
MARS
HELICOPTER


NASA

1
00:00:12,589 --> 00:00:08,179
ingenuity represents the most remarkable

2
00:00:14,450 --> 00:00:12,599
things that humanity is capable of these

3
00:00:16,760 --> 00:00:14,460
achievements are not just the product of

4
00:00:19,330 --> 00:00:16,770
pure determination their combination of

5
00:00:23,230 --> 00:00:19,340
human perseverance ingenuity

6
00:00:26,230 --> 00:00:23,240
hi Vanessa my name is Mimi um I work at

7
00:00:29,470 --> 00:00:26,240
NASA Jet Propulsion Laboratory JPL and

8
00:00:32,320 --> 00:00:29,480
my job there is a project manager for

9
00:00:34,060 --> 00:00:32,330
marcella copter Mars helicopter is a

10
00:00:38,020 --> 00:00:34,070
technology demonstration flight

11
00:00:41,890 --> 00:00:38,030
experiment that Mars 2020 perseverance

12
00:00:43,810 --> 00:00:41,900
rover is hosting and we're going for the

13
00:00:48,820 --> 00:00:43,820

attempt at flying the first ever flight

14
00:00:50,799 --> 00:00:48,830
on another planet so I've been really

15
00:00:53,770 --> 00:00:50,809
excited about this phone call to talk to

16
00:00:56,620 --> 00:00:53,780
you because I'm getting to share with

17
00:00:59,139 --> 00:00:56,630
you the news that your proposed name has

18
00:01:03,370 --> 00:00:59,149
been chosen as the name for Mars

19
00:01:06,340 --> 00:01:03,380
helicopter well that's amazing so on

20
00:01:09,910 --> 00:01:06,350
behalf of our entire Mars helicopter

21
00:01:17,180 --> 00:01:09,920
team I'd like to thank you for our name

22
00:01:22,610 --> 00:01:20,150
it's the perfect name for us we really

23
00:01:26,540 --> 00:01:22,620
we love the name so thank you

24
00:01:28,550 --> 00:01:26,550
thank you guys ingenuity is what allows

25
00:01:30,500 --> 00:01:28,560
people to accomplish amazing things and

26
00:01:33,390 --> 00:01:30,510
it allows us to expand our horizons to

27
00:01:39,289 --> 00:01:33,400
the edges of the universe

28
00:01:42,539 --> 00:01:39,299
[Music]

29
00:01:45,060 --> 00:01:42,549
hi I'm Eric Evan with a with the News

30
00:01:47,370 --> 00:01:45,070
team at NASA's Jet Propulsion Laboratory

31
00:01:49,230 --> 00:01:47,380
in California hitching a ride on the

32
00:01:52,469 --> 00:01:49,240
perseverance Rover launched into Mars

33
00:01:55,590 --> 00:01:52,479
this summer is the Mars helicopter which

34
00:01:56,819 --> 00:01:55,600
now has a name ingenuity and we want to

35
00:01:59,490 --> 00:01:56,829
give you a chance to learn more about

36
00:02:01,559 --> 00:01:59,500
this experiment as ingenuity will try to

37
00:02:03,630 --> 00:02:01,569
be the first powered flight on another

38
00:02:06,569 --> 00:02:03,640

planet and we are following social

39
00:02:09,089 --> 00:02:06,579
distancing rules that's why me me young

40
00:02:11,729 --> 00:02:09,099
the Mars helicopter project manager

41
00:02:14,490 --> 00:02:11,739
joins me from the Mars helicopter test

42
00:02:17,250 --> 00:02:14,500
lab at JPL she's the only person there

43
00:02:19,470 --> 00:02:17,260
the helicopter is in Florida awaiting

44
00:02:21,569 --> 00:02:19,480
launch and I have a couple questions to

45
00:02:24,059 --> 00:02:21,579
get us started and then will be asking

46
00:02:26,819 --> 00:02:24,069
me questions submitted with the ask NASA

47
00:02:30,420 --> 00:02:26,829
hashtag me thanks for answering our

48
00:02:32,880 --> 00:02:30,430
questions today you're welcome thanks

49
00:02:35,970 --> 00:02:32,890
for having me here of course so to get

50
00:02:37,800 --> 00:02:35,980
started how does a helicopter work on

51
00:02:40,490 --> 00:02:37,810
Mars I see you have a model behind you

52
00:02:43,740 --> 00:02:40,500
can you kind of explain it using that

53
00:02:46,410 --> 00:02:43,750
sure this is a full-scale model behind

54
00:02:49,410 --> 00:02:46,420
me the helicopter has a solar panel on

55
00:02:52,050 --> 00:02:49,420
top with the communication antenna right

56
00:02:53,910 --> 00:02:52,060
underneath this a rotor system it's a

57
00:02:56,699 --> 00:02:53,920
pair of counter-rotating blades that

58
00:02:59,340 --> 00:02:56,709
will spin up to about 2400 revolutions

59
00:03:01,710 --> 00:02:59,350
per minute very fast and underneath is

60
00:03:04,680 --> 00:03:01,720
the fuselage containing the battery and

61
00:03:08,009 --> 00:03:04,690
special electronic boards thermal

62
00:03:10,199 --> 00:03:08,019
components sensors tremors and at the

63
00:03:13,110 --> 00:03:10,209

very bottom is the landing gear the

64
00:03:13,830 --> 00:03:13,120
entire vehicle weights about 1.8

65
00:03:17,490 --> 00:03:13,840
kilograms

66
00:03:19,770 --> 00:03:17,500
just about four pounds Wow and can you

67
00:03:21,720 --> 00:03:19,780
talk about the teamwork and innovation

68
00:03:23,449 --> 00:03:21,730
that took place to get this project off

69
00:03:26,759 --> 00:03:23,459
the ground

70
00:03:29,670 --> 00:03:26,769
yes building for the first time a

71
00:03:32,099 --> 00:03:29,680
helicopter that can fly in the very thin

72
00:03:34,650 --> 00:03:32,109
atmosphere of Mars was considered to be

73
00:03:38,490 --> 00:03:34,660
almost impossible definitely really

74
00:03:40,460 --> 00:03:38,500
challenging so to have a helicopter that

75
00:03:43,140 --> 00:03:40,470
can fly in the thin atmosphere

76
00:03:46,110 --> 00:03:43,150
autonomously and survive autonomously on

77
00:03:47,990 --> 00:03:46,120
the surface of Mars and to be operable

78
00:03:49,530 --> 00:03:48,000
you know all the way back from Earth

79
00:03:52,619 --> 00:03:49,540
that took in

80
00:03:55,910 --> 00:03:52,629
Genuity hard work and really true

81
00:03:59,280 --> 00:03:55,920
teamwork teamwork from many disciplines

82
00:04:01,140 --> 00:03:59,290
we there is a significant team behind

83
00:04:03,539 --> 00:04:01,150
the making of the Mars helicopter

84
00:04:05,970 --> 00:04:03,549
I really wish everybody on our team is

85
00:04:08,490 --> 00:04:05,980
here today to share our stories with you

86
00:04:11,339 --> 00:04:08,500
but I'm really proud to be representing

87
00:04:13,319 --> 00:04:11,349
the team here from you know all the way

88
00:04:16,279 --> 00:04:13,329

from the mathematical equations that

89
00:04:18,810 --> 00:04:16,289
represent the helicopter to software

90
00:04:22,350 --> 00:04:18,820
electronics mechanical structures

91
00:04:24,510 --> 00:04:22,360
thermal power materials special fixtures

92
00:04:26,999 --> 00:04:24,520
special facilities that it takes to test

93
00:04:29,999 --> 00:04:27,009
it's a very long list of technical

94
00:04:32,370 --> 00:04:30,009
specialty that it took and to meet these

95
00:04:34,589 --> 00:04:32,380
challenges we work together really

96
00:04:37,379 --> 00:04:34,599
tightly both technically in each

97
00:04:39,659 --> 00:04:37,389
discipline and as the system together to

98
00:04:42,270 --> 00:04:39,669
make this work and we're really tight

99
00:04:43,070 --> 00:04:42,280
team we are really happy to be where we

100
00:04:47,010 --> 00:04:43,080
are today

101
00:04:50,279 --> 00:04:47,020
ready integrated onto perseverance Rover

102
00:04:55,080 --> 00:04:50,289
for launch to Mars for a bit very first

103
00:04:57,149 --> 00:04:55,090
test flight at Mars and you were just

104
00:04:59,430 --> 00:04:57,159
touching on this now the Mars helicopter

105
00:05:02,550 --> 00:04:59,440
is riding on the perseverance rover so

106
00:05:04,860 --> 00:05:02,560
how does the idea of perseverance work

107
00:05:09,980 --> 00:05:04,870
with the idea of ingenuity for your team

108
00:05:12,330 --> 00:05:09,990
a marcella copter call ingenuity on

109
00:05:15,420 --> 00:05:12,340
aerobic or perseverance

110
00:05:17,790 --> 00:05:15,430
how much more perfect can I get you know

111
00:05:21,779 --> 00:05:17,800
Mars helicopter is a first of a kind

112
00:05:24,870 --> 00:05:21,789
system that's going to attempt the very

113
00:05:27,300 --> 00:05:24,880

first flight of a helicopter on another

114
00:05:30,629 --> 00:05:27,310
planet right very much like a Wright

115
00:05:33,420 --> 00:05:30,639
brothers first test flight moment and it

116
00:05:35,610 --> 00:05:33,430
took ingenuity hard work and definitely

117
00:05:37,800 --> 00:05:35,620
perseverance to get to where we are

118
00:05:40,529 --> 00:05:37,810
today and here we are

119
00:05:43,980 --> 00:05:40,539
ingenuity helicopter integrated on

120
00:05:46,950 --> 00:05:43,990
perseverance Rover or launch to Mars for

121
00:05:50,040 --> 00:05:46,960
the very first flight tests on the

122
00:05:51,510 --> 00:05:50,050
surface of Mars and I heard that the

123
00:05:54,779 --> 00:05:51,520
team found out about the name this

124
00:05:56,159 --> 00:05:54,789
morning how did it all go oh it was

125
00:05:58,890 --> 00:05:56,169
incredible

126
00:06:01,010 --> 00:05:58,900
a big part of our team a subset of our

127
00:06:05,570 --> 00:06:01,020
team got together

128
00:06:08,089 --> 00:06:05,580
and we got to have the name shared very

129
00:06:11,659 --> 00:06:08,099
shortly you know before the announcement

130
00:06:14,689 --> 00:06:11,669
we had it shared by the student of

131
00:06:16,790 --> 00:06:14,699
venice' that wrote the essay that

132
00:06:19,700 --> 00:06:16,800
inspired the name and it was an

133
00:06:21,830 --> 00:06:19,710
incredible experience we it's an

134
00:06:26,839 --> 00:06:21,840
extraordinary moment for our team really

135
00:06:30,379 --> 00:06:26,849
it's been a very tough challenging

136
00:06:34,070 --> 00:06:30,389
journey our team has been just inspired

137
00:06:36,529 --> 00:06:34,080
by this opportunity this chance to build

138
00:06:39,830 --> 00:06:36,539

the first of a kind system that will

139
00:06:41,570 --> 00:06:39,840
introduce the aerial dimension to the

140
00:06:44,510 --> 00:06:41,580
way we do deep-space exploration today

141
00:06:46,790 --> 00:06:44,520
right ability to fly in the atmosphere

142
00:06:49,040 --> 00:06:46,800
of another planet or another planetary

143
00:06:50,839 --> 00:06:49,050
target and so we've been really driven

144
00:06:53,330 --> 00:06:50,849
by all of this over the past five or six

145
00:06:56,719 --> 00:06:53,340
years and this is definitely one of

146
00:06:59,450 --> 00:06:56,729
those extremely special moments where we

147
00:07:01,730 --> 00:06:59,460
have a name you know for this helicopter

148
00:07:04,790 --> 00:07:01,740
that we've been working so hard on I

149
00:07:07,040 --> 00:07:04,800
kept saying throughout the whole event

150
00:07:08,659 --> 00:07:07,050
the meeting though that I one thing i

151
00:07:11,540 --> 00:07:08,669
really wish was that i could have been

152
00:07:13,399 --> 00:07:11,550
in the room in person with everyone in

153
00:07:16,760 --> 00:07:13,409
the team you know but with the current

154
00:07:20,149 --> 00:07:16,770
situation it was done through remote

155
00:07:21,529 --> 00:07:20,159
meeting but i can't I really wish I

156
00:07:23,029 --> 00:07:21,539
really really wish that I could have

157
00:07:25,760 --> 00:07:23,039
been in the room with everybody else

158
00:07:27,200 --> 00:07:25,770
we're just such a tight team and I

159
00:07:29,450 --> 00:07:27,210
really wish we could have been all

160
00:07:29,930 --> 00:07:29,460
together nevertheless it was a great

161
00:07:31,839 --> 00:07:29,940
event

162
00:07:34,700 --> 00:07:31,849
very I'll never forget this day oh

163
00:07:37,129 --> 00:07:34,710

that's so great to hear now thanks for

164
00:07:39,950 --> 00:07:37,139
answering my questions I have some ask

165
00:07:43,189 --> 00:07:39,960
NASA questions to ask now the first one

166
00:07:46,129 --> 00:07:43,199
it's very similar Kwan AJ want to ask

167
00:07:48,260 --> 00:07:46,139
what Daniel is asking what are some of

168
00:07:50,510 --> 00:07:48,270
the difficulties when designing airborne

169
00:07:52,820 --> 00:07:50,520
machines for use in other atmospheres

170
00:07:55,610 --> 00:07:52,830
when compared to Earth's and is there a

171
00:08:00,430 --> 00:07:55,620
way the NASA team can simulate Mars like

172
00:08:03,499 --> 00:08:00,440
environments on earth for testing yes

173
00:08:06,950 --> 00:08:03,509
definitely flying a helicopter for Mars

174
00:08:08,779 --> 00:08:06,960
in this very thin atmosphere you know

175
00:08:10,519 --> 00:08:08,789
with a different mark number and

176
00:08:12,200 --> 00:08:10,529
Reynolds number combination just a

177
00:08:14,480 --> 00:08:12,210
different atmospheric composition and

178
00:08:15,950 --> 00:08:14,490
very different atmospheric density

179
00:08:19,430 --> 00:08:15,960
turns out to be quite different from

180
00:08:22,040 --> 00:08:19,440
designing a helicopter for us and so we

181
00:08:24,230 --> 00:08:22,050
really a team had to go back all the way

182
00:08:27,680 --> 00:08:24,240
to the fundamentals of modeling the lift

183
00:08:30,860 --> 00:08:27,690
and the drag of a blade really optimize

184
00:08:34,579 --> 00:08:30,870
it and then develop a helicopter around

185
00:08:36,649 --> 00:08:34,589
there it has to be very light you know

186
00:08:38,329 --> 00:08:36,659
as you know it has our helicopter weighs

187
00:08:41,540 --> 00:08:38,339
about 1.8 kilograms

188
00:08:44,990 --> 00:08:41,550

it has Systrom it has to spin extremely

189
00:08:47,030 --> 00:08:45,000
fast about 2400 RPM so the very first

190
00:08:50,110 --> 00:08:47,040
challenge was to meet that stringent

191
00:08:53,060 --> 00:08:50,120
mass constraint to fit all of the

192
00:08:55,370 --> 00:08:53,070
autonomous capability autonomous flight

193
00:08:57,850 --> 00:08:55,380
autonomous survival staying warm through

194
00:09:01,070 --> 00:08:57,860
the cold night being able to communicate

195
00:09:02,449 --> 00:09:01,080
being able to charge itself you know

196
00:09:05,300 --> 00:09:02,459
through the Sun and storing the energy

197
00:09:07,370 --> 00:09:05,310
and having enough energy to survive the

198
00:09:08,870 --> 00:09:07,380
cold ice and flying coming up with a

199
00:09:10,790 --> 00:09:08,880
design with those constraints that was

200
00:09:13,160 --> 00:09:10,800
the first challenge we overcame and then

201
00:09:16,220 --> 00:09:13,170
second is to build and test it in terms

202
00:09:20,060 --> 00:09:16,230
of the environment to test on earth we

203
00:09:24,079 --> 00:09:20,070
utilize a special facility called the

204
00:09:28,010 --> 00:09:24,089
space simulator facility a chamber is a

205
00:09:30,440 --> 00:09:28,020
special chamber at JPL I said 25 foot

206
00:09:33,079 --> 00:09:30,450
diameter chamber that can be pumped down

207
00:09:35,120 --> 00:09:33,089
to vacuum and what we did was we pumped

208
00:09:37,370 --> 00:09:35,130
that vacuum down to near vacuum bag

209
00:09:40,579 --> 00:09:37,380
filled with carbon dioxide to represent

210
00:09:43,400 --> 00:09:40,589
the Martian atmosphere and you know and

211
00:09:45,829 --> 00:09:43,410
and performed our test flights there one

212
00:09:48,350 --> 00:09:45,839
thing that we can't compensate on on

213
00:09:51,260 --> 00:09:48,360

earth it's the gravity the gravity on

214
00:09:54,440 --> 00:09:51,270
Mars is significantly less than on earth

215
00:09:57,889 --> 00:09:54,450
right like about 40% compared to Earth's

216
00:10:01,100 --> 00:09:57,899
so we did add a gravity offload just to

217
00:10:03,710 --> 00:10:01,110
offload the helicopter at a consistent

218
00:10:07,010 --> 00:10:03,720
you know difference to make up for the

219
00:10:08,930 --> 00:10:07,020
different gravity that's the question

220
00:10:12,019 --> 00:10:08,940
everyone wanted to know and now I have

221
00:10:14,990 --> 00:10:12,029
one from Brian and Malloy from Facebook

222
00:10:18,290 --> 00:10:15,000
who asks how long can ingenuity sustain

223
00:10:22,960 --> 00:10:18,300
flight does it solar charge or return to

224
00:10:27,530 --> 00:10:22,970
the rover to dock and recharge yes so

225
00:10:28,050 --> 00:10:27,540
ingenuity can fly up to about 90 seconds

226
00:10:30,060 --> 00:10:28,060
there

227
00:10:32,370 --> 00:10:30,070
how we've designed it for this first of

228
00:10:34,440 --> 00:10:32,380
a kind vehicle this is a small proof of

229
00:10:38,400 --> 00:10:34,450
concept vehicle so for this vehicle we

230
00:10:40,710 --> 00:10:38,410
have decided to fly up to 90 seconds we

231
00:10:46,100 --> 00:10:40,720
can in that distance we can do up to

232
00:10:49,770 --> 00:10:46,110
about 300 meters round-trip in bed and

233
00:10:51,960 --> 00:10:49,780
if the vehicle has a solar panel and it

234
00:10:53,910 --> 00:10:51,970
it will be recharged to this color panel

235
00:10:56,100 --> 00:10:53,920
and will be storing the energy in the

236
00:10:58,680 --> 00:10:56,110
batteries and supplying the energy so

237
00:11:02,160 --> 00:10:58,690
it's the ultimate ultimate green machine

238
00:11:05,040 --> 00:11:02,170

it's powered by solar energy we store

239
00:11:07,620 --> 00:11:05,050
the energy and we you know we kind of

240
00:11:09,990 --> 00:11:07,630
supply we apply the energy for flying

241
00:11:13,500 --> 00:11:10,000
and surviving at night so we will not be

242
00:11:16,800 --> 00:11:13,510
going back to the rover to recharge in

243
00:11:19,020 --> 00:11:16,810
fact once perseverance Rover delivers us

244
00:11:21,600 --> 00:11:19,030
to the surface and drives away we never

245
00:11:24,450 --> 00:11:21,610
will be returning to the rover instead

246
00:11:25,860 --> 00:11:24,460
we'll be communicating wirelessly the

247
00:11:28,560 --> 00:11:25,870
helicopter will communicate wirelessly

248
00:11:30,720 --> 00:11:28,570
to the base station that we have left on

249
00:11:32,910 --> 00:11:30,730
the rover and the base station will talk

250
00:11:34,500 --> 00:11:32,920
to the rover which will relay the

251
00:11:37,410 --> 00:11:34,510
messages back and forth to the

252
00:11:39,420 --> 00:11:37,420
helicopter and we have another question

253
00:11:41,610 --> 00:11:39,430
about survival and that bumble on

254
00:11:43,920 --> 00:11:41,620
Twitter actually asks what about the

255
00:11:47,550 --> 00:11:43,930
storms on Mars will the helicopter

256
00:11:51,420 --> 00:11:47,560
blades survive this yes

257
00:11:55,710 --> 00:11:51,430
so this helicopter is designed to be

258
00:11:59,390 --> 00:11:55,720
able to fight the winds up to nine ten

259
00:12:05,210 --> 00:11:59,400
meters per second during flight and

260
00:12:08,490 --> 00:12:05,220
those are lower speeds then those are

261
00:12:12,390 --> 00:12:08,500
let's see our vehicle is designed to

262
00:12:15,930 --> 00:12:12,400
fight the worst predicted wind level

263
00:12:17,760 --> 00:12:15,940

okay so definitely the way the

264
00:12:19,470 --> 00:12:17,770
controllability of the blades that the

265
00:12:23,310 --> 00:12:19,480
way we have structured the rotor system

266
00:12:26,340 --> 00:12:23,320
matches the worst predicted win and with

267
00:12:29,490 --> 00:12:26,350
margin on top of that okay so it will be

268
00:12:32,730 --> 00:12:29,500
flying during the well known conditions

269
00:12:36,210 --> 00:12:32,740
and then while is sitting on the surface

270
00:12:38,900 --> 00:12:36,220
with the lakes feet firmly planted on

271
00:12:41,750 --> 00:12:38,910
the ground it can take even much higher

272
00:12:44,300 --> 00:12:41,760
winds because the dynamic

273
00:12:46,310 --> 00:12:44,310
on in the atmosphere of Mars will

274
00:12:48,230 --> 00:12:46,320
actually be much less so you'll be able

275
00:12:50,960 --> 00:12:48,240
to take much higher level of winds so

276
00:12:53,990 --> 00:12:50,970
yes we very carefully designed the

277
00:12:58,340 --> 00:12:54,000
helicopter to take on the winds that we

278
00:13:00,650 --> 00:12:58,350
expect to encounter in that regard what

279
00:13:02,510 --> 00:13:00,660
steps will happen once it lands on Mars

280
00:13:05,570 --> 00:13:02,520
are there going to be certain milestones

281
00:13:09,800 --> 00:13:05,580
it has to hit yes

282
00:13:14,240 --> 00:13:09,810
so ingenuity is the very first flight

283
00:13:17,690 --> 00:13:14,250
test on Mars remember so very analogous

284
00:13:20,090 --> 00:13:17,700
to the think of the Wright brothers very

285
00:13:23,360 --> 00:13:20,100
first flight on earth except we're gonna

286
00:13:26,150 --> 00:13:23,370
do it at Mars so on earth we have tested

287
00:13:28,100 --> 00:13:26,160
the Marcela copter all that we can in

288
00:13:31,970 --> 00:13:28,110

the simulated environment that we just

289
00:13:35,540 --> 00:13:31,980
discussed and the next step it's now to

290
00:13:37,730 --> 00:13:35,550
perform this test test the helicopter in

291
00:13:42,380 --> 00:13:37,740
the environment that we've designed it

292
00:13:45,640 --> 00:13:42,390
for in space and at Mars so with that

293
00:13:48,230 --> 00:13:45,650
the high risk but very high reward

294
00:13:51,640 --> 00:13:48,240
flight experiment that we're going for

295
00:13:55,400 --> 00:13:51,650
at Mars and we have a checklist of

296
00:13:57,620 --> 00:13:55,410
milestones that we will be looking for

297
00:13:59,870 --> 00:13:57,630
checking off and learning every step of

298
00:14:02,300 --> 00:13:59,880
the way so the first step will start

299
00:14:04,240 --> 00:14:02,310
with surviving the launch in the trip to

300
00:14:07,340 --> 00:14:04,250
Mars and getting to the surface and

301
00:14:10,340 --> 00:14:07,350
getting deployed to the surface of Mars

302
00:14:12,500 --> 00:14:10,350
in confirming our first communication

303
00:14:16,670 --> 00:14:12,510
from the helicopter to the base station

304
00:14:19,460 --> 00:14:16,680
on the rover and then surviving the

305
00:14:21,230 --> 00:14:19,470
first coal night autonomously you know

306
00:14:24,650 --> 00:14:21,240
the temperatures are very cold minus

307
00:14:27,110 --> 00:14:24,660
ninety degrees Celsius in the nighttime

308
00:14:28,790 --> 00:14:27,120
at Mars surviving the helicopter

309
00:14:31,610 --> 00:14:28,800
standing on its own surviving their

310
00:14:34,970 --> 00:14:31,620
first night it's a major milestone a big

311
00:14:36,800 --> 00:14:34,980
checkmark will get confirming that we're

312
00:14:40,240 --> 00:14:36,810
charging through the solar panel and

313
00:14:44,150 --> 00:14:40,250

garnering the energy a big checkmark

314
00:14:47,600 --> 00:14:44,160
then the very first spin on Mars and

315
00:14:49,790 --> 00:14:47,610
then the very first lift and then the

316
00:14:52,670 --> 00:14:49,800
very first flight in the very first

317
00:14:55,250 --> 00:14:52,680
landing and then after that we'll be

318
00:14:59,270 --> 00:14:55,260
repeating the flights

319
00:15:01,070 --> 00:14:59,280
within the 30 Martian souls that we have

320
00:15:03,710 --> 00:15:01,080
available to us for our flight

321
00:15:06,650 --> 00:15:03,720
experiments so we are really looking

322
00:15:10,060 --> 00:15:06,660
forward to learning every step of the

323
00:15:12,860 --> 00:15:10,070
way going across our checklists in

324
00:15:14,480 --> 00:15:12,870
mentally and medically we're really

325
00:15:17,930 --> 00:15:14,490
looking forward to learning from every

326
00:15:19,220 --> 00:15:17,940
single step that's great and Allah star

327
00:15:21,620 --> 00:15:19,230
on Twitter has a question kind of

328
00:15:24,320 --> 00:15:21,630
looking into the future if this is a

329
00:15:28,150 --> 00:15:24,330
proven method of exploration could it be

330
00:15:30,140 --> 00:15:28,160
used more and in greater numbers oh

331
00:15:34,330 --> 00:15:30,150
absolutely

332
00:15:36,860 --> 00:15:34,340
this is the first of a kind proof of

333
00:15:39,800 --> 00:15:36,870
concept proof of concept technology

334
00:15:44,050 --> 00:15:39,810
demonstration flight to show that we can

335
00:15:48,320 --> 00:15:44,060
fly and operate a helicopter at Mars

336
00:15:51,080 --> 00:15:48,330
from Earth right and like you say it is

337
00:15:52,910 --> 00:15:51,090
just the Pathfinder and our team has

338
00:15:55,910 --> 00:15:52,920

been working really hard over the five

339
00:15:58,280 --> 00:15:55,920
years because of the motivation to

340
00:16:01,660 --> 00:15:58,290
introduce aerial to mention what's once

341
00:16:05,060 --> 00:16:01,670
we proven it our dream is the future

342
00:16:07,660 --> 00:16:05,070
larger more capable vehicles that are

343
00:16:11,090 --> 00:16:07,670
more autonomous much longer flight times

344
00:16:14,060 --> 00:16:11,100
carrying larger payloads you know we're

345
00:16:18,650 --> 00:16:14,070
imagining this is a 1.8 kilogram system

346
00:16:20,870 --> 00:16:18,660
we can imagine 10 kilogram plus systems

347
00:16:24,200 --> 00:16:20,880
carrying you know one to two kilograms

348
00:16:28,340 --> 00:16:24,210
of payload very specialized payload to

349
00:16:30,890 --> 00:16:28,350
service Scouts for you know Rovers

350
00:16:33,890 --> 00:16:30,900
getting high-definition images before

351
00:16:37,490 --> 00:16:33,900
the long traverses and reconnaissance

352
00:16:40,040 --> 00:16:37,500
for astronauts for exploration at Mars

353
00:16:44,180 --> 00:16:40,050
when humans start to explore in person

354
00:16:47,210 --> 00:16:44,190
over there at Mars right in addition

355
00:16:50,870 --> 00:16:47,220
Ariel to mesh areola vehicles will allow

356
00:16:54,050 --> 00:16:50,880
us to get to X areas that we simply

357
00:16:58,250 --> 00:16:54,060
cannot access today you know Rovers

358
00:17:00,410 --> 00:16:58,260
cannot get to sites are very steep

359
00:17:02,240 --> 00:17:00,420
cliffs that are areas of interest to us

360
00:17:05,390 --> 00:17:02,250
or very steep volcanoes that we cannot

361
00:17:08,840 --> 00:17:05,400
get into being able to fly about will

362
00:17:10,360 --> 00:17:08,850
you enable us to extend our exploration

363
00:17:13,789 --> 00:17:10,370

through the aerial dimension

364
00:17:16,010 --> 00:17:13,799
complementary to how we explore on the

365
00:17:19,640 --> 00:17:16,020
surface with Rovers and spacecraft in

366
00:17:21,919 --> 00:17:19,650
orbit today and you can imagine the

367
00:17:25,299 --> 00:17:21,929
audience can imagine the next generation

368
00:17:27,710 --> 00:17:25,309
you must imagine so our team is simply

369
00:17:31,310 --> 00:17:27,720
introducing the aerial dimension where

370
00:17:33,799 --> 00:17:31,320
we are really externally proud and

371
00:17:36,560 --> 00:17:33,809
really grateful for this opportunity to

372
00:17:38,210 --> 00:17:36,570
get a chance to show how we would fly

373
00:17:42,049 --> 00:17:38,220
but it's really up to future generations

374
00:17:45,350 --> 00:17:42,059
to take flight literally in the aerial

375
00:17:46,940 --> 00:17:45,360
dimension that's great thank you so much

376
00:17:48,919 --> 00:17:46,950
Mimi for answering our questions and

377
00:17:55,190 --> 00:17:48,929
thank you for all the as NASA questions

378
00:17:58,159 --> 00:17:55,200
thanks again thank you now perseverance

379
00:17:59,840 --> 00:17:58,169
with ingenuity on board is set to launch

380
00:18:02,870 --> 00:17:59,850
from Cape Canaveral Florida this summer

381
00:18:06,440 --> 00:18:02,880
and it will land on Mars February 18 20

382
00:18:09,529 --> 00:18:06,450
21 and in the learning space section of

383
00:18:12,049 --> 00:18:09,539
the JPL website we have some fun

384
00:18:14,360 --> 00:18:12,059
hands-on projects to share with you now

385
00:18:18,140 --> 00:18:14,370
if you have kids at home you can make

386
00:18:20,630 --> 00:18:18,150
your own paper helicopter and you know

387
00:18:23,090 --> 00:18:20,640
what it actually works check this out

388
00:18:26,029 --> 00:18:23,100

you can fly just like they can at home

389
00:18:28,789 --> 00:18:26,039
and you can explore the Red Planet like

390
00:18:32,090 --> 00:18:28,799
the Mars ingenuity helicopter will by

391
00:18:35,210 --> 00:18:32,100
learning to program a video game now all

392
00:18:39,740 --> 00:18:35,220
the projects are available at JPL NASA

393
00:18:42,350 --> 00:18:39,750
gov slash edu slash learning - space and

394
00:18:47,289 --> 00:18:42,360
you can follow the helicopters journey