
MARS HELICOPTER &
THE FUTURE OF
EXTRATERRESTRIAL
FLIGHT LIVE

1
00:00:06,600 --> 00:00:06,370
[Music]

2
00:00:35,500 --> 00:00:06,610
[Applause]

3
00:01:09,750 --> 00:00:58,640
[Music]

4
00:01:13,310 --> 00:01:09,760
we can now say that human beings have

5
00:01:20,149 --> 00:01:13,320
thrown a rotorcraft on another planet

6
00:01:25,590 --> 00:01:22,310
hello everyone and welcome to another of

7
00:01:27,350 --> 00:01:25,600
nasa science live my name is jordy cook

8
00:01:29,590 --> 00:01:27,360
and i'm the news events and project

9
00:01:30,710 --> 00:01:29,600
supervisor at nasa's jet propulsion lab

10
00:01:32,390 --> 00:01:30,720
and i'm going to be your host for

11
00:01:33,830 --> 00:01:32,400
today's episode

12
00:01:36,950 --> 00:01:33,840
so today we're going to talk about the

13
00:01:39,230 --> 00:01:36,960

historic flights of nasa's ingenuity

14
00:01:41,670 --> 00:01:39,240
helicopter and what they could mean for

15
00:01:43,510 --> 00:01:41,680
extraterrestrial flight in the future

16
00:01:45,030 --> 00:01:43,520
over the past month nasa has been

17
00:01:46,870 --> 00:01:45,040
pushing the boundaries of what is

18
00:01:50,870 --> 00:01:46,880
possible and turning science into

19
00:01:53,670 --> 00:01:50,880
science fast on april 19 the ingenuity

20
00:01:56,630 --> 00:01:53,680
mars helicopter became the first

21
00:01:58,950 --> 00:01:56,640
spacecraft to achieve powered controlled

22
00:02:01,749 --> 00:01:58,960
flight on another world

23
00:02:03,590 --> 00:02:01,759
since then it has completed four flights

24
00:02:05,749 --> 00:02:03,600
that have taken this four pound

25
00:02:09,109 --> 00:02:05,759
spacecraft higher

26
00:02:10,869 --> 00:02:09,119
farther and faster than ever before

27
00:02:13,270 --> 00:02:10,879
and now that the telecast it's

28
00:02:16,309 --> 00:02:13,280
technology tests it gets to try new

29
00:02:18,470 --> 00:02:16,319
things that are all gravy engineering

30
00:02:20,949 --> 00:02:18,480
has just started an operational

31
00:02:23,030 --> 00:02:20,959
demonstration where it will try to fly

32
00:02:25,510 --> 00:02:23,040
along with its fellow robot nasa's

33
00:02:27,830 --> 00:02:25,520
perseverance rover and it will test how

34
00:02:29,830 --> 00:02:27,840
well it works as a scout

35
00:02:32,070 --> 00:02:29,840
ingenuity recently demonstrated that it

36
00:02:34,070 --> 00:02:32,080
could fly some fairly long distances

37
00:02:36,470 --> 00:02:34,080
about one and a third football fields

38
00:02:38,869 --> 00:02:36,480

out and then back again taking lots of

39
00:02:40,869 --> 00:02:38,879
pictures along the way the fourth flight

40
00:02:45,030 --> 00:02:40,879
was the most ambitious so far let's take

41
00:02:49,110 --> 00:02:47,589
all right i see data products coming in

42
00:02:50,470 --> 00:02:49,120
so i think we're ready to begin

43
00:02:53,030 --> 00:02:50,480
processing

44
00:02:54,710 --> 00:02:53,040
all right telemetry should be in

45
00:02:57,750 --> 00:02:54,720
i have a plot to show here showing

46
00:03:00,680 --> 00:02:57,760
helicopter flying out and back

47
00:03:13,750 --> 00:03:00,690
that's us going out and back

48
00:03:16,869 --> 00:03:15,589
that's a room full of happy engineers at

49
00:03:18,949 --> 00:03:16,879
jpl

50
00:03:20,630 --> 00:03:18,959
the engineer the ingenuity team is

51
00:03:22,630 --> 00:03:20,640
currently working on planning their

52
00:03:24,710 --> 00:03:22,640
fifth flight so we hope they get to look

53
00:03:27,430 --> 00:03:24,720
that same way again soon

54
00:03:29,509 --> 00:03:27,440
so but for now let's talk to the experts

55
00:03:31,509 --> 00:03:29,519
so because this historic flight on mars

56
00:03:34,229 --> 00:03:31,519
has implications for how we will explore

57
00:03:36,869 --> 00:03:34,239
other worlds we are joined today by both

58
00:03:39,350 --> 00:03:36,879
a mars helicopter pilot and a team

59
00:03:40,309 --> 00:03:39,360
member from nasa's upcoming dragonfly

60
00:03:42,149 --> 00:03:40,319
mission

61
00:03:43,030 --> 00:03:42,159
which will take flight to a whole other

62
00:03:44,949 --> 00:03:43,040
world

63
00:03:47,030 --> 00:03:44,959

saturn's moon titan

64
00:03:49,030 --> 00:03:47,040
you can join the conversation too submit

65
00:03:52,550 --> 00:03:49,040
your questions about ingenuity and

66
00:03:54,229 --> 00:03:52,560
dragonfly using the hashtag asknasa and

67
00:03:55,750 --> 00:03:54,239
we'll answer as many as we can

68
00:03:57,670 --> 00:03:55,760
throughout the show

69
00:03:59,910 --> 00:03:57,680
so right now with a nod to asian

70
00:04:02,630 --> 00:03:59,920
american and pacific islander heritage

71
00:04:05,429 --> 00:04:02,640
month in may i'm joined by johnny lamb a

72
00:04:07,750 --> 00:04:05,439
pilot for ingenuity and nishant mehta

73
00:04:09,830 --> 00:04:07,760
deputy lead for the dragonfly mobility

74
00:04:12,070 --> 00:04:09,840
system thank you both so much for

75
00:04:14,710 --> 00:04:12,080
joining us

76
00:04:15,990 --> 00:04:14,720
thank you for having us

77
00:04:17,909 --> 00:04:16,000
so johnny

78
00:04:19,909 --> 00:04:17,919
titles uh at nasa can be a little bit

79
00:04:22,150 --> 00:04:19,919
technical can you explain what your

80
00:04:24,070 --> 00:04:22,160
titles mean what do you actually do on

81
00:04:25,430 --> 00:04:24,080
your missions so johnny we'll start with

82
00:04:28,310 --> 00:04:25,440
you

83
00:04:30,870 --> 00:04:28,320
so my day job is actually a guidance and

84
00:04:33,510 --> 00:04:30,880
control engineer uh which is also a

85
00:04:36,230 --> 00:04:33,520
little bit technical too uh

86
00:04:38,150 --> 00:04:36,240
so on ingenuity i helped i worked on the

87
00:04:40,310 --> 00:04:38,160
team that developed the flight flight

88
00:04:42,629 --> 00:04:40,320

control algorithms and the soft and

89
00:04:44,790 --> 00:04:42,639
flight control software and now that

90
00:04:47,830 --> 00:04:44,800
ingenuity is part of a

91
00:04:49,590 --> 00:04:47,840
operations phase i'm one of the pilots

92
00:04:51,189 --> 00:04:49,600
which involves doing a lot of the flight

93
00:04:52,469 --> 00:04:51,199
planning that gets loaded onto the

94
00:04:53,830 --> 00:04:52,479
helicopter

95
00:04:55,749 --> 00:04:53,840
and then

96
00:04:57,670 --> 00:04:55,759
downloading the data off the helicopter

97
00:04:59,990 --> 00:04:57,680
and analyzing the post flight results

98
00:05:02,629 --> 00:05:00,000
afterwards

99
00:05:04,150 --> 00:05:02,639
and what about you nisha

100
00:05:05,590 --> 00:05:04,160
thank you jerry

101
00:05:07,270 --> 00:05:05,600
i work at the johns hopkins applied

102
00:05:09,430 --> 00:05:07,280
physics lab in maryland where i'm in a

103
00:05:11,909 --> 00:05:09,440
team of scientists and engineers working

104
00:05:13,590 --> 00:05:11,919
on what we call mobility

105
00:05:15,909 --> 00:05:13,600
mobility is the system that will tell

106
00:05:18,550 --> 00:05:15,919
dragonfly how to fly from place to place

107
00:05:20,629 --> 00:05:18,560
on titan without human intervention

108
00:05:22,790 --> 00:05:20,639
my main job on a day-to-day basis is to

109
00:05:24,870 --> 00:05:22,800
help coordinate activities across

110
00:05:26,150 --> 00:05:24,880
certain aspects of mobility um

111
00:05:27,670 --> 00:05:26,160
for example one of the things i do is

112
00:05:29,510 --> 00:05:27,680
work with a wonderful group of people on

113
00:05:31,189 --> 00:05:29,520

the cameras and algorithms that will

114
00:05:33,029 --> 00:05:31,199
help dragonfly

115
00:05:34,710 --> 00:05:33,039
tell dragonfly where it's going while

116
00:05:36,310 --> 00:05:34,720
it's flying on titan

117
00:05:37,990 --> 00:05:36,320
i'll also add that in terms of titles

118
00:05:40,310 --> 00:05:38,000
they can be hard to understand very

119
00:05:42,390 --> 00:05:40,320
cryptic sometimes so folks working on

120
00:05:44,870 --> 00:05:42,400
dragonfly will often use the term dragon

121
00:05:47,189 --> 00:05:44,880
flyers

122
00:05:50,629 --> 00:05:47,199
so we've got a dragonflyer and a mars

123
00:05:52,790 --> 00:05:50,639
helicopter pilot with us today

124
00:05:55,590 --> 00:05:52,800
so perseverance carried a lot of

125
00:05:56,870 --> 00:05:55,600
technology with it to the red planet um

126
00:05:58,710 --> 00:05:56,880
you know one of the technology

127
00:06:00,309 --> 00:05:58,720
experiments is the moxie instrument and

128
00:06:02,309 --> 00:06:00,319
it just showed us the other week that

129
00:06:04,070 --> 00:06:02,319
oxygen can be extracted from the martian

130
00:06:05,749 --> 00:06:04,080
atmosphere and that'll help with

131
00:06:07,990 --> 00:06:05,759
launching rockets off of mars and

132
00:06:09,029 --> 00:06:08,000
eventually making oxygen for astronauts

133
00:06:11,029 --> 00:06:09,039
to breathe

134
00:06:12,710 --> 00:06:11,039
the meta instrument helps prepare for

135
00:06:14,870 --> 00:06:12,720
human exploration by providing

136
00:06:17,990 --> 00:06:14,880
information about weather climate

137
00:06:20,629 --> 00:06:18,000
surface radiation and dust so johnny

138
00:06:22,870 --> 00:06:20,639

what kinds of horizons does the mars

139
00:06:25,909 --> 00:06:22,880
helicopter technology demonstration open

140
00:06:28,230 --> 00:06:25,919
up for future nasa missions

141
00:06:30,150 --> 00:06:28,240
so i think with the success of ingenuity

142
00:06:32,550 --> 00:06:30,160
we've basically kind of unlocked an

143
00:06:34,230 --> 00:06:32,560
aerial dimension the exploration so

144
00:06:35,270 --> 00:06:34,240
we've always kind of had the orbiters

145
00:06:37,670 --> 00:06:35,280
who can

146
00:06:39,749 --> 00:06:37,680
uh provide observations from up high

147
00:06:42,790 --> 00:06:39,759
above and now we and we've always had

148
00:06:45,110 --> 00:06:42,800
rovers who can provide observations from

149
00:06:47,909 --> 00:06:45,120
way close to the ground and now this

150
00:06:50,070 --> 00:06:47,919
kind of provides us another dimension

151
00:06:51,990 --> 00:06:50,080
to kind of explore that gap in between

152
00:06:55,189 --> 00:06:52,000
where we can kind of reach some hard to

153
00:06:58,469 --> 00:06:55,199
reach areas we can provide images

154
00:07:00,790 --> 00:06:58,479
reconnaissance we can scout ahead we can

155
00:07:03,670 --> 00:07:00,800
look for the best pass best path to

156
00:07:05,909 --> 00:07:03,680
traverse and eventually all these things

157
00:07:06,950 --> 00:07:05,919
can also help with human exploration on

158
00:07:09,749 --> 00:07:06,960
mars

159
00:07:11,350 --> 00:07:09,759
or other planets

160
00:07:13,029 --> 00:07:11,360
yeah and i know that you guys have done

161
00:07:14,710 --> 00:07:13,039
a lot of testing on earth you know

162
00:07:17,189 --> 00:07:14,720
there's like a space simulation chamber

163
00:07:19,589 --> 00:07:17,199

at jpl but what have you learned from

164
00:07:21,189 --> 00:07:19,599
flying this helicopter on mars that we

165
00:07:25,270 --> 00:07:21,199
couldn't gain from flying it in the

166
00:07:30,150 --> 00:07:27,909
so that's a good question so we

167
00:07:32,950 --> 00:07:30,160
we spent a lot of time in the 25 foot

168
00:07:34,710 --> 00:07:32,960
space simulator at jpl now we're it's a

169
00:07:37,189 --> 00:07:34,720
pretty big chamber but and we're a

170
00:07:39,110 --> 00:07:37,199
pretty small helicopter but even with

171
00:07:41,670 --> 00:07:39,120
all that we were only able to ever go

172
00:07:44,469 --> 00:07:41,680
about a meter up off the ground and

173
00:07:46,869 --> 00:07:44,479
about half a meter side to side

174
00:07:49,270 --> 00:07:46,879
uh and we always had a lot of cables and

175
00:07:51,830 --> 00:07:49,280
wires and ground support equipment

176
00:07:53,189 --> 00:07:51,840
all while trying to simulate a large a

177
00:07:55,990 --> 00:07:53,199
martian uh

178
00:07:58,150 --> 00:07:56,000
environment now we're here at mars

179
00:07:59,830 --> 00:07:58,160
we've been kind of freed of all the all

180
00:08:02,309 --> 00:07:59,840
of us and we're allowed to just kind of

181
00:08:05,110 --> 00:08:02,319
soar the skies and what we demonstrated

182
00:08:07,110 --> 00:08:05,120
is we actually can control flight in the

183
00:08:09,350 --> 00:08:07,120
actual martian environment

184
00:08:11,189 --> 00:08:09,360
and as was shown in like flight 3 we

185
00:08:13,189 --> 00:08:11,199
were able to fly 50 meters downrange

186
00:08:15,670 --> 00:08:13,199
which is the farthest we've been back

187
00:08:17,990 --> 00:08:15,680
and that's the farthest we've ever gone

188
00:08:19,270 --> 00:08:18,000

and in the process we're validating all

189
00:08:21,749 --> 00:08:19,280
our models

190
00:08:24,230 --> 00:08:21,759
all our testing we're able to kind of

191
00:08:25,990 --> 00:08:24,240
inform and refine our models and it

192
00:08:27,029 --> 00:08:26,000
turned out a lot of it matched really

193
00:08:28,950 --> 00:08:27,039
well

194
00:08:30,790 --> 00:08:28,960
and now we we're collecting all this

195
00:08:32,630 --> 00:08:30,800
valuable engineering data back so that

196
00:08:34,870 --> 00:08:32,640
we can kind of help

197
00:08:37,990 --> 00:08:34,880
data mine it and improve our

198
00:08:39,589 --> 00:08:38,000
our uh knowledge for for future missions

199
00:08:41,990 --> 00:08:39,599
now as we move on to kind of an

200
00:08:43,350 --> 00:08:42,000
operational demonstration phase

201
00:08:45,750 --> 00:08:43,360
uh we're going to learn how to work with

202
00:08:48,070 --> 00:08:45,760
perseverance we're going to try to scout

203
00:08:49,990 --> 00:08:48,080
and try to figure out how that how to

204
00:08:50,949 --> 00:08:50,000
play together so that we can inform

205
00:08:52,470 --> 00:08:50,959
future

206
00:08:53,829 --> 00:08:52,480
missions on

207
00:08:55,990 --> 00:08:53,839
on how they would handle this in the

208
00:08:57,269 --> 00:08:56,000
future

209
00:08:58,350 --> 00:08:57,279
yeah so it's going to be a little bit

210
00:09:01,590 --> 00:08:58,360
like a buddy movie

211
00:09:03,030 --> 00:09:01,600
[Laughter]

212
00:09:04,790 --> 00:09:03,040
all right so

213
00:09:06,550 --> 00:09:04,800

what makes it really hard to fly at mars

214
00:09:08,710 --> 00:09:06,560
is that the atmosphere is really thin

215
00:09:11,110 --> 00:09:08,720
but it tightens saturn's largest moon

216
00:09:13,670 --> 00:09:11,120
it's a different world entirely has a

217
00:09:15,750 --> 00:09:13,680
much denser atmosphere than mars and

218
00:09:17,509 --> 00:09:15,760
nishan i know we've talked about how you

219
00:09:20,230 --> 00:09:17,519
know if you were to kind of get some

220
00:09:23,509 --> 00:09:20,240
speed going you could actually soar for

221
00:09:24,470 --> 00:09:23,519
quite a bit of time on titan on your own

222
00:09:26,310 --> 00:09:24,480
so

223
00:09:29,590 --> 00:09:26,320
what can the dragonfly mission learn

224
00:09:31,990 --> 00:09:29,600
from the ingenuity mars helicopter

225
00:09:34,150 --> 00:09:32,000
that's a great question um i'll say that

226
00:09:36,070 --> 00:09:34,160
we are always learning from past based

227
00:09:38,870 --> 00:09:36,080
missions here at apl every time we build

228
00:09:41,509 --> 00:09:38,880
a spacecraft we apply those lessons um

229
00:09:43,430 --> 00:09:41,519
to later efforts in particular uh yeah

230
00:09:45,030 --> 00:09:43,440
we were very excited to see ingenuity

231
00:09:46,070 --> 00:09:45,040
fly on mars um

232
00:09:47,829 --> 00:09:46,080
while there are a lot of differences

233
00:09:49,590 --> 00:09:47,839
between ingenuity and dragonfly there

234
00:09:52,070 --> 00:09:49,600
are also a lot of similarities when

235
00:09:54,790 --> 00:09:52,080
you're designing and operating a vehicle

236
00:09:57,190 --> 00:09:54,800
to on another planet

237
00:09:58,470 --> 00:09:57,200
especially to fly one example is that

238
00:10:00,230 --> 00:09:58,480

flights for both engineerity and

239
00:10:01,509 --> 00:10:00,240
dragonfly are autonomous

240
00:10:03,590 --> 00:10:01,519
titan is

241
00:10:05,670 --> 00:10:03,600
very far from earth it takes over an

242
00:10:07,350 --> 00:10:05,680
hour to send data to titan and over an

243
00:10:09,190 --> 00:10:07,360
hour to get that data back

244
00:10:12,389 --> 00:10:09,200
because of that we can't simply have

245
00:10:14,550 --> 00:10:12,399
someone driving or flying from the earth

246
00:10:16,829 --> 00:10:14,560
we need to dragonfly to be able to go

247
00:10:18,870 --> 00:10:16,839
from place to place on its own like

248
00:10:20,389 --> 00:10:18,880
ingenuity and so

249
00:10:21,910 --> 00:10:20,399
ingenuities

250
00:10:23,990 --> 00:10:21,920
of the team's experience flying

251
00:10:25,829 --> 00:10:24,000
autonomous and mars will be very

252
00:10:28,150 --> 00:10:25,839
valuable we'll um

253
00:10:29,590 --> 00:10:28,160
learn from the challenges they faced and

254
00:10:31,350 --> 00:10:29,600
how they solve them

255
00:10:33,350 --> 00:10:31,360
and i will say that another reason i'm

256
00:10:35,190 --> 00:10:33,360
really excited about ingenuity and

257
00:10:37,670 --> 00:10:35,200
dragonfly of course is that they provide

258
00:10:39,430 --> 00:10:37,680
um these missions provide inspiration uh

259
00:10:41,350 --> 00:10:39,440
they'll inspire future ideas for

260
00:10:42,790 --> 00:10:41,360
planetary exploration and

261
00:10:44,150 --> 00:10:42,800
certainly help us push our boundaries

262
00:10:45,990 --> 00:10:44,160
even further

263
00:10:47,269 --> 00:10:46,000

and um

264
00:10:49,030 --> 00:10:47,279
these missions also inspire the next

265
00:10:51,190 --> 00:10:49,040
generation of scientists and engineers

266
00:10:53,269 --> 00:10:51,200
and uh i hope that students um like my

267
00:10:55,509 --> 00:10:53,279
own daughters will be inspired to uh

268
00:10:57,990 --> 00:10:55,519
pursue space exploration and who knows

269
00:11:00,389 --> 00:10:58,000
um maybe themselves work with dragonfly

270
00:11:02,470 --> 00:11:00,399
when it gets to titan in the 2030s

271
00:11:05,350 --> 00:11:02,480
uh continue exploration of mars or other

272
00:11:07,509 --> 00:11:05,360
places in our universe

273
00:11:11,110 --> 00:11:07,519
yeah and it's pretty hard to figure out

274
00:11:13,269 --> 00:11:11,120
how to fly on another world so nisha why

275
00:11:15,910 --> 00:11:13,279
would we even want an aerial dimension

276
00:11:18,230 --> 00:11:15,920
to explore titan

277
00:11:20,630 --> 00:11:18,240
yeah i think johnny put it very well

278
00:11:23,509 --> 00:11:20,640
earlier flying opens up a lot of new

279
00:11:25,670 --> 00:11:23,519
possibilities for us right we can cover

280
00:11:27,430 --> 00:11:25,680
a lot of ground a larger area than we

281
00:11:29,030 --> 00:11:27,440
than we could otherwise

282
00:11:31,269 --> 00:11:29,040
we can do our science investigation a

283
00:11:32,630 --> 00:11:31,279
lot of different places on titan both on

284
00:11:35,030 --> 00:11:32,640
the surface and

285
00:11:35,829 --> 00:11:35,040
collect data while we're in the air

286
00:11:38,069 --> 00:11:35,839
and

287
00:11:39,670 --> 00:11:38,079
in particular for titan

288
00:11:42,310 --> 00:11:39,680

actually makes a lot of sense to fly

289
00:11:43,910 --> 00:11:42,320
since it's relatively easy uh thanks to

290
00:11:46,550 --> 00:11:43,920
uh like you mentioned uh the really

291
00:11:47,590 --> 00:11:46,560
thick atmosphere there and low gravity

292
00:11:49,269 --> 00:11:47,600
in fact

293
00:11:52,710 --> 00:11:49,279
titan actually has lower gravity than

294
00:11:56,790 --> 00:11:55,350
great yeah so you know lots of different

295
00:11:59,430 --> 00:11:56,800
kinds of worlds

296
00:12:02,230 --> 00:11:59,440
in our solar system so i see that there

297
00:12:03,509 --> 00:12:02,240
are questions coming in online uh if

298
00:12:05,350 --> 00:12:03,519
you'd like to submit a question to be

299
00:12:07,829 --> 00:12:05,360
answered during the show use the hashtag

300
00:12:09,829 --> 00:12:07,839
asknasa or comment in the stream

301
00:12:12,629 --> 00:12:09,839
wherever you're watching this so our

302
00:12:15,350 --> 00:12:12,639
first question is from erica liebel on

303
00:12:17,670 --> 00:12:15,360
twitter asks what has surprised you the

304
00:12:19,990 --> 00:12:17,680
most about ingenuity's accomplishments

305
00:12:21,750 --> 00:12:20,000
so far uh why don't we start with johnny

306
00:12:24,550 --> 00:12:21,760
and any shot you can let me know if you

307
00:12:25,990 --> 00:12:24,560
had anything that surprised you

308
00:12:35,590 --> 00:12:26,000
i

309
00:12:37,110 --> 00:12:35,600
performed on mars uh

310
00:12:38,870 --> 00:12:37,120
we've been looking at these flights

311
00:12:40,470 --> 00:12:38,880
we've been getting back the data we've

312
00:12:42,710 --> 00:12:40,480
dug into it

313
00:12:45,829 --> 00:12:42,720

and they've matched extremely well with

314
00:12:47,829 --> 00:12:45,839
our models uh with how we tested it

315
00:12:53,110 --> 00:12:47,839
and and it's been a very pleasant

316
00:12:56,389 --> 00:12:54,550
you shot did you have anything that

317
00:12:59,030 --> 00:12:56,399
surprised you as you were watching the

318
00:13:00,790 --> 00:12:59,040
ingenuity flights

319
00:13:03,110 --> 00:13:00,800
uh one of the things that surprised me

320
00:13:05,910 --> 00:13:03,120
um you know often usually in space

321
00:13:07,829 --> 00:13:05,920
flight right you try to use hardware

322
00:13:09,590 --> 00:13:07,839
that has been tested extensively in

323
00:13:12,150 --> 00:13:09,600
space and you don't want to take those

324
00:13:14,470 --> 00:13:12,160
sort of risks but with ingenuity you

325
00:13:18,230 --> 00:13:14,480
know learning that they had used

326
00:13:19,829 --> 00:13:18,240
common cell phone processors for example

327
00:13:21,590 --> 00:13:19,839
is really inspiring and it was really

328
00:13:24,870 --> 00:13:21,600
surprising to me and um

329
00:13:29,750 --> 00:13:27,269
great uh next question comes from moon

330
00:13:32,829 --> 00:13:29,760
to mars quest on twitter

331
00:13:35,269 --> 00:13:32,839
will flight testing of the quad chopper

332
00:13:38,150 --> 00:13:35,279
dragonfly be similar to

333
00:13:40,870 --> 00:13:38,160
ingenuity uh performed at jpl's high

334
00:13:42,790 --> 00:13:40,880
vacuum chamber or somewhere like nasa

335
00:13:44,310 --> 00:13:42,800
armstrong or the applied physics lab

336
00:13:46,949 --> 00:13:44,320
facility i guess you know where where

337
00:13:49,110 --> 00:13:46,959
will it be tested nishan

338
00:13:51,509 --> 00:13:49,120

yeah that's a great question um so the

339
00:13:53,750 --> 00:13:51,519
drone it's uh we have a model drone that

340
00:13:56,790 --> 00:13:53,760
we fly to test our algorithms and

341
00:13:59,189 --> 00:13:56,800
sensors and so forth um as the the video

342
00:14:01,509 --> 00:13:59,199
is currently showing uh we will fly that

343
00:14:04,150 --> 00:14:01,519
um at various locations uh

344
00:14:07,110 --> 00:14:04,160
a lot here at the apl we plan on going

345
00:14:10,389 --> 00:14:07,120
out to um deserts out in the uh western

346
00:14:11,829 --> 00:14:10,399
us to run some flight tests there

347
00:14:14,150 --> 00:14:11,839
but that's not the end of the story so

348
00:14:16,230 --> 00:14:14,160
flight you know the actual dragonfly

349
00:14:18,069 --> 00:14:16,240
lander is quite large it's about the

350
00:14:20,069 --> 00:14:18,079
about the size of curiosity actually the

351
00:14:22,790 --> 00:14:20,079
size of a small car makes it very

352
00:14:25,269 --> 00:14:22,800
difficult to test the full-scale

353
00:14:27,189 --> 00:14:25,279
um lander here on earth um you can't

354
00:14:29,350 --> 00:14:27,199
build a chamber quite that big

355
00:14:31,829 --> 00:14:29,360
and so what we'll do is um supplement

356
00:14:33,350 --> 00:14:31,839
our drone flight tests um the test

357
00:14:36,310 --> 00:14:33,360
drones that we um

358
00:14:38,870 --> 00:14:36,320
we're building with uh simulations a lot

359
00:14:40,629 --> 00:14:38,880
of simulations um to

360
00:14:42,710 --> 00:14:40,639
cover all the various possibilities of

361
00:14:45,829 --> 00:14:42,720
what we think we might experience when

362
00:14:49,750 --> 00:14:45,839
we get to titan

363
00:14:51,750 --> 00:14:49,760

great and so uh cinecom on twitter asks

364
00:14:53,189 --> 00:14:51,760
and and i'll apply this uh johnny you

365
00:14:55,509 --> 00:14:53,199
can talk about mars and nishan you can

366
00:14:57,750 --> 00:14:55,519
talk about titan what is the greatest

367
00:15:02,470 --> 00:14:57,760
challenge to a successful flight and how

368
00:15:07,829 --> 00:15:05,509
that's a good question uh so

369
00:15:09,990 --> 00:15:07,839
i think always the most

370
00:15:12,150 --> 00:15:10,000
challenging parts to the flight are

371
00:15:12,949 --> 00:15:12,160
going to be the takeoff and the landing

372
00:15:15,430 --> 00:15:12,959
uh

373
00:15:18,310 --> 00:15:15,440
it's certainly where everything kind of

374
00:15:20,790 --> 00:15:18,320
works or doesn't for the takeoff

375
00:15:22,389 --> 00:15:20,800
we we kind of do a we have a scheme

376
00:15:25,030 --> 00:15:22,399
where essentially we

377
00:15:26,870 --> 00:15:25,040
we apply a large amount of thrust to to

378
00:15:28,470 --> 00:15:26,880
kind of hop it off the ground

379
00:15:30,550 --> 00:15:28,480
and at that point we kind of do a

380
00:15:31,990 --> 00:15:30,560
controlled flight up up to the altitude

381
00:15:33,749 --> 00:15:32,000
that we want to

382
00:15:37,509 --> 00:15:33,759
and then on landing

383
00:15:39,749 --> 00:15:37,519
we actually drive it down um

384
00:15:42,310 --> 00:15:39,759
at a at a meter per second

385
00:15:45,110 --> 00:15:42,320
coming down and then we wait until we we

386
00:15:46,870 --> 00:15:45,120
detect enough velocity error

387
00:15:48,870 --> 00:15:46,880
to to determine that it that we've

388
00:15:52,310 --> 00:15:48,880

actually reached the ground and then the

389
00:15:57,110 --> 00:15:54,230
and nishant what about titan what's the

390
00:15:59,189 --> 00:15:57,120
greatest challenge there

391
00:16:01,110 --> 00:15:59,199
oh uh there are a significant number of

392
00:16:03,030 --> 00:16:01,120
challenges um

393
00:16:05,350 --> 00:16:03,040
you know we haven't gotten there yet but

394
00:16:06,870 --> 00:16:05,360
i can say that a couple of things that

395
00:16:08,949 --> 00:16:06,880
we're looking at

396
00:16:10,150 --> 00:16:08,959
include the thermal environment uh by

397
00:16:11,910 --> 00:16:10,160
that i mean the temperature on the

398
00:16:14,069 --> 00:16:11,920
surface of titan it is

399
00:16:16,310 --> 00:16:14,079
very very cold um

400
00:16:18,069 --> 00:16:16,320
about negative 300 degrees fahrenheit

401
00:16:19,670 --> 00:16:18,079
which is kind of hard to fathom right we

402
00:16:21,189 --> 00:16:19,680
don't have any equivalent experience

403
00:16:24,230 --> 00:16:21,199
here on earth

404
00:16:26,389 --> 00:16:24,240
and designing a lander that can survive

405
00:16:28,230 --> 00:16:26,399
those temperatures and operate on those

406
00:16:30,550 --> 00:16:28,240
temperatures is a challenge

407
00:16:32,310 --> 00:16:30,560
um and i'll um

408
00:16:34,310 --> 00:16:32,320
so you know what johnny said is also

409
00:16:36,550 --> 00:16:34,320
true right i mean the

410
00:16:37,910 --> 00:16:36,560
building um something that can take off

411
00:16:40,310 --> 00:16:37,920
from one location fly to another

412
00:16:41,590 --> 00:16:40,320
autonomously is difficult and will be

413
00:16:47,110 --> 00:16:41,600

one of the

414
00:16:49,670 --> 00:16:47,120
and and if i may i'd like to add a

415
00:16:52,069 --> 00:16:49,680
little bit to what nishant was saying uh

416
00:16:54,629 --> 00:16:52,079
he's right survivability is actually one

417
00:16:56,150 --> 00:16:54,639
of the bigger challenges as well and

418
00:16:57,990 --> 00:16:56,160
there's there's a lot of work to being

419
00:16:59,670 --> 00:16:58,000
able to survive like a cool night in

420
00:17:02,069 --> 00:16:59,680
mars and

421
00:17:03,910 --> 00:17:02,079
all the work that went involved to

422
00:17:05,429 --> 00:17:03,920
having the heater there to keep it at a

423
00:17:08,069 --> 00:17:05,439
certain temperature

424
00:17:10,150 --> 00:17:08,079
uh keep it there live having it wake up

425
00:17:13,590 --> 00:17:10,160
every day that there's a lot of work

426
00:17:15,669 --> 00:17:13,600
that went into that and a lot of testing

427
00:17:17,669 --> 00:17:15,679
yeah i remember mimi young the project

428
00:17:19,750 --> 00:17:17,679
manager saying she would be

429
00:17:22,470 --> 00:17:19,760
so happy when it when the helicopter

430
00:17:27,510 --> 00:17:22,480
survived its first night

431
00:17:33,430 --> 00:17:31,350
great okay so um because everyone always

432
00:17:36,470 --> 00:17:33,440
wants to know about pictures

433
00:17:38,950 --> 00:17:36,480
adrian on facebook asks can dragonfly

434
00:17:41,190 --> 00:17:38,960
record videos and send it back to earth

435
00:17:43,669 --> 00:17:41,200
as well

436
00:17:46,230 --> 00:17:43,679
that's that is an excellent question

437
00:17:48,950 --> 00:17:46,240
we have a set of cameras on board

438
00:17:50,789 --> 00:17:48,960

dragonfly uh a science set of cameras

439
00:17:53,669 --> 00:17:50,799
called dragon cam

440
00:17:55,270 --> 00:17:53,679
and a set of cameras that we'll use

441
00:17:57,669 --> 00:17:55,280
just for navigation something we call

442
00:17:59,750 --> 00:17:57,679
our nav cams which is uh what we'll use

443
00:18:00,710 --> 00:17:59,760
for mobility to fly from one location to

444
00:18:03,270 --> 00:18:00,720
another

445
00:18:05,110 --> 00:18:03,280
um we'll be taking pictures certainly um

446
00:18:07,830 --> 00:18:05,120
we'll be taking pictures very frequently

447
00:18:10,070 --> 00:18:07,840
on as we fly however i wouldn't

448
00:18:11,350 --> 00:18:10,080
necessarily call it a video we're not

449
00:18:13,430 --> 00:18:11,360
going to be

450
00:18:15,669 --> 00:18:13,440
able to collect high rate like you know

451
00:18:17,270 --> 00:18:15,679
30 frames a second or 60 frames a second

452
00:18:19,110 --> 00:18:17,280
kind of videos and get all that data

453
00:18:20,710 --> 00:18:19,120
down to earth a couple of challenges

454
00:18:23,029 --> 00:18:20,720
there um

455
00:18:24,870 --> 00:18:23,039
one is you know just designing a system

456
00:18:26,950 --> 00:18:24,880
that can handle that video data rate

457
00:18:28,789 --> 00:18:26,960
with everything else that's going on on

458
00:18:30,710 --> 00:18:28,799
board the lander

459
00:18:32,390 --> 00:18:30,720
so for example our navigation cameras i

460
00:18:34,630 --> 00:18:32,400
can speak to those uh we'll collect data

461
00:18:37,430 --> 00:18:34,640
as we're flying at about one picture

462
00:18:38,470 --> 00:18:37,440
every second which isn't very often

463
00:18:39,909 --> 00:18:38,480

um

464
00:18:41,830 --> 00:18:39,919
the second challenge the next challenge

465
00:18:43,669 --> 00:18:41,840
is how do you get all that data back

466
00:18:46,310 --> 00:18:43,679
from titan to the earth

467
00:18:48,310 --> 00:18:46,320
um you know it sounds easy right you

468
00:18:50,070 --> 00:18:48,320
have a big antenna on dragonfly and you

469
00:18:51,669 --> 00:18:50,080
start sending data but

470
00:18:53,510 --> 00:18:51,679
uh for those of you that you know sort

471
00:18:55,590 --> 00:18:53,520
of understand what data rates look like

472
00:18:58,710 --> 00:18:55,600
um we're talking about

473
00:19:00,870 --> 00:18:58,720
10 ish kilobits bits per second

474
00:19:01,830 --> 00:19:00,880
from titan back to earth which is not a

475
00:19:02,950 --> 00:19:01,840
lot

476
00:19:04,950 --> 00:19:02,960
and so

477
00:19:06,950 --> 00:19:04,960
you know we will be spending a lot of

478
00:19:08,710 --> 00:19:06,960
time optimizing

479
00:19:09,990 --> 00:19:08,720
what data we want to bring down working

480
00:19:12,390 --> 00:19:10,000
with the scientists to figure out what's

481
00:19:15,510 --> 00:19:12,400
most interesting and when we finally get

482
00:19:19,510 --> 00:19:15,520
to titan implement that and get what

483
00:19:24,630 --> 00:19:21,750
yeah and and johnny there's some cameras

484
00:19:27,270 --> 00:19:24,640
on board ingenuity as well right

485
00:19:29,110 --> 00:19:27,280
yes uh we have two cameras uh one is our

486
00:19:31,110 --> 00:19:29,120
navigation camera that's kind of our

487
00:19:32,870 --> 00:19:31,120
black and white camera pointing mostly

488
00:19:35,029 --> 00:19:32,880

down slightly board

489
00:19:36,310 --> 00:19:35,039
uh and that's where the kind of that

490
00:19:38,390 --> 00:19:36,320
iconic first

491
00:19:39,830 --> 00:19:38,400
first flight image comes from

492
00:19:40,870 --> 00:19:39,840
where it took a picture of its own

493
00:19:43,590 --> 00:19:40,880
shadow

494
00:19:45,430 --> 00:19:43,600
uh and then we have the color camera we

495
00:19:47,830 --> 00:19:45,440
call it the rte or return to earth

496
00:19:50,830 --> 00:19:47,840
camera and that's the one that's taking

497
00:19:54,070 --> 00:19:50,840
the images uh all a little bit more

498
00:19:57,750 --> 00:19:54,080
forward-facing uh now we don't have

499
00:19:59,510 --> 00:19:57,760
video capability uh there we

500
00:20:02,070 --> 00:19:59,520
were

501
00:20:04,149 --> 00:20:02,080
for for the color camera we take we take

502
00:20:06,390 --> 00:20:04,159
some images for the net for the

503
00:20:08,789 --> 00:20:06,400
navigation camera we collect more images

504
00:20:09,909 --> 00:20:08,799
so we can't have limited data recording

505
00:20:11,830 --> 00:20:09,919
if you will

506
00:20:13,430 --> 00:20:11,840
uh that's as long as we can pro get all

507
00:20:16,470 --> 00:20:13,440
those images down

508
00:20:18,710 --> 00:20:16,480
and process them in that way

509
00:20:20,870 --> 00:20:18,720
but but we're overall kind of

510
00:20:23,830 --> 00:20:20,880
restricted by

511
00:20:25,669 --> 00:20:23,840
processing load and

512
00:20:27,190 --> 00:20:25,679
trying to collect that much data is kind

513
00:20:30,630 --> 00:20:27,200

of a lot while in the middle of trying

514
00:20:32,070 --> 00:20:30,640
to maintain flight at the same time

515
00:20:33,669 --> 00:20:32,080
right and there have been some videos

516
00:20:36,710 --> 00:20:33,679
that came back but they were taken by

517
00:20:38,870 --> 00:20:36,720
your buddy the rover right

518
00:20:40,789 --> 00:20:38,880
um and i know that we have some great

519
00:20:43,590 --> 00:20:40,799
orbiters around mars that have been able

520
00:20:45,029 --> 00:20:43,600
to kind of give us those high data rates

521
00:20:46,470 --> 00:20:45,039
um

522
00:20:48,950 --> 00:20:46,480
we'll have to see what kind of support i

523
00:20:52,390 --> 00:20:48,960
guess you guys have it tightening you

524
00:20:54,870 --> 00:20:52,400
don't have a relay network yet there

525
00:20:57,350 --> 00:20:54,880
now um the plan for dragonfly is direct

526
00:20:59,110 --> 00:20:57,360
to earth communications what we call um

527
00:21:01,430 --> 00:20:59,120
dte so

528
00:21:03,669 --> 00:21:01,440
um yeah dragonfly has a large antenna

529
00:21:04,870 --> 00:21:03,679
what we call the high gain antenna or

530
00:21:06,310 --> 00:21:04,880
hga

531
00:21:08,149 --> 00:21:06,320
which will be communicating directly

532
00:21:10,070 --> 00:21:08,159
back to earth

533
00:21:12,870 --> 00:21:10,080
we don't have any other support

534
00:21:17,510 --> 00:21:14,789
okay well there's another question about

535
00:21:18,390 --> 00:21:17,520
dragonfly and i don't know um nisha if

536
00:21:20,789 --> 00:21:18,400
you've

537
00:21:23,590 --> 00:21:20,799
you know settled all these things but

538
00:21:25,430 --> 00:21:23,600

robert hill group on youtube asks what

539
00:21:29,110 --> 00:21:25,440
are the specific dimensions being

540
00:21:31,190 --> 00:21:29,120
proposed for the dragonfly mission

541
00:21:32,950 --> 00:21:31,200
ah yeah so um we're still in the middle

542
00:21:35,110 --> 00:21:32,960
of a design phase so there are things

543
00:21:37,990 --> 00:21:35,120
that will change um

544
00:21:40,789 --> 00:21:38,000
if you you know we're fairly close to

545
00:21:44,710 --> 00:21:40,799
about the size of a a small

546
00:21:46,230 --> 00:21:44,720
mini uh type of car or um you know or

547
00:21:48,710 --> 00:21:46,240
even curiosity

548
00:21:50,630 --> 00:21:48,720
um i'm not i don't have the exact

549
00:21:52,630 --> 00:21:50,640
dimensions off the you know on the tip

550
00:21:55,909 --> 00:21:52,640
of my tongue here but um you can think

551
00:22:01,190 --> 00:21:59,190
cool okay yeah which is much larger than

552
00:22:03,190 --> 00:22:01,200
ingenuity which i think the fuselage is

553
00:22:04,470 --> 00:22:03,200
like the size of a tissue box right

554
00:22:07,669 --> 00:22:04,480
johnny

555
00:22:09,590 --> 00:22:07,679
yes that's about the correct

556
00:22:10,390 --> 00:22:09,600
comparison

557
00:22:11,590 --> 00:22:10,400
yeah

558
00:22:13,990 --> 00:22:11,600
well here's a question about the

559
00:22:17,110 --> 00:22:14,000
helicopter um

560
00:22:19,669 --> 00:22:17,120
douglas arago on twitter asks what is

561
00:22:22,549 --> 00:22:19,679
the flight ceiling on mars and how does

562
00:22:25,590 --> 00:22:22,559
that compare to earth or a helicopter of

563
00:22:30,870 --> 00:22:28,390

the size ceiling i guess i'm not

564
00:22:33,669 --> 00:22:30,880
completely um understanding that

565
00:22:35,750 --> 00:22:33,679
question perhaps so like how high could

566
00:22:38,870 --> 00:22:35,760
it go since i think the atmosphere gets

567
00:22:41,270 --> 00:22:38,880
a little bit thinner right as you go up

568
00:22:43,590 --> 00:22:41,280
well i mean i think our our limitation

569
00:22:45,750 --> 00:22:43,600
right now is kind of our sensor package

570
00:22:47,270 --> 00:22:45,760
we we've been comfortable flying with

571
00:22:50,870 --> 00:22:47,280
the altimeter

572
00:22:51,990 --> 00:22:50,880
uh at five meters uh altitude

573
00:22:54,149 --> 00:22:52,000
and we

574
00:22:55,990 --> 00:22:54,159
we're also planning uh we are also

575
00:22:58,630 --> 00:22:56,000
comfortable probably going as high as 10

576
00:23:00,470 --> 00:22:58,640
maybe 15 meters altitude but beyond that

577
00:23:01,830 --> 00:23:00,480
we're a little we we start to get a

578
00:23:05,190 --> 00:23:01,840
little

579
00:23:07,750 --> 00:23:05,200
um cautious because it

580
00:23:10,470 --> 00:23:07,760
thing things might not work well

581
00:23:13,669 --> 00:23:10,480
at that at that altitude so that's kind

582
00:23:15,190 --> 00:23:13,679
of our limit uh at the moment

583
00:23:18,630 --> 00:23:15,200
but all the flights up to the state have

584
00:23:21,909 --> 00:23:18,640
been at the five meter altitude

585
00:23:23,510 --> 00:23:21,919
yeah okay so let's see oh speaking of

586
00:23:26,789 --> 00:23:23,520
you're talking about sensor but here's a

587
00:23:29,430 --> 00:23:26,799
question about energy so rando knot on

588
00:23:31,350 --> 00:23:29,440

twitter asks what kind of energy could

589
00:23:36,230 --> 00:23:31,360
be used for the next generation of

590
00:23:40,390 --> 00:23:38,390
is that directed to me or

591
00:23:41,990 --> 00:23:40,400
yeah johnny i guess if there's like um

592
00:23:43,430 --> 00:23:42,000
let's say there's a helicopter that goes

593
00:23:45,029 --> 00:23:43,440
on but yeah nisha why don't you talk

594
00:23:46,870 --> 00:23:45,039
about the power source for your

595
00:23:48,870 --> 00:23:46,880
rotorcraft too but johnny won't you go

596
00:23:50,549 --> 00:23:48,880
first

597
00:23:52,470 --> 00:23:50,559
well i mean for the mars helicopter we

598
00:23:55,510 --> 00:23:52,480
have that solar panel it's uh it's that

599
00:23:57,750 --> 00:23:55,520
rectangular strip you see at the top

600
00:23:58,870 --> 00:23:57,760
uh and it's been it's been performing

601
00:24:00,950 --> 00:23:58,880
well for us

602
00:24:03,350 --> 00:24:00,960
it's giving us plenty of charge for

603
00:24:05,830 --> 00:24:03,360
overnight uh over the course of the day

604
00:24:07,110 --> 00:24:05,840
so that we're ready and able and

605
00:24:11,830 --> 00:24:07,120
power healthy

606
00:24:15,669 --> 00:24:13,430
and nishant you're much farther away

607
00:24:17,990 --> 00:24:15,679
from the sun or you will be so how do

608
00:24:19,830 --> 00:24:18,000
you guys get power

609
00:24:22,870 --> 00:24:19,840
yeah we can't use uh solar panels

610
00:24:25,269 --> 00:24:22,880
unfortunately when um at titan um but we

611
00:24:27,510 --> 00:24:25,279
use um a power source very much like

612
00:24:29,510 --> 00:24:27,520
curiosity and perseverance too

613
00:24:31,510 --> 00:24:29,520

it's what's called an mm rtg it's a bit

614
00:24:33,830 --> 00:24:31,520
of a mouthful and multi-mission radio

615
00:24:36,390 --> 00:24:33,840
isotope

616
00:24:38,230 --> 00:24:36,400
a thermoelectric generator

617
00:24:40,390 --> 00:24:38,240
it is uh uses a new

618
00:24:43,510 --> 00:24:40,400
the decay of materials to generate heat

619
00:24:45,990 --> 00:24:43,520
which gets turned into electricity on

620
00:24:48,549 --> 00:24:46,000
board and um so what dragonfly will do

621
00:24:50,230 --> 00:24:48,559
is it'll use that it and that provides

622
00:24:52,630 --> 00:24:50,240
about

623
00:24:54,310 --> 00:24:52,640
50 to 60 watts of power will charge

624
00:24:55,190 --> 00:24:54,320
batteries on board which will then be

625
00:24:57,669 --> 00:24:55,200
used

626
00:25:00,230 --> 00:24:57,679
um for flight

627
00:25:02,230 --> 00:25:00,240
and other activities

628
00:25:04,470 --> 00:25:02,240
okay great yeah and it's a power source

629
00:25:05,269 --> 00:25:04,480
that's been used on many missions before

630
00:25:07,190 --> 00:25:05,279
too

631
00:25:09,590 --> 00:25:07,200
um okay well that's all the time that we

632
00:25:12,230 --> 00:25:09,600
have for today so thank you for joining

633
00:25:13,830 --> 00:25:12,240
us johnny and nishant

634
00:25:15,269 --> 00:25:13,840
thank you for having us and go

635
00:25:19,029 --> 00:25:15,279
engineering

636
00:25:24,070 --> 00:25:20,549
if you'd like to stay updated on the

637
00:25:25,909 --> 00:25:24,080
mars helicopter visit go.nasa.gov

638
00:25:27,350 --> 00:25:25,919

ingenuity and to learn more about the

639
00:25:32,390 --> 00:25:27,360
dragonfly mission visit

640
00:25:36,710 --> 00:25:34,149
be sure to keep up with the perseverance

641
00:25:39,430 --> 00:25:36,720
rover as well on facebook and twitter as

642
00:25:41,590 --> 00:25:39,440
the helicopter moves into this new phase

643
00:25:44,070 --> 00:25:41,600
graduating if you will into an

644
00:25:46,149 --> 00:25:44,080
operational demonstration perseverance

645
00:25:48,470 --> 00:25:46,159
will also begin to focus on its science

646
00:25:50,789 --> 00:25:48,480
campaign which includes searching for

647
00:25:54,230 --> 00:25:50,799
signs of ancient life on mars and you

648
00:25:55,750 --> 00:25:54,240
can follow along by visiting nasa.gov

649
00:25:56,950 --> 00:25:55,760
perseverance

650
00:25:59,430 --> 00:25:56,960
and since we've been talking about

651
00:26:01,590 --> 00:25:59,440
turning science fiction into reality i

652
00:26:04,549 --> 00:26:01,600
should also wish everyone out there a

653
00:26:06,630 --> 00:26:04,559
happy star wars day this may 4th may the

654
00:26:08,230 --> 00:26:06,640
force be with you nasa will be

655
00:26:10,310 --> 00:26:08,240
celebrating throughout the day on social

656
00:26:11,830 --> 00:26:10,320
media so stay tuned for some fun

657
00:26:13,750 --> 00:26:11,840
surprises

658
00:26:16,149 --> 00:26:13,760
science fiction encourages all of us at

659
00:26:18,390 --> 00:26:16,159
nasa to dream big and we can't do things

660
00:26:20,470 --> 00:26:18,400
like fly on mars or titan without the

661
00:26:21,830 --> 00:26:20,480
expertise and knowledge of those around

662
00:26:23,669 --> 00:26:21,840
the agency

663
00:26:25,669 --> 00:26:23,679

during asian american and pacific

664
00:26:27,269 --> 00:26:25,679
islander heritage month we'd like to

665
00:26:28,950 --> 00:26:27,279
honor some of these employees playing

666
00:26:31,590 --> 00:26:28,960
key roles at nasa

667
00:26:34,470 --> 00:26:31,600
here at jpl for example we count chen

668
00:26:36,870 --> 00:26:34,480
shisen a chinese-american specialist in

669
00:26:39,430 --> 00:26:36,880
fluid mechanics as one of our original

670
00:26:41,269 --> 00:26:39,440
founders we'll close on a video sharing

671
00:26:43,430 --> 00:26:41,279
words from some of our asian american

672
00:26:46,800 --> 00:26:43,440
and pacific islander employees thank you

673
00:27:01,750 --> 00:26:46,810
so much for joining us until next time

674
00:27:05,909 --> 00:27:03,750
hi i'm kelly busquets i'm an engineer

675
00:27:07,669 --> 00:27:05,919
with the goddard space flight center hi

676
00:27:09,350 --> 00:27:07,679
my name is tony arviola and i work at

677
00:27:11,510 --> 00:27:09,360
langley research center my name is

678
00:27:12,710 --> 00:27:11,520
karthik shade i'm an astrophysicist

679
00:27:14,710 --> 00:27:12,720
working in the science mission

680
00:27:16,870 --> 00:27:14,720
directorate this is kenji nikki my name

681
00:27:18,389 --> 00:27:16,880
is jenny stags my name is steve she i'm

682
00:27:20,310 --> 00:27:18,399
the associate administrator for

683
00:27:22,149 --> 00:27:20,320
diversity and equal opportunity here at

684
00:27:24,070 --> 00:27:22,159
nasa i'm a research materials engineer

685
00:27:25,990 --> 00:27:24,080
i'm a program analyst i work as a

686
00:27:27,750 --> 00:27:26,000
software engineer i do research on

687
00:27:28,950 --> 00:27:27,760
electric propulsion i came here from

688
00:27:31,190 --> 00:27:28,960

japan

689
00:27:32,789 --> 00:27:31,200
long time ago hoping that i could work

690
00:27:35,830 --> 00:27:32,799
for nasa

691
00:27:38,710 --> 00:27:35,840
actually this is my favorite picture

692
00:27:41,350 --> 00:27:38,720
that i kept near my desk for a long time

693
00:27:43,430 --> 00:27:41,360
i am proud to be an asian american and

694
00:27:45,430 --> 00:27:43,440
i'm so proud to be a part of the nasa

695
00:27:47,269 --> 00:27:45,440
family i'm the second generation of

696
00:27:48,789 --> 00:27:47,279
vietnamese and timelines ascent i grew

697
00:27:50,789 --> 00:27:48,799
up in the philippines i'm indian

698
00:27:52,549 --> 00:27:50,799
american i'm filipino both my parents

699
00:27:55,669 --> 00:27:52,559
are from the philippines i come from

700
00:27:58,789 --> 00:27:55,679
india i am really honored and blessed to

701
00:28:00,389 --> 00:27:58,799
be part of an organization that

702
00:28:02,470 --> 00:28:00,399
embraces

703
00:28:05,110 --> 00:28:02,480
diverse backgrounds but never in my

704
00:28:07,990 --> 00:28:05,120
wildest dreams did i expect to be

705
00:28:11,669 --> 00:28:08,000
working at this i am profoundly deaf

706
00:28:15,350 --> 00:28:11,679
which makes me a unique person who is a

707
00:28:17,269 --> 00:28:15,360
deaf asian employed at nasa i'm an

708
00:28:19,350 --> 00:28:17,279
ambitious woman and i do not let anyone

709
00:28:21,430 --> 00:28:19,360
discourage me i'm so grateful for the

710
00:28:24,070 --> 00:28:21,440
opportunity to work in an agency where

711
00:28:26,630 --> 00:28:24,080
our work benefits the entire world you

712
00:28:29,510 --> 00:28:26,640
notice my speaking i had some speaking

713
00:28:30,789 --> 00:28:29,520

problems on top of a japanese accent but

714
00:28:34,070 --> 00:28:30,799
in

715
00:28:36,630 --> 00:28:34,080
nasa no one care about it they just

716
00:28:38,630 --> 00:28:36,640
care what i'm doing so it makes me very

717
00:28:41,190 --> 00:28:38,640
happy thank you for joining us and

718
00:28:42,470 --> 00:28:41,200
celebrating uh asian american pacific

719
00:28:45,220 --> 00:28:42,480
islander

720
00:28:46,789 --> 00:28:45,230
heritage month happy aapi heritage month

721
00:28:49,669 --> 00:28:46,799
[Music]

722
00:28:59,190 --> 00:28:52,020
namaste