:36,320
and up next that kind of leads us to

286
00:09:39,750 --> 00:09:37,440
john's question

287
00:09:41,110 --> 00:09:39,760
on twitter he asks what will the mars

288
00:09:44,710 --> 00:09:41,120

helicopter do

289
00:09:47,350 --> 00:09:44,720
what's its purpose uh so

290
00:09:49,670 --> 00:09:47,360
hinted at that earlier um we are a

291
00:09:51,430 --> 00:09:49,680
technology demonstrator period

292
00:09:53,750 --> 00:09:51,440
ingenuity does not carry any science

293
00:09:57,030 --> 00:09:53,760
payloads we are not a

294
00:09:59,509 --> 00:09:57,040
science uh you know oriented mission

295
00:10:01,269 --> 00:09:59,519
our goal plain and simple is to prove

296
00:10:03,670 --> 00:10:01,279
that we can fly on mars

297
00:10:05,350 --> 00:10:03,680
once we do that we hope that this is

298
00:10:06,150 --> 00:10:05,360
going to blow the doors open for the

299
00:10:08,790 --> 00:10:06,160
future

300
00:10:09,990 --> 00:10:08,800
of of martian exploration unlocking that

301
00:10:11,430 --> 00:10:10,000
aerial dimension

302
00:10:13,670 --> 00:10:11,440
we think is going to be extremely

303
00:10:16,790 --> 00:10:13,680
exciting for humanity uh

304
00:10:17,190 --> 00:10:16,800
and for scientists within nasa um and

305
00:10:19,670 --> 00:10:17,200
the

306
00:10:21,509 --> 00:10:19,680
you know larger exploration community uh

307
00:10:23,509 --> 00:10:21,519
we really think this is going to be

308
00:10:26,949 --> 00:10:23,519
that kind of breakthrough moment for us

309
00:10:29,670 --> 00:10:26,959
to try out new ways to explore mars

310
00:10:30,150 --> 00:10:29,680
and up next um michael on youtube wants

311
00:10:33,509 --> 00:10:30,160
to know

312
00:10:34,069 --> 00:10:33,519
how high will it go uh so a handful of

313
00:10:37,110 --> 00:10:34,079

meters

314
00:10:40,550 --> 00:10:37,120
um uh especially for that first flight

315
00:10:42,790 --> 00:10:40,560
we want to just maintain you know uh a

316
00:10:44,470 --> 00:10:42,800
close range uh we're not gonna be going

317
00:10:45,350 --> 00:10:44,480
for any long-range distances like i said

318
00:10:47,990 --> 00:10:45,360
we're just gonna

319
00:10:48,470 --> 00:10:48,000
take off hover a couple meters off the

320
00:10:50,790 --> 00:10:48,480
ground

321
00:10:52,470 --> 00:10:50,800
and then come back down and for american

322
00:10:54,790 --> 00:10:52,480
viewers how much is that in

323
00:10:56,949 --> 00:10:54,800
feet uh about we're gonna go about 15

324
00:11:00,230 --> 00:10:56,959
feet off the ground

325
00:11:02,470 --> 00:11:00,240
now ralph on youtube asks did you use

326
00:11:03,910 --> 00:11:02,480
open source hardware software just for

327
00:11:06,790 --> 00:11:03,920
this tech demo

328
00:11:08,470 --> 00:11:06,800
uh yeah so there's there's a good amount

329
00:11:10,949 --> 00:11:08,480
of open source software

330
00:11:13,030 --> 00:11:10,959
um f prime which those of you at home

331
00:11:15,590 --> 00:11:13,040
can go onto github right now and

332
00:11:16,710 --> 00:11:15,600
look at the f-prime repositories that

333
00:11:19,990 --> 00:11:16,720
are open sourced

334
00:11:23,030 --> 00:11:20,000
runs ingenuity that is the key

335
00:11:25,750 --> 00:11:23,040
to to all of the software architecture

336
00:11:27,509 --> 00:11:25,760
that ingenuity runs on and not just

337
00:11:29,590 --> 00:11:27,519
ingenuity but the base station for

338
00:11:31,829 --> 00:11:29,600

ingenuity on the rover as well

339
00:11:33,590 --> 00:11:31,839
so yeah huge component of how we we

340
00:11:37,190 --> 00:11:33,600
operate

341
00:11:39,509 --> 00:11:37,200
and up next is pilot pico on youtube

342
00:11:41,590 --> 00:11:39,519
says let's hope a dust devil doesn't

343
00:11:44,230 --> 00:11:41,600
come along and knock over ingenuity

344
00:11:46,389 --> 00:11:44,240
before its first inaugural flight now is

345
00:11:49,430 --> 00:11:46,399
that scenario possible

346
00:11:49,829 --> 00:11:49,440
right so uh this question has come up a

347
00:11:51,829 --> 00:11:49,839
lot

348
00:11:53,350 --> 00:11:51,839
uh for a bunch of different uh team

349
00:11:56,629 --> 00:11:53,360
members

350
00:11:58,230 --> 00:11:56,639
the way that martian uh dust storms and

351
00:12:00,550 --> 00:11:58,240
windstorms are portrayed

352
00:12:02,069 --> 00:12:00,560
in movies is a little exaggerated um the

353
00:12:03,670 --> 00:12:02,079
thing that that you need to keep in mind

354
00:12:06,230 --> 00:12:03,680
is that the martian atmosphere is one

355
00:12:08,470 --> 00:12:06,240
percent the density of earth's

356
00:12:09,509 --> 00:12:08,480
not a lot of not a lot of you know

357
00:12:12,550 --> 00:12:09,519
molecules

358
00:12:14,870 --> 00:12:12,560
falling around or flowing around in the

359
00:12:15,750 --> 00:12:14,880
air to impart a lot of inertia to knock

360
00:12:17,590 --> 00:12:15,760
something over

361
00:12:19,750 --> 00:12:17,600
that's not to say that it wasn't looked

362
00:12:22,069 --> 00:12:19,760
at and analyzed

363
00:12:23,269 --> 00:12:22,079

our engineers did look at you know what

364
00:12:25,030 --> 00:12:23,279
are some of the peak

365
00:12:26,389 --> 00:12:25,040
wind velocities that we could see on the

366
00:12:28,069 --> 00:12:26,399
surface and

367
00:12:29,430 --> 00:12:28,079
you know how might that pose a risk to

368
00:12:30,870 --> 00:12:29,440
us that's

369
00:12:32,550 --> 00:12:30,880
a landed concern and then there's also

370
00:12:33,910 --> 00:12:32,560
the flight concern right how do those

371
00:12:37,350 --> 00:12:33,920
winds affect us

372
00:12:38,870 --> 00:12:37,360
uh when we're aloft right and

373
00:12:40,389 --> 00:12:38,880
that's part of the testing campaign the

374
00:12:41,670 --> 00:12:40,399
extensive testing campaign that we did

375
00:12:43,750 --> 00:12:41,680
here at jpl

376
00:12:46,470 --> 00:12:43,760
we're lucky enough to have a space

377
00:12:50,470 --> 00:12:46,480
simulator uh 25-foot space simulator

378
00:12:52,949 --> 00:12:50,480
um 25 feet wide uh several stories tall

379
00:12:54,790 --> 00:12:52,959
and we built our own martian wind tunnel

380
00:12:57,670 --> 00:12:54,800
in there to to test that out

381
00:12:59,430 --> 00:12:57,680
see how does the baby perform in a

382
00:13:01,190 --> 00:12:59,440
little bit of crosswind

383
00:13:02,790 --> 00:13:01,200
so it's not the same image that people

384
00:13:06,230 --> 00:13:02,800
might have of a dust devil on earth

385
00:13:08,710 --> 00:13:06,240
at all no all right scott on youtube

386
00:13:09,750 --> 00:13:08,720
says from the photos it appears that the

387
00:13:11,910 --> 00:13:09,760
solar powers oh

388
00:13:13,269 --> 00:13:11,920

we already took a question similar to

389
00:13:14,389 --> 00:13:13,279
that so i'm going to go on to terry on

390
00:13:16,389 --> 00:13:14,399
youtube who asks

391
00:13:18,389 --> 00:13:16,399
will you be checking for wind gusts

392
00:13:22,150 --> 00:13:18,399
before it takes off

393
00:13:25,670 --> 00:13:22,160
uh so we're gonna try and characterize

394
00:13:27,269 --> 00:13:25,680
uh soul to soul um as best we can

395
00:13:28,790 --> 00:13:27,279
the environment leading up to first

396
00:13:30,310 --> 00:13:28,800
flight but

397
00:13:32,629 --> 00:13:30,320
there won't be an instantaneous

398
00:13:36,230 --> 00:13:32,639
pre-flight check for wind gusts

399
00:13:38,150 --> 00:13:36,240
uh the way operations works with mars is

400
00:13:40,069 --> 00:13:38,160
we need to kind of send the signals up

401
00:13:40,870 --> 00:13:40,079
we go to bed and we wake up the next day

402
00:13:43,990 --> 00:13:40,880
and find out

403
00:13:46,870 --> 00:13:44,000
how things went so there is no

404
00:13:48,629 --> 00:13:46,880
notion for flight operations of being

405
00:13:50,870 --> 00:13:48,639
able to do an immediate lifetime check

406
00:13:55,509 --> 00:13:50,880
like that

407
00:13:57,910 --> 00:13:55,519
and then up next we have uh

408
00:13:59,269 --> 00:13:57,920
barat on twitter asks is it going to be

409
00:14:03,110 --> 00:13:59,279
possible to watch

410
00:14:06,710 --> 00:14:03,120
the mars helicopter while flying

411
00:14:08,790 --> 00:14:06,720
uh i guess there's two ways i guess

412
00:14:10,710 --> 00:14:08,800
that question may be meant to be phrased

413
00:14:12,629 --> 00:14:10,720

so uh

414
00:14:15,030 --> 00:14:12,639
you can follow along with us after we

415
00:14:17,269 --> 00:14:15,040
downlink uh the telemetry and

416
00:14:18,150 --> 00:14:17,279
and later on some images but that won't

417
00:14:20,150 --> 00:14:18,160
be live that

418
00:14:21,670 --> 00:14:20,160
like i said that'll again be the soul

419
00:14:23,670 --> 00:14:21,680
after um

420
00:14:25,110 --> 00:14:23,680
or several souls after we fly to get all

421
00:14:28,710 --> 00:14:25,120
that telemetry back

422
00:14:30,230 --> 00:14:28,720
uh there's also the component of what

423
00:14:32,150 --> 00:14:30,240
will perseverance be doing uh

424
00:14:34,069 --> 00:14:32,160
we're going to try to get some images

425
00:14:36,310 --> 00:14:34,079
from perseverance's perspective of

426
00:14:39,269 --> 00:14:36,320
ingenuity when we're in flight as well

427
00:14:41,110 --> 00:14:39,279
but again that won't be live what will

428
00:14:44,389 --> 00:14:41,120
it be like for you watching

429
00:14:46,310 --> 00:14:44,399
and waiting for a

430
00:14:47,910 --> 00:14:46,320
one of the most uh nervous moments of my

431
00:14:50,310 --> 00:14:47,920
life um

432
00:14:51,110 --> 00:14:50,320
and the whole team uh you know we're

433
00:14:53,590 --> 00:14:51,120
gonna send

434
00:14:54,710 --> 00:14:53,600
that sequence up the night before and

435
00:14:57,509 --> 00:14:54,720
and you know

436
00:14:58,069 --> 00:14:57,519
knock on wood we're gonna cros cross our

437
00:14:59,750 --> 00:14:58,079
fingers and

438
00:15:01,350 --> 00:14:59,760

hope that everything goes the way that

439
00:15:02,230 --> 00:15:01,360
we've tested and planned and tested

440
00:15:04,470 --> 00:15:02,240
again

441
00:15:05,670 --> 00:15:04,480
um but there's no telling right space is

442
00:15:07,189 --> 00:15:05,680
hard so we're gonna

443
00:15:08,710 --> 00:15:07,199
we're gonna see how that first flight

444
00:15:09,990 --> 00:15:08,720
goes and then build off that

445
00:15:12,230 --> 00:15:10,000
well we definitely have our fingers

446
00:15:13,750 --> 00:15:12,240
crossed for you knocking out some wood

447
00:15:15,750 --> 00:15:13,760
that is all the time we have for

448
00:15:16,710 --> 00:15:15,760
questions today thank you so much for

449
00:15:17,269 --> 00:15:16,720
joining us thank you very much

450
00:15:19,990 --> 00:15:17,279
appreciate it

451
00:15:21,030 --> 00:15:20,000
thanks i'm going to have you step back

452
00:15:24,790 --> 00:15:21,040
and we're going to

453
00:15:26,230 --> 00:15:24,800
actually sanitize the chair for mimi to

454
00:15:28,230 --> 00:15:26,240
come step in so

455
00:15:29,749 --> 00:15:28,240
while we wait remember that you can send

456
00:15:32,870 --> 00:15:29,759
in your questions using

457
00:15:35,910 --> 00:15:32,880
the mars helicopter hashtag and

458
00:15:36,629 --> 00:15:35,920
when we're ready we will get to mimi you

459
00:15:43,430 --> 00:15:36,639
can come step

460
00:15:51,829 --> 00:15:47,269
hi mimi hi good morning good morning

461
00:15:55,110 --> 00:15:51,839
so how does it feel how are you doing

462
00:15:58,870 --> 00:15:55,120
as teddy said our team is over the moon

463
00:16:00,710 --> 00:15:58,880

very happy not there yet so we we

464
00:16:02,550 --> 00:16:00,720
we're very happy about where we are so

465
00:16:05,829 --> 00:16:02,560
far and it's been wonderful

466
00:16:08,310 --> 00:16:05,839
so perseverance rover delivered us

467
00:16:09,509 --> 00:16:08,320
with its mars helicopter delivery system

468
00:16:12,550 --> 00:16:09,519
mhds

469
00:16:13,269 --> 00:16:12,560
perfectly to the ground ingenuity woke

470
00:16:16,550 --> 00:16:13,279
up

471
00:16:19,030 --> 00:16:16,560
exactly as designed two hours 15 minutes

472
00:16:20,550 --> 00:16:19,040
later took a couple pictures went back

473
00:16:22,150 --> 00:16:20,560
to sleep and

474
00:16:24,470 --> 00:16:22,160
last night we got the first set of data

475
00:16:27,590 --> 00:16:24,480
back so we couldn't be happier but

476
00:16:29,189 --> 00:16:27,600
cautiously happy many many steps between

477
00:16:29,509 --> 00:16:29,199
now and the first flight like can you

478
00:16:32,470 --> 00:16:29,519
get

479
00:16:33,110 --> 00:16:32,480
into what are those next steps coming up

480
00:16:35,430 --> 00:16:33,120
yeah so

481
00:16:36,470 --> 00:16:35,440
the next step really the today and

482
00:16:39,749 --> 00:16:36,480
tomorrow

483
00:16:40,310 --> 00:16:39,759
really fully confirm this energy thermal

484
00:16:42,949 --> 00:16:40,320
model

485
00:16:44,710 --> 00:16:42,959
and you know the whole uh interview has

486
00:16:45,990 --> 00:16:44,720
been about energy and thermal at the end

487
00:16:47,670 --> 00:16:46,000
of the day

488
00:16:48,870 --> 00:16:47,680

because if we don't have enough energy

489
00:16:50,150 --> 00:16:48,880
you know we can't fly and we can't

490
00:16:52,389 --> 00:16:50,160
survive the night so

491
00:16:54,470 --> 00:16:52,399
we're carefully taking more temperature

492
00:16:56,949 --> 00:16:54,480
data the battery state of charge

493
00:16:58,790 --> 00:16:56,959
and really looking at the the current

494
00:16:59,910 --> 00:16:58,800
you know coming in from the solar panel

495
00:17:02,150 --> 00:16:59,920
and confirm

496
00:17:04,710 --> 00:17:02,160
and we will use that information to

497
00:17:07,029 --> 00:17:04,720
actually optimize the time to fly

498
00:17:09,829 --> 00:17:07,039
the helicopter we really want to fly it

499
00:17:12,150 --> 00:17:09,839
when the battery has charged up

500
00:17:13,669 --> 00:17:12,160
fully and then we want to fly early

501
00:17:14,470 --> 00:17:13,679
enough so that after the flight we can

502
00:17:16,789 --> 00:17:14,480
charge again

503
00:17:18,150 --> 00:17:16,799
before the evening arrives to be ready

504
00:17:20,150 --> 00:17:18,160
to survive that long

505
00:17:21,429 --> 00:17:20,160
cold night so we'll be doing that the

506
00:17:22,949 --> 00:17:21,439
next two days

507
00:17:24,470 --> 00:17:22,959
and then we will be ready to start

508
00:17:27,510 --> 00:17:24,480
turning our attention

509
00:17:28,470 --> 00:17:27,520
to the rotor system and so the first

510
00:17:30,630 --> 00:17:28,480
thing we'll do

511
00:17:32,390 --> 00:17:30,640
in about three days is uh and three

512
00:17:35,110 --> 00:17:32,400
salts i guess martian days

513
00:17:35,510 --> 00:17:35,120

three saws two is to release the blades

514
00:17:38,870 --> 00:17:35,520
the

515
00:17:40,310 --> 00:17:38,880
blade pitch restraint

516
00:17:42,150 --> 00:17:40,320
that's why they are now pointing

517
00:17:44,470 --> 00:17:42,160
straight north south right now

518
00:17:46,310 --> 00:17:44,480
and we will be ready to release them and

519
00:17:48,710 --> 00:17:46,320
that takes uh rotating the

520
00:17:50,390 --> 00:17:48,720
the blades um in the same direction

521
00:17:52,630 --> 00:17:50,400
instead of counter rotating in the same

522
00:17:54,549 --> 00:17:52,640
direction just for a fraction of a cycle

523
00:17:55,990 --> 00:17:54,559
and that will release the blades major

524
00:17:56,789 --> 00:17:56,000
deal the blades have to be fully

525
00:17:59,110 --> 00:17:56,799
released

526
00:18:01,190 --> 00:17:59,120
and then we will check out wiggle the

527
00:18:01,830 --> 00:18:01,200
blades the day after that and do a very

528
00:18:03,909 --> 00:18:01,840
slow spin

529
00:18:06,150 --> 00:18:03,919
50 revolutions per minute and that will

530
00:18:07,190 --> 00:18:06,160
confirm that our motor control the servo

531
00:18:09,270 --> 00:18:07,200
controls our s

532
00:18:10,870 --> 00:18:09,280
the way we've designed it and then

533
00:18:12,630 --> 00:18:10,880
lastly still on the ground

534
00:18:14,630 --> 00:18:12,640
we're going to do a full speed spin

535
00:18:15,190 --> 00:18:14,640
approximately 2 400 revolutions per

536
00:18:17,270 --> 00:18:15,200
minute

537
00:18:19,430 --> 00:18:17,280
full speed spin to fully check out

538
00:18:22,070 --> 00:18:19,440

without taking off check out the rotor

539
00:18:23,110 --> 00:18:22,080
performing at that point we'll be as

540
00:18:25,110 --> 00:18:23,120
ready as we can be

541
00:18:27,029 --> 00:18:25,120
and will take one day to again fully

542
00:18:28,950 --> 00:18:27,039
charge the vehicle to maximize

543
00:18:30,549 --> 00:18:28,960
probability of success for that very

544
00:18:31,430 --> 00:18:30,559
very first flight the most important

545
00:18:34,630 --> 00:18:31,440
first flight

546
00:18:36,789 --> 00:18:34,640
you've been mentioning

547
00:18:39,029 --> 00:18:36,799
souls how are they different from earth

548
00:18:42,789 --> 00:18:39,039
days for our audience at home

549
00:18:45,190 --> 00:18:42,799
sure a soul is about 39 about 40 minutes

550
00:18:46,789 --> 00:18:45,200
longer the martian day is about 40

551
00:18:49,990 --> 00:18:46,799
minutes longer than earth's uh

552
00:18:51,990 --> 00:18:50,000
day so uh all the events of the

553
00:18:53,270 --> 00:18:52,000
helicopter activities are time at the

554
00:18:55,669 --> 00:18:53,280
martian time

555
00:18:57,270 --> 00:18:55,679
and so teddy had mentioned just now you

556
00:19:00,070 --> 00:18:57,280
know we took measurement at noon

557
00:19:01,029 --> 00:19:00,080
uh yesterday and then for example today

558
00:19:04,630 --> 00:19:01,039
we're looking around

559
00:19:07,350 --> 00:19:04,640
2 p.m martian time and so events happen

560
00:19:10,310 --> 00:19:07,360
at mars following the daytime at mars

561
00:19:11,430 --> 00:19:10,320
and then we we stay awake just following

562
00:19:14,789 --> 00:19:11,440
the martian time

563
00:19:15,510 --> 00:19:14,799

on earth so well this helicopter has

564
00:19:18,310 --> 00:19:15,520
certainly been

565
00:19:18,789 --> 00:19:18,320
on its journey i wanted to talk to you

566
00:19:20,470 --> 00:19:18,799
about

567
00:19:22,150 --> 00:19:20,480
your personal journey can you kind of

568
00:19:24,950 --> 00:19:22,160
explain your career path

569
00:19:26,470 --> 00:19:24,960
and what led you here to eventually work

570
00:19:29,830 --> 00:19:26,480
on the team

571
00:19:32,150 --> 00:19:29,840
sure i came to nasa's jet propulsion

572
00:19:34,870 --> 00:19:32,160
laboratory jpl here 30 years ago

573
00:19:37,190 --> 00:19:34,880
and i started i've always been in the

574
00:19:39,510 --> 00:19:37,200
deep space exploration

575
00:19:41,190 --> 00:19:39,520
and the first thing was to uh write the

576
00:19:43,430 --> 00:19:41,200
signal processing communication

577
00:19:44,310 --> 00:19:43,440
algorithms to track these tiny tiny weak

578
00:19:46,950 --> 00:19:44,320
signals

579
00:19:48,549 --> 00:19:46,960
coming from deep space right and in fact

580
00:19:50,150 --> 00:19:48,559
we have now spacecraft that are out that

581
00:19:50,630 --> 00:19:50,160
have left our solar system right like

582
00:19:53,430 --> 00:19:50,640
the

583
00:19:54,870 --> 00:19:53,440
voyager anyway so we really working on

584
00:19:57,110 --> 00:19:54,880
the algorithms and up

585
00:19:59,029 --> 00:19:57,120
when uh deep space network was upgrading

586
00:20:00,789 --> 00:19:59,039
the receiver digital

587
00:20:02,710 --> 00:20:00,799
making the first digital receiver to

588
00:20:05,190 --> 00:20:02,720

check the signals from there so

589
00:20:07,029 --> 00:20:05,200
that's how i started at jpl and over the

590
00:20:08,390 --> 00:20:07,039
years i transitioned over to the

591
00:20:11,110 --> 00:20:08,400
spacecraft site

592
00:20:13,270 --> 00:20:11,120
and uh got involved with you know

593
00:20:16,470 --> 00:20:13,280
spacecraft design and systems

594
00:20:18,390 --> 00:20:16,480
and specifically uh over the last 15 uh

595
00:20:20,870 --> 00:20:18,400
years a little more than that i have

596
00:20:23,669 --> 00:20:20,880
really fallen in love with

597
00:20:24,870 --> 00:20:23,679
increasingly autonomous capabilities of

598
00:20:26,789 --> 00:20:24,880
space systems

599
00:20:28,230 --> 00:20:26,799
that we need to develop so we have

600
00:20:31,270 --> 00:20:28,240
wonderful you know orbiters

601
00:20:31,909 --> 00:20:31,280
lenders and rovers but there is plenty

602
00:20:34,070 --> 00:20:31,919
of room

603
00:20:35,029 --> 00:20:34,080
for spacecraft to be more autonomous

604
00:20:37,350 --> 00:20:35,039
being able to

605
00:20:39,190 --> 00:20:37,360
function and make decisions on his own

606
00:20:41,350 --> 00:20:39,200
and explore more autonomously

607
00:20:42,630 --> 00:20:41,360
so that's the area that i've been uh

608
00:20:45,750 --> 00:20:42,640
dedicating myself

609
00:20:47,909 --> 00:20:45,760
to and along the line

610
00:20:49,990 --> 00:20:47,919
mars helicopter came along and that's an

611
00:20:52,630 --> 00:20:50,000
ultimate autonomous uh

612
00:20:53,029 --> 00:20:52,640
machine and so here i am and so about uh

613
00:20:56,470 --> 00:20:53,039

six

614
00:20:58,549 --> 00:20:56,480
in and uh

615
00:21:00,470 --> 00:20:58,559
you know uh joined the mars helicopter

616
00:21:02,470 --> 00:21:00,480
effort and it's been wonderful

617
00:21:04,149 --> 00:21:02,480
well was it an interest you always had

618
00:21:06,070 --> 00:21:04,159
as a child or when did you know you

619
00:21:09,510 --> 00:21:06,080
wanted to get into this

620
00:21:10,149 --> 00:21:09,520
oh it's uh you know i grew up in asia i

621
00:21:14,149 --> 00:21:10,159
was

622
00:21:16,390 --> 00:21:14,159
doing getting their phds at the

623
00:21:17,750 --> 00:21:16,400
university of illinois but after they

624
00:21:21,430 --> 00:21:17,760
received their phd i

625
00:21:23,430 --> 00:21:21,440
um my formative years were in myanmar

626
00:21:25,430 --> 00:21:23,440
and then also in malaysia and then i

627
00:21:27,990 --> 00:21:25,440
came back when i was 16 years old

628
00:21:28,549 --> 00:21:28,000
so having grown up in a other part of

629
00:21:31,750 --> 00:21:28,559
the world

630
00:21:33,270 --> 00:21:31,760
it wasn't like i had a direct dream i've

631
00:21:34,630 --> 00:21:33,280
always been fascinated with space i mean

632
00:21:36,549 --> 00:21:34,640
you can see stars and the

633
00:21:37,830 --> 00:21:36,559
fundamental questions of is there life

634
00:21:39,590 --> 00:21:37,840
there are we alone

635
00:21:40,950 --> 00:21:39,600
that's something that question just run

636
00:21:42,630 --> 00:21:40,960
deep inside of me i mean

637
00:21:44,230 --> 00:21:42,640
it runs deep inside of most people right

638
00:21:45,590 --> 00:21:44,240

it's the ultimate question of humanity

639
00:21:48,070 --> 00:21:45,600
are we alone

640
00:21:49,510 --> 00:21:48,080
but i really didn't know if i would have

641
00:21:53,190 --> 00:21:49,520
the opportunity

642
00:21:55,350 --> 00:21:53,200
to be a part of nasa a space exploration

643
00:21:56,950 --> 00:21:55,360
so always dreamed but didn't know if i

644
00:21:58,950 --> 00:21:56,960
could get there but one step at a time

645
00:22:00,390 --> 00:21:58,960
you follow the path to education i came

646
00:22:03,350 --> 00:22:00,400
back to the u.s

647
00:22:04,789 --> 00:22:03,360
followed my educational path and ended

648
00:22:06,310 --> 00:22:04,799
up at jpl and it

649
00:22:07,510 --> 00:22:06,320
i think the realization was when i

650
00:22:09,669 --> 00:22:07,520
finished my master's degree in

651
00:22:11,830 --> 00:22:09,679
electrical engineering it was time to

652
00:22:13,190 --> 00:22:11,840
interview for jobs and then one of the

653
00:22:15,750 --> 00:22:13,200
professors said

654
00:22:17,990 --> 00:22:15,760
nasa jpl you know they have these

655
00:22:19,110 --> 00:22:18,000
extremely large antennas with very low

656
00:22:20,789 --> 00:22:19,120
noise amplifiers

657
00:22:22,390 --> 00:22:20,799
extremely lowest noise temperature

658
00:22:24,230 --> 00:22:22,400
amplifiers you know

659
00:22:25,510 --> 00:22:24,240
possible to really be able to track the

660
00:22:27,830 --> 00:22:25,520
very weak signals

661
00:22:28,950 --> 00:22:27,840
and then all the old dreams and the

662
00:22:31,430 --> 00:22:28,960
current moment

663
00:22:33,669 --> 00:22:31,440

clicked together and i did everything i

664
00:22:35,430 --> 00:22:33,679
could to get an interview at jpl and

665
00:22:36,789 --> 00:22:35,440
got the interview and was hired and it's

666
00:22:38,149 --> 00:22:36,799
been a dream ever since

667
00:22:40,230 --> 00:22:38,159
well you're certainly doing a lot to

668
00:22:42,070 --> 00:22:40,240
inspire the future generations those

669
00:22:43,350 --> 00:22:42,080
are all the questions i have now we're

670
00:22:43,990 --> 00:22:43,360
going to get to some social media

671
00:22:47,029 --> 00:22:44,000
questions

672
00:22:50,390 --> 00:22:47,039
that's all right uh first up

673
00:22:53,590 --> 00:22:50,400
we have wilson on youtube

674
00:22:58,149 --> 00:22:53,600
asks what does the mars helicopter sound

675
00:23:00,950 --> 00:22:58,159
like oh well the helicopter is a

676
00:23:01,350 --> 00:23:00,960
very high power operation the peak power

677
00:23:04,630 --> 00:23:01,360
of

678
00:23:05,270 --> 00:23:04,640
close to 350 watts you know it's a very

679
00:23:08,710 --> 00:23:05,280
high

680
00:23:09,750 --> 00:23:08,720
uh power operation to 2 400 revolutions

681
00:23:12,710 --> 00:23:09,760
per minute

682
00:23:13,669 --> 00:23:12,720
even in the thin atmosphere so if you

683
00:23:16,310 --> 00:23:13,679
have seen

684
00:23:18,310 --> 00:23:16,320
some of the test videos out there it can

685
00:23:20,549 --> 00:23:18,320
be quite loud

686
00:23:23,110 --> 00:23:20,559
in the test chamber that we have because

687
00:23:25,590 --> 00:23:23,120
it's an enclosed room right that we have

688
00:23:27,510 --> 00:23:25,600

pumped out uh most of the air and then

689
00:23:29,270 --> 00:23:27,520
come back in with carbon dioxide to

690
00:23:31,110 --> 00:23:29,280
you know simulate this approximately one

691
00:23:32,070 --> 00:23:31,120
percent of the density compared to earth

692
00:23:34,789 --> 00:23:32,080
right so

693
00:23:36,470 --> 00:23:34,799
in the chamber it's extremely loud on

694
00:23:40,149 --> 00:23:36,480
mars in open space

695
00:23:42,470 --> 00:23:40,159
uh there are a lot of debates and uh

696
00:23:44,070 --> 00:23:42,480
of guessing you know how audible it

697
00:23:45,830 --> 00:23:44,080
would be so i think it would be

698
00:23:47,909 --> 00:23:45,840
it would be difficult to hear if you are

699
00:23:48,630 --> 00:23:47,919
standing on mars with a flight you know

700
00:23:51,350 --> 00:23:48,640
uh that's

701
00:23:53,029 --> 00:23:51,360
50 100 meters away but uh it sure is

702
00:23:54,549 --> 00:23:53,039
high power and you can definitely hear

703
00:23:55,909 --> 00:23:54,559
it very loudly in the chamber test

704
00:23:57,669 --> 00:23:55,919
chamber here

705
00:23:59,029 --> 00:23:57,679
well that will be exciting uh this next

706
00:24:02,549 --> 00:23:59,039
one we might

707
00:24:05,430 --> 00:24:02,559
make use of our helicopter model uh

708
00:24:06,630 --> 00:24:05,440
alex on youtube asks why is there a

709
00:24:09,830 --> 00:24:06,640
little hole

710
00:24:10,470 --> 00:24:09,840
on one of the feet on the helicopter oh

711
00:24:13,590 --> 00:24:10,480
yes

712
00:24:16,070 --> 00:24:13,600
so um very good eye and

713
00:24:16,789 --> 00:24:16,080

it is not on this model for a very good

714
00:24:18,870 --> 00:24:16,799
reason

715
00:24:20,789 --> 00:24:18,880
um when we built the flight model

716
00:24:22,950 --> 00:24:20,799
ingenuity this is the copy that's at

717
00:24:26,870 --> 00:24:22,960
mars right ingenuity itself

718
00:24:30,710 --> 00:24:26,880
the feet uh were all the same and then

719
00:24:33,669 --> 00:24:30,720
later after the helicopter was developed

720
00:24:35,350 --> 00:24:33,679
we started designing the the rover team

721
00:24:36,470 --> 00:24:35,360
started designing the mars helicopter

722
00:24:38,470 --> 00:24:36,480
delivery system on

723
00:24:39,590 --> 00:24:38,480
how to hold the helicopter under the

724
00:24:42,950 --> 00:24:39,600
belly pen

725
00:24:44,789 --> 00:24:42,960
and really to minimize protrusion

726
00:24:46,470 --> 00:24:44,799
of like a helicopter hanging down under

727
00:24:47,430 --> 00:24:46,480
the belly pan instead of hanging

728
00:24:49,830 --> 00:24:47,440
vertically

729
00:24:51,590 --> 00:24:49,840
the helicopter was stored sideways you

730
00:24:55,110 --> 00:24:51,600
know with the blades aligned

731
00:24:58,470 --> 00:24:55,120
and restrained and the legs actually

732
00:25:00,870 --> 00:24:58,480
pulled back and held by you know some

733
00:25:03,909 --> 00:25:00,880
systems that later you know released uh

734
00:25:07,029 --> 00:25:03,919
a few days ago right so in order to hold

735
00:25:08,310 --> 00:25:07,039
uh it turned out uh one of the feet had

736
00:25:10,549 --> 00:25:08,320
to be redesigned

737
00:25:11,350 --> 00:25:10,559
to match the mars helicopter delivery

738
00:25:13,590 --> 00:25:11,360

system

739
00:25:14,870 --> 00:25:13,600
so in that sense that's why one of the

740
00:25:18,390 --> 00:25:14,880
lakes is different

741
00:25:21,269 --> 00:25:18,400
but uh also all the lakes we actually

742
00:25:21,669 --> 00:25:21,279
of the in ingenuity were retrofitted

743
00:25:24,789 --> 00:25:21,679
because

744
00:25:26,310 --> 00:25:24,799
in order to fit into the mhds the lakes

745
00:25:28,230 --> 00:25:26,320
actually had to be capable of bending

746
00:25:30,630 --> 00:25:28,240
back and be held like that for

747
00:25:32,149 --> 00:25:30,640
over a year right since before launch

748
00:25:34,470 --> 00:25:32,159
and have springs in them

749
00:25:36,310 --> 00:25:34,480
and have flexure so that after being

750
00:25:39,110 --> 00:25:36,320
held when they're released they still

751
00:25:39,430 --> 00:25:39,120
have the tension to snap down and latch

752
00:25:42,149 --> 00:25:39,440
and

753
00:25:42,789 --> 00:25:42,159
see the legs come into the position that

754
00:25:46,070 --> 00:25:42,799
they have

755
00:25:48,789 --> 00:25:46,080
done so it looks very um simple

756
00:25:49,750 --> 00:25:48,799
but there is quite a bit of mechanical

757
00:25:52,470 --> 00:25:49,760
engineering

758
00:25:53,350 --> 00:25:52,480
in this uh late edition and so that's

759
00:25:54,950 --> 00:25:53,360
why they're

760
00:25:56,789 --> 00:25:54,960
a little bit different and we that's why

761
00:25:59,750 --> 00:25:56,799
we're extraordinarily happy

762
00:26:00,870 --> 00:25:59,760
when the lakes came down and they it we

763
00:26:02,470 --> 00:26:00,880

knew that they latched

764
00:26:03,990 --> 00:26:02,480
and they're standing you know exactly

765
00:26:05,269 --> 00:26:04,000
the helicopter standing exactly the way

766
00:26:08,390 --> 00:26:05,279
it was designed for

767
00:26:10,470 --> 00:26:08,400
every milestone is very important all

768
00:26:13,029 --> 00:26:10,480
right up next we have

769
00:26:16,470 --> 00:26:13,039
um patrick on youtube who asks why was

770
00:26:19,510 --> 00:26:16,480
the flight date postponed to april 11th

771
00:26:22,149 --> 00:26:19,520
oh yes um so

772
00:26:23,190 --> 00:26:22,159
you know i'm gonna give a very long

773
00:26:26,230 --> 00:26:23,200
story

774
00:26:29,190 --> 00:26:26,240
this is the first ever test

775
00:26:31,110 --> 00:26:29,200
experiment on mars and you know it's a

776
00:26:34,149 --> 00:26:31,120
very very rare opportunity

777
00:26:34,950 --> 00:26:34,159
that we are extremely protective about

778
00:26:37,350 --> 00:26:34,960
so

779
00:26:38,149 --> 00:26:37,360
uh short answer is to be extremely

780
00:26:40,470 --> 00:26:38,159
careful

781
00:26:41,190 --> 00:26:40,480
and so we were originally targeting

782
00:26:44,230 --> 00:26:41,200
april 8

783
00:26:45,190 --> 00:26:44,240
to fly and we moved it to april 11th for

784
00:26:48,390 --> 00:26:45,200
two reasons

785
00:26:50,870 --> 00:26:48,400
one when we were getting ready to uh

786
00:26:52,470 --> 00:26:50,880
drop the helicopter the hell mhds had

787
00:26:54,870 --> 00:26:52,480
turned rotated the

788
00:26:55,990 --> 00:26:54,880

helicopter to a vertical position and

789
00:26:58,149 --> 00:26:56,000
before we dropped

790
00:26:59,590 --> 00:26:58,159
uh we also wanted to take the time to

791
00:27:02,470 --> 00:26:59,600
make sure that the

792
00:27:03,190 --> 00:27:02,480
under some harnesses under the belly pan

793
00:27:05,990 --> 00:27:03,200
uh

794
00:27:07,669 --> 00:27:06,000
of the rover that they were going to be

795
00:27:08,870 --> 00:27:07,679
clear you know now that we're on actual

796
00:27:10,470 --> 00:27:08,880
terrain the rover's in the actual

797
00:27:12,789 --> 00:27:10,480
terrain and when we drop

798
00:27:14,630 --> 00:27:12,799
you see this little antenna here that's

799
00:27:17,269 --> 00:27:14,640
sticking up here

800
00:27:18,310 --> 00:27:17,279
we uh looking at the images that the you

801
00:27:19,909 --> 00:27:18,320
know the rovers

802
00:27:21,750 --> 00:27:19,919
watson camera had taken we wanted to

803
00:27:22,710 --> 00:27:21,760
make sure that the little antenna

804
00:27:24,870 --> 00:27:22,720
sticking up

805
00:27:26,470 --> 00:27:24,880
wouldn't catch on in harnesses or

806
00:27:28,710 --> 00:27:26,480
anything else under the rover

807
00:27:30,230 --> 00:27:28,720
on this actual terrain that there is no

808
00:27:32,549 --> 00:27:30,240
chance of it snagging

809
00:27:34,710 --> 00:27:32,559
and so we wanted to take an extra you

810
00:27:36,310 --> 00:27:34,720
know extra time to look at that

811
00:27:39,190 --> 00:27:36,320
and that's the first one and then

812
00:27:41,510 --> 00:27:39,200
secondly uh for this energy story

813
00:27:42,630 --> 00:27:41,520

uh we decided that after the drop we

814
00:27:45,029 --> 00:27:42,640
wanted to add

815
00:27:46,470 --> 00:27:45,039
uh extra days to make sure that we can

816
00:27:49,110 --> 00:27:46,480
actually characterize

817
00:27:50,950 --> 00:27:49,120
uh the energy uh story and make sure the

818
00:27:51,510 --> 00:27:50,960
solar panel is charging the way we think

819
00:27:53,990 --> 00:27:51,520
it is

820
00:27:55,830 --> 00:27:54,000
and the hour by hour profile of the

821
00:27:58,230 --> 00:27:55,840
energy right as you're charging up

822
00:28:00,149 --> 00:27:58,240
expanding the energy charging up again

823
00:28:02,070 --> 00:28:00,159
that our energy is positive uh

824
00:28:04,870 --> 00:28:02,080
throughout all of the day so

825
00:28:06,789 --> 00:28:04,880
uh everything is healthy on you know the

826
00:28:07,590 --> 00:28:06,799
rover's deployment size helicopter site

827
00:28:10,630 --> 00:28:07,600
but we really

828
00:28:13,029 --> 00:28:10,640
decided together to take care so

829
00:28:13,669 --> 00:28:13,039
wow well thank you so much for joining

830
00:28:16,710 --> 00:28:13,679
us and

831
00:28:17,110 --> 00:28:16,720
good luck this week i'm very excited for

832
00:28:20,549 --> 00:28:17,120
you

833
00:28:22,310 --> 00:28:20,559
lots more

834
00:28:23,909 --> 00:28:22,320
lots of milestones ahead that we are

835
00:28:26,710 --> 00:28:23,919
looking forward to and

836
00:28:27,590 --> 00:28:26,720
learning from every single step ahead of

837
00:28:29,029 --> 00:28:27,600
us

838
00:28:30,710 --> 00:28:29,039

all the way up leading to the first

839
00:28:32,710 --> 00:28:30,720
flight well thank you mimi

840
00:28:36,070 --> 00:28:32,720
and thank you for your social media

841
00:28:39,350 --> 00:28:36,080
questions so for updates on ingenuity

842
00:28:42,230 --> 00:28:39,360
follow at nasa jpl and use

843
00:28:43,029 --> 00:28:42,240
the mars helicopter to keep asking your

844
00:28:46,149 --> 00:28:43,039
questions

845
00:28:49,990 --> 00:28:46,159
also visit go.nasa.gov

846
00:28:52,230 --> 00:28:50,000
ingenuity for images and videos and

847
00:28:53,990 --> 00:28:52,240
upcoming webinars in fact there's one