1
00:00:05,950 --> 00:00:02,570
Martian winter so I'm Ashley Stroupe and

2
00:00:09,010 --> 00:00:05,960
this was your free spirit update

3
00:00:12,010 --> 00:00:09,020
all right with us now is Ashley Stroupe

4
00:00:14,680 --> 00:00:12,020
she's one of our Rover drivers and lots

5
00:00:16,450 --> 00:00:14,690
of people have no idea how these Rovers

6
00:00:19,300 --> 00:00:16,460
are operated on Mars Spirit and

7
00:00:21,970 --> 00:00:19,310
Opportunity you're not driving them with

8
00:00:25,300 --> 00:00:21,980
a joystick and you know okay they're

9
00:00:28,120 --> 00:00:25,310
that rock you know you actually have to

10
00:00:31,839 --> 00:00:28,130
program it so before we go any further

11
00:00:35,200 --> 00:00:31,849
let's just explain to folks exactly what

12
00:00:37,900 --> 00:00:35,210
a rover driver does sure well it is like

13
00:00:41,080 --> 00:00:37,910

driving a car with a computer program so

14
00:00:43,630 --> 00:00:41,090
every day we have to sit down and look

15
00:00:45,279 --> 00:00:43,640
at the images of the world around us and

16
00:00:48,189 --> 00:00:45,289
figure out where the rover is going to

17
00:00:50,020 --> 00:00:48,199
go and then we have to build a program

18
00:00:52,840 --> 00:00:50,030
essentially that will guide the rover

19
00:00:55,479 --> 00:00:52,850
along that desired path let's go to the

20
00:00:59,110 --> 00:00:55,489
video and you can show folks consider

21
00:01:03,340 --> 00:00:59,120
some examples let's go to the videotape

22
00:01:05,620 --> 00:01:03,350
and this is the rover driving so you are

23
00:01:08,020 --> 00:01:05,630
in a room essential right we sit in the

24
00:01:09,760 --> 00:01:08,030
room at a computer terminal where we can

25
00:01:13,510 --> 00:01:09,770
pull up all of the images here you can

26
00:01:16,060 --> 00:01:13,520
see two of my colleagues evaluating some

27
00:01:18,760 --> 00:01:16,070
terrain from opportunity and they're

28
00:01:20,499 --> 00:01:18,770
looking at the potential hazards they're

29
00:01:22,450 --> 00:01:20,509
looking for any rocks and hills any

30
00:01:27,039 --> 00:01:22,460
loose soil that they would want to avoid

31
00:01:31,330 --> 00:01:27,049
driving into we can also look at these

32
00:01:32,800 --> 00:01:31,340
images in 3d and so we can see Mars the

33
00:01:34,420 --> 00:01:32,810
way the rover would see it or the way we

34
00:01:36,279 --> 00:01:34,430
would see it if we were there so we can

35
00:01:39,490 --> 00:01:36,289
get a better of assessment there you can

36
00:01:41,529 --> 00:01:39,500
actually see the 3d glasses that we use

37
00:01:43,810 --> 00:01:41,539
to be able to look at the terrain and

38
00:01:46,209 --> 00:01:43,820

predict what rocks are dangerous and

39
00:01:47,560 --> 00:01:46,219
what rocks are safe to go over and we

40
00:01:49,569 --> 00:01:47,570
also have tools where we can measure

41
00:01:51,459 --> 00:01:49,579
things in the image using the stereo

42
00:01:53,260 --> 00:01:51,469
models that the rover has built for us

43
00:01:55,090 --> 00:01:53,270
so we can see if there are any rocks

44
00:01:57,670 --> 00:01:55,100
that are dangerous for the rover to

45
00:01:59,920 --> 00:01:57,680
drive over now once we've assembled the

46
00:02:01,569 --> 00:01:59,930
the plan of what we wanted to do we sit

47
00:02:03,849 --> 00:02:01,579
down and we write the program and build

48
00:02:05,770 --> 00:02:03,859
the sequence of commands and then we

49
00:02:08,800 --> 00:02:05,780
simulate those commands we play them

50
00:02:11,710 --> 00:02:08,810
back in a full model of the rover and

51
00:02:14,020 --> 00:02:11,720
the terrain so we can see how the rover

52
00:02:15,610 --> 00:02:14,030
is going to interact with the terrain we

53
00:02:17,320 --> 00:02:15,620
do that both for driving or as you can

54
00:02:19,670 --> 00:02:17,330
see in the video this is an example of

55
00:02:22,880 --> 00:02:19,680
testing out the robotic

56
00:02:25,039 --> 00:02:22,890
the ID D and a sequence of commands

57
00:02:28,550 --> 00:02:25,049
replacing an instrument how involved is

58
00:02:30,949 --> 00:02:28,560
that do you meet you know once a day and

59
00:02:32,899 --> 00:02:30,959
figure out the marching orders for the

60
00:02:35,899 --> 00:02:32,909
Rovers every day or right so pretty much

61
00:02:38,240 --> 00:02:35,909
once a day we sit down with all the

62
00:02:40,069 --> 00:02:38,250
engineers and all the scientists and we

63
00:02:41,390 --> 00:02:40,079

come up with the general plan of what

64
00:02:42,830 --> 00:02:41,400
the robots going to do for that day

65
00:02:44,809 --> 00:02:42,840
where it's going to draw over what

66
00:02:46,910 --> 00:02:44,819
targets it's going to look at with its

67
00:02:48,979 --> 00:02:46,920
science instruments and then each sub

68
00:02:50,660 --> 00:02:48,989
team goes off and builds their part of

69
00:02:53,149 --> 00:02:50,670
the program and then we come back

70
00:02:55,309 --> 00:02:53,159
together and we walk through every line

71
00:02:57,740 --> 00:02:55,319
of the program that's going to go up to

72
00:03:00,470 --> 00:02:57,750
the rover twice before we then send it

73
00:03:02,629 --> 00:03:00,480
to the rover on Mars so we then send the

74
00:03:05,000 --> 00:03:02,639
plan up the rover then execute the plan

75
00:03:06,770 --> 00:03:05,010
and at the end of the day she calls back

76
00:03:08,539 --> 00:03:06,780
home and lets us know how everything

77
00:03:10,220 --> 00:03:08,549
went so we have to often wait a long

78
00:03:12,349 --> 00:03:10,230
time before we know how things went on

79
00:03:14,809 --> 00:03:12,359
Mars and and what's involved in the

80
00:03:17,690 --> 00:03:14,819
planning you know isn't it mostly

81
00:03:19,250 --> 00:03:17,700
scientists saying boy that walk over

82
00:03:21,259 --> 00:03:19,260
there to the right really looks

83
00:03:24,319 --> 00:03:21,269
interesting could you get us over there

84
00:03:26,240 --> 00:03:24,329
right that's we are a science mission as

85
00:03:28,400 --> 00:03:26,250
exciting as the engineering is we really

86
00:03:30,229 --> 00:03:28,410
are a science mission so it all begins

87
00:03:32,000 --> 00:03:30,239
with what the scientists sit down and

88
00:03:33,439 --> 00:03:32,010

they say this is what we want to do here

89
00:03:34,789 --> 00:03:33,449
are the interesting things around here

90
00:03:37,640 --> 00:03:34,799
and we want to go look at these things

91
00:03:39,430 --> 00:03:37,650
and then we try to evaluate all of those

92
00:03:41,659 --> 00:03:39,440
different places they want to go and

93
00:03:43,039 --> 00:03:41,669
hopefully we can accommodate all of them

94
00:03:44,750 --> 00:03:43,049
but sometimes something might be too

95
00:03:46,490 --> 00:03:44,760
dangerous or too difficult to reach and

96
00:03:48,439 --> 00:03:46,500
we have to tell them but we can't quite

97
00:03:50,839 --> 00:03:48,449
do that how about this and so there's a

98
00:03:52,789 --> 00:03:50,849
little bit of negotiation going on but

99
00:03:55,280 --> 00:03:52,799
we do start with the science first and

100
00:03:56,809 --> 00:03:55,290
we really try to to get the scientists

101
00:03:59,089 --> 00:03:56,819
what they need because ultimately that's

102
00:04:02,330 --> 00:03:59,099
what we're trying to do well the purpose

103
00:04:05,270 --> 00:04:02,340
of our talk today is figuring out ways

104
00:04:09,640 --> 00:04:05,280
to free spirit right and here we have a

105
00:04:13,099 --> 00:04:09,650
suggestion here from someone on Ustream

106
00:04:16,219 --> 00:04:13,109
why don't you use a harness to make the

107
00:04:19,750 --> 00:04:16,229
test rover weigh the same on Mars do you

108
00:04:22,520 --> 00:04:19,760
really need to do that though well

109
00:04:24,140 --> 00:04:22,530
sometimes we do have to do testing and

110
00:04:26,270 --> 00:04:24,150
in fact you know when we're first

111
00:04:28,610 --> 00:04:26,280
building a robot we often do that kind

112
00:04:31,040 --> 00:04:28,620
of testing - exactly exactly simulate

113
00:04:32,990 --> 00:04:31,050

what Mars gravity would have but our our

114
00:04:33,480 --> 00:04:33,000
test Rover is actually lighter weight

115
00:04:35,460 --> 00:04:33,490
than

116
00:04:37,439 --> 00:04:35,470
one on Mars so it's not quite down to

117
00:04:40,469 --> 00:04:37,449
Mars gravity but it's part of the way

118
00:04:42,120 --> 00:04:40,479
there and actually that is a close

119
00:04:44,129 --> 00:04:42,130
enough model for the kinds of things

120
00:04:46,200 --> 00:04:44,139
we're trying to do actually the rover

121
00:04:48,270 --> 00:04:46,210
being a little bit heavier actually

122
00:04:50,010 --> 00:04:48,280
makes driving in this stuff a little bit

123
00:04:52,680 --> 00:04:50,020
harder so we're sort of modeling the

124
00:04:54,420 --> 00:04:52,690
worst case if you like by letting the

125
00:04:56,670 --> 00:04:54,430
rover be a little bit too heavy for Mars

126
00:04:58,589 --> 00:04:56,680
I think a lot of people are learning

127
00:05:01,499 --> 00:04:58,599
about that for the first time that we

128
00:05:03,360 --> 00:05:01,509
have two different Rovers there's a test

129
00:05:04,890 --> 00:05:03,370
rover that's the same weight as the

130
00:05:07,170 --> 00:05:04,900
rover on Mars

131
00:05:08,790 --> 00:05:07,180
almost almost like it's missing some of

132
00:05:11,100 --> 00:05:08,800
the batteries and the solar panels and

133
00:05:12,689 --> 00:05:11,110
some of the other heavy components but

134
00:05:15,719 --> 00:05:12,699
it's very close to the weight of the

135
00:05:17,640 --> 00:05:15,729
rover on Mars and I'm not sure very many

136
00:05:20,159 --> 00:05:17,650
people realize that there's a difference

137
00:05:22,589 --> 00:05:20,169
and having to factor in gravity that's

138
00:05:25,350 --> 00:05:22,599

right of course the gravity of Mars is a

139
00:05:26,999 --> 00:05:25,360
little under 40% that aversive things

140
00:05:27,540 --> 00:05:27,009
weigh about a third there that they do

141
00:05:30,059 --> 00:05:27,550
on earth

142
00:05:31,950 --> 00:05:30,069
and of course how you interact with the

143
00:05:34,620 --> 00:05:31,960
ground is very dependent on your weight

144
00:05:35,909 --> 00:05:34,630
so sometimes you really do need to take

145
00:05:38,610 --> 00:05:35,919
that into account when you're modeling

146
00:05:40,649 --> 00:05:38,620
things all right we're going to some of

147
00:05:44,189 --> 00:05:40,659
the email questions now this one's from

148
00:05:46,770 --> 00:05:44,199
mark park mark Parker could the denser

149
00:05:49,770 --> 00:05:46,780
material be placed under one wheel at a

150
00:05:52,999 --> 00:05:49,780
time on the soft side to raise that side

151
00:05:56,279 --> 00:05:53,009
enough to clear the object underneath

152
00:05:57,659 --> 00:05:56,289
you know that's a good suggestion a lot

153
00:05:59,129 --> 00:05:57,669
of people have been thinking about that

154
00:06:01,680 --> 00:05:59,139
kind of thing but unfortunately we don't

155
00:06:04,830 --> 00:06:01,690
have any way to transport material under

156
00:06:06,570 --> 00:06:04,840
the wheels the arm could only reach the

157
00:06:08,219 --> 00:06:06,580
front wheels anyway but it also isn't

158
00:06:11,159 --> 00:06:08,229
really strong enough to move large

159
00:06:12,689 --> 00:06:11,169
amounts of material particularly we also

160
00:06:14,100 --> 00:06:12,699
be at risk of damaging some of the

161
00:06:15,809 --> 00:06:14,110
science instruments if we actually tried

162
00:06:17,939 --> 00:06:15,819
to interact with the ground in that way

163
00:06:20,459 --> 00:06:17,949

so fortunately we don't have a good way

164
00:06:22,200 --> 00:06:20,469
to actually change the soil or add rocks

165
00:06:25,200 --> 00:06:22,210
or add more soil with traction

166
00:06:27,839 --> 00:06:25,210
underneath the left side okay this one's

167
00:06:30,029 --> 00:06:27,849
from Rogers Silber does the rover

168
00:06:33,510 --> 00:06:30,039
instrument arm have enough strength to

169
00:06:36,870 --> 00:06:33,520
provide a useful force vector to free

170
00:06:39,240 --> 00:06:36,880
the rover unfortunately not the arm can

171
00:06:41,730 --> 00:06:39,250
only exert about 15 to 20 pounds of

172
00:06:44,430 --> 00:06:41,740
force it really can't do anything

173
00:06:46,320 --> 00:06:44,440
approximating lifting the rover or move

174
00:06:46,920 --> 00:06:46,330
any large rocks or anything like that

175
00:06:48,659 --> 00:06:46,930
if

176
00:06:51,270 --> 00:06:48,669
really only designed to just sort of

177
00:06:53,010 --> 00:06:51,280
gently contact the ground it was never

178
00:06:56,219 --> 00:06:53,020
designed to actually really exert much

179
00:06:58,860 --> 00:06:56,229
force how much force could the arm exert

180
00:07:01,740 --> 00:06:58,870
if used in such an emergency sort of

181
00:07:04,140 --> 00:07:01,750
push assist scenario right probably only

182
00:07:06,029 --> 00:07:04,150
about 20 pounds of force so in a real

183
00:07:07,620 --> 00:07:06,039
emergency we might give it a try that

184
00:07:09,930 --> 00:07:07,630
might be the little bit of a difference

185
00:07:12,629 --> 00:07:09,940
that we need but because that is such a

186
00:07:14,640 --> 00:07:12,639
risk to possibly damaging the arm that's

187
00:07:16,560 --> 00:07:14,650
a long way off before we try that but

188
00:07:18,300 --> 00:07:16,570

you know as a last-ditch effort we might

189
00:07:19,920 --> 00:07:18,310
give something like that a try but it

190
00:07:23,159 --> 00:07:19,930
won't be much of a help just a little

191
00:07:25,560 --> 00:07:23,169
okay this is an email question from Lee

192
00:07:27,960 --> 00:07:25,570
Wilkerson the current position of the

193
00:07:30,779 --> 00:07:27,970
spirit rover shows the right wheels on

194
00:07:33,240 --> 00:07:30,789
what appears to be a firm surface with

195
00:07:36,000 --> 00:07:33,250
the left wheels mired in the soft soil

196
00:07:38,820 --> 00:07:36,010
layer however the rover in the test

197
00:07:41,850 --> 00:07:38,830
sandbox has all wheels embedded in the

198
00:07:44,550 --> 00:07:41,860
soft soil why was this scenario chosen

199
00:07:45,120 --> 00:07:44,560
for the simulation that's a really good

200
00:07:47,400 --> 00:07:45,130
question

201
00:07:49,740 --> 00:07:47,410
so the particular simulant that we

202
00:07:52,830 --> 00:07:49,750
picked has some interesting material

203
00:07:55,020 --> 00:07:52,840
properties if you pack it down tightly

204
00:07:57,480 --> 00:07:55,030
it actually stays kind of firm and

205
00:07:59,730 --> 00:07:57,490
strong but if you fluff it up then it

206
00:08:01,529 --> 00:07:59,740
becomes loose and fluffy like what we

207
00:08:02,790 --> 00:08:01,539
see under the left side and we had

208
00:08:05,399 --> 00:08:02,800
really hopes that we'd be able to use

209
00:08:08,189 --> 00:08:05,409
one material compact it differently and

210
00:08:10,350 --> 00:08:08,199
have that work for both of the different

211
00:08:12,839 --> 00:08:10,360
types of soils we see on Mars right now

212
00:08:15,029 --> 00:08:12,849
in fact today we're having a big meeting

213
00:08:16,409 --> 00:08:15,039

with the engineers and the scientist to

214
00:08:19,260 --> 00:08:16,419
look at the tests that we've already

215
00:08:21,540 --> 00:08:19,270
done and see if that assumption holds up

216
00:08:24,180 --> 00:08:21,550
we are seeing some differences and as a

217
00:08:26,310 --> 00:08:24,190
result of that we may likely change that

218
00:08:27,810 --> 00:08:26,320
soil that's under the right wheels so

219
00:08:29,850 --> 00:08:27,820
excellent question and we may be

220
00:08:31,550 --> 00:08:29,860
changing that for our next set of tests

221
00:08:34,440 --> 00:08:31,560
well here's another question regarding

222
00:08:37,500 --> 00:08:34,450
opportunity can opportunity help and

223
00:08:39,920 --> 00:08:37,510
what is opportunity doing and we have

224
00:08:42,120 --> 00:08:39,930
some little Jascha great questions

225
00:08:44,210 --> 00:08:42,130
opportunity is unfortunately on the

226
00:08:46,980 --> 00:08:44,220
complete opposite side of the planet and

227
00:08:50,850 --> 00:08:46,990
given that they you know have driven at

228
00:08:53,190 --> 00:08:50,860
most about ten miles in five and a half

229
00:08:53,790 --> 00:08:53,200
years they probably will never meet each

230
00:08:56,720 --> 00:08:53,800
other

231
00:08:59,790 --> 00:08:56,730
so unfortunately opportunity can't help

232
00:09:01,340 --> 00:08:59,800
but opportunity where we've now

233
00:09:07,380 --> 00:09:01,350
got a video up that showing basically

234
00:09:09,329 --> 00:09:07,390
opportunity's entire ten-mile + Trek she

235
00:09:11,490 --> 00:09:09,339
started at a little tiny crater called

236
00:09:15,420 --> 00:09:11,500
Eagle and then visited a larger crater

237
00:09:18,000 --> 00:09:15,430
called an endurance and then drove

238
00:09:20,190 --> 00:09:18,010

several miles across some sandy plains

239
00:09:22,259 --> 00:09:20,200
to hit Erebus which are just about to

240
00:09:23,940 --> 00:09:22,269
see the video catch up there and then

241
00:09:26,160 --> 00:09:23,950
headed off to a really large crater

242
00:09:29,639 --> 00:09:26,170
called Victoria which we spent about a

243
00:09:31,430 --> 00:09:29,649
year exploring Victoria and now we're

244
00:09:35,009 --> 00:09:31,440
actually heading towards the south

245
00:09:37,980 --> 00:09:35,019
towards a about a huge crater that's

246
00:09:40,530 --> 00:09:37,990
miles across called endeavour and that

247
00:09:42,210 --> 00:09:40,540
is opportunity's next goal we're really

248
00:09:44,069 --> 00:09:42,220
hoping this is a very old crater it's

249
00:09:46,470 --> 00:09:44,079
very deep but it's very eroded so the

250
00:09:48,389 --> 00:09:46,480
sides are gentle slopes so we're hoping

251
00:09:50,130 --> 00:09:48,399
we can drive deeply into that crater and

252
00:09:51,780 --> 00:09:50,140
see some really old layers that are

253
00:09:54,889 --> 00:09:51,790
exposed nowhere else that the rover's

254
00:09:59,340 --> 00:09:54,899
have bends did anyone ever imagine that

255
00:10:02,060 --> 00:09:59,350
opportunity would be going that far no I

256
00:10:05,130 --> 00:10:02,070
don't think anybody imagined that

257
00:10:06,900 --> 00:10:05,140
certainly we all sort of hoped and even

258
00:10:10,319 --> 00:10:06,910
maybe a little expected that we'd go far

259
00:10:13,740 --> 00:10:10,329
beyond our 300 meter design guideline

260
00:10:15,660 --> 00:10:13,750
but in terms of 10 plus miles no I don't

261
00:10:19,319 --> 00:10:15,670
think that was in anybody's wildest

262
00:10:21,690 --> 00:10:19,329
dreams but we long since gave up trying

263
00:10:23,220 --> 00:10:21,700

to bet on when it would end because if

264
00:10:25,319 --> 00:10:23,230
you bet against the Rovers you're just

265
00:10:27,030 --> 00:10:25,329
going to lose they just keep going but I

266
00:10:29,250 --> 00:10:27,040
guess we have to keep in mind that the

267
00:10:31,290 --> 00:10:29,260
Rovers are getting older so Rovers are

268
00:10:34,560 --> 00:10:31,300
getting older they each have some faulty

269
00:10:36,690 --> 00:10:34,570
joints now spirit has a broken right

270
00:10:38,850 --> 00:10:36,700
front drive wheel but opportunity also

271
00:10:40,170 --> 00:10:38,860
has a steering wheel that a steering

272
00:10:42,600 --> 00:10:40,180
motor on the right front wheel that's

273
00:10:45,600 --> 00:10:42,610
broken and one of the shoulder joints is

274
00:10:47,610 --> 00:10:45,610
also broken now gratefully these these

275
00:10:50,160 --> 00:10:47,620
have not done anything other than

276
00:10:51,960 --> 00:10:50,170
slightly slowed them down they certainly

277
00:10:54,810 --> 00:10:51,970
are still able to do much of their

278
00:10:57,269 --> 00:10:54,820
normal capabilities but they are aging

279
00:10:59,850 --> 00:10:57,279
we're sort of creating a new field robot

280
00:11:02,009 --> 00:10:59,860
gerontology because robots on earth when

281
00:11:03,240 --> 00:11:02,019
this happens you dispense them we this

282
00:11:05,460 --> 00:11:03,250
is the first time we've ever been an

283
00:11:07,880 --> 00:11:05,470
experience where we've had to continue

284
00:11:10,889 --> 00:11:07,890
operations with continually changing

285
00:11:13,350 --> 00:11:10,899
performance and degradation over over

286
00:11:16,380 --> 00:11:13,360
this many years well you know the sub J

287
00:11:19,319 --> 00:11:16,390
opportunity keeps coming up and and

288
00:11:21,750 --> 00:11:19,329

they're asking can opportunity help

289
00:11:24,210 --> 00:11:21,760
well opportunity has helped well

290
00:11:25,980 --> 00:11:24,220
actually yes opportunity did help we

291
00:11:28,110 --> 00:11:25,990
wanted to do something a little bit

292
00:11:30,600 --> 00:11:28,120
risky with spirit to help diagnose her

293
00:11:31,889 --> 00:11:30,610
situation we wanted to take out the

294
00:11:34,740 --> 00:11:31,899
robotic arm and take a picture

295
00:11:36,509 --> 00:11:34,750
underneath the rover's belly so we could

296
00:11:38,759 --> 00:11:36,519
see the middle wheels which we normally

297
00:11:40,769 --> 00:11:38,769
can't see see how buried they were see

298
00:11:43,110 --> 00:11:40,779
if there were rocks hung up on the rover

299
00:11:45,660 --> 00:11:43,120
and because we were in some very

300
00:11:48,750 --> 00:11:45,670
complicated geometry we didn't want to

301
00:11:50,190 --> 00:11:48,760
pull spirits arm out if we didn't think

302
00:11:51,540 --> 00:11:50,200
that this would actually be helpful

303
00:11:54,000 --> 00:11:51,550
there was a risk of hitting it against

304
00:11:56,910 --> 00:11:54,010
Iraq so opportunity actually did that

305
00:11:58,949 --> 00:11:56,920
first we had opportunity deploy her arm

306
00:12:01,560 --> 00:11:58,959
and take a picture underneath herself

307
00:12:03,960 --> 00:12:01,570
and we got fabulous results we could

308
00:12:04,980 --> 00:12:03,970
really see a lot of detail so after we

309
00:12:06,690 --> 00:12:04,990
knew that it was going to be a

310
00:12:08,460 --> 00:12:06,700
worthwhile pursuit we then figured out

311
00:12:10,650 --> 00:12:08,470
how to get the arm safely out and did

312
00:12:12,449 --> 00:12:10,660
take a picture which has told us a lot

313
00:12:15,300 --> 00:12:12,459

we in fact do have a rock that may well

314
00:12:17,759 --> 00:12:15,310
be touching the bottom of Spirit we can

315
00:12:19,590 --> 00:12:17,769
see how buried the middle wheels are

316
00:12:21,240 --> 00:12:19,600
which we couldn't see any other way and

317
00:12:24,540 --> 00:12:21,250
so that has really helped our our

318
00:12:26,460 --> 00:12:24,550
diagnostic problems well opportunity be

319
00:12:28,680 --> 00:12:26,470
called upon again in the future do you

320
00:12:30,540 --> 00:12:28,690
think if there's another risky thing

321
00:12:32,670 --> 00:12:30,550
that we have to do we may test it on

322
00:12:34,800 --> 00:12:32,680
opportunity first because opportunity is

323
00:12:37,050 --> 00:12:34,810
in a much more benign terrain it's much

324
00:12:39,720 --> 00:12:37,060
safer for her to try out new and

325
00:12:41,639 --> 00:12:39,730
different things so and so certainly

326
00:12:43,319 --> 00:12:41,649
that could happen all right

327
00:12:46,110 --> 00:12:43,329
so here's another question another

328
00:12:49,920 --> 00:12:46,120
suggestion from our viewers what about

329
00:12:52,980 --> 00:12:49,930
using very slow wheels continuously

330
00:12:55,590 --> 00:12:52,990
would that help get out of this soil

331
00:12:58,590 --> 00:12:55,600
that is an excellent question that is

332
00:13:01,230 --> 00:12:58,600
one of the things we are considering if

333
00:13:02,579 --> 00:13:01,240
you if you slow down the wheels you you

334
00:13:04,710 --> 00:13:02,589
might be able to get slightly better

335
00:13:06,810 --> 00:13:04,720
traction if you're spinning fast you're

336
00:13:08,790 --> 00:13:06,820
more likely to slip and so that is

337
00:13:10,530 --> 00:13:08,800
certainly one of the things that in the

338
00:13:13,319 --> 00:13:10,540

next round of testing we are considering

339
00:13:15,000 --> 00:13:13,329
looking at we don't know yet how well

340
00:13:16,500 --> 00:13:15,010
that will work but that is that is an

341
00:13:19,439 --> 00:13:16,510
excellent suggestion and we are thinking

342
00:13:21,780 --> 00:13:19,449
about giving that a try so how has the

343
00:13:23,430 --> 00:13:21,790
testing you've been going you know are

344
00:13:26,069 --> 00:13:23,440
you seeing certain things working

345
00:13:27,090 --> 00:13:26,079
certain things not working at all right

346
00:13:30,030 --> 00:13:27,100
so we've we've done

347
00:13:31,650 --> 00:13:30,040
a bunch of testing I we've done forward

348
00:13:33,840 --> 00:13:31,660
driving backward driving we've done even

349
00:13:35,610 --> 00:13:33,850
some sort of side words crab driving as

350
00:13:38,460 --> 00:13:35,620
we saw in the video a little while ago

351
00:13:40,080 --> 00:13:38,470
and we are seeing that the good news is

352
00:13:42,270 --> 00:13:40,090
even though we think this is sort of a

353
00:13:44,190 --> 00:13:42,280
worst-case model with really slippery

354
00:13:46,500 --> 00:13:44,200
soil and the wheels buried a little bit

355
00:13:49,020 --> 00:13:46,510
more than they are on Mars we are seeing

356
00:13:50,880 --> 00:13:49,030
that the rover rover is able to move at

357
00:13:53,640 --> 00:13:50,890
least a little bit even under these very

358
00:13:55,350 --> 00:13:53,650
adverse conditions and so that has told

359
00:13:57,720 --> 00:13:55,360
us that we actually do have a good

360
00:14:01,200 --> 00:13:57,730
chance of spirit being able to get out

361
00:14:06,360 --> 00:14:01,210
once we start this on Mars at the moment

362
00:14:08,040 --> 00:14:06,370
it looks like that we don't have quite

363
00:14:09,690 --> 00:14:08,050

enough data to really distinguish which

364
00:14:11,640 --> 00:14:09,700
individual things are going to be the

365
00:14:13,530 --> 00:14:11,650
best but all of the things we've tried

366
00:14:16,320 --> 00:14:13,540
have have moved them over a little bit

367
00:14:18,240 --> 00:14:16,330
we're very optimistic about this idea of

368
00:14:22,140 --> 00:14:18,250
possibly being able to crab and go

369
00:14:23,670 --> 00:14:22,150
slightly uphill we do have unfortunately

370
00:14:25,350 --> 00:14:23,680
we'd like to rely on gravity in these

371
00:14:27,390 --> 00:14:25,360
situations but downhill from us is an

372
00:14:29,370 --> 00:14:27,400
even worse sandpit than the one we're in

373
00:14:32,400 --> 00:14:29,380
so we could get uphill and away from

374
00:14:34,590 --> 00:14:32,410
these possible hazards that would be a

375
00:14:35,880 --> 00:14:34,600
really good thing so that's one of the

376
00:14:37,580 --> 00:14:35,890
things that we're definitely going to be

377
00:14:41,070 --> 00:14:37,590
looking at as well and once again

378
00:14:43,170 --> 00:14:41,080
explain crabbing it's padding so only

379
00:14:45,390 --> 00:14:43,180
the front and rear wheels on the rover

380
00:14:47,910 --> 00:14:45,400
steer but what we can do is we can steer

381
00:14:49,650 --> 00:14:47,920
those wheels at an angle and then drive

382
00:14:51,330 --> 00:14:49,660
them forward and they're all driving in

383
00:14:54,510 --> 00:14:51,340
the same direction which kind of pulls

384
00:14:57,060 --> 00:14:54,520
the rover to the side a little bit and

385
00:14:59,430 --> 00:14:57,070
we have used that before to try to

386
00:15:00,900 --> 00:14:59,440
approach science our science targets

387
00:15:03,600 --> 00:15:00,910
when they were off to the side of us a

388
00:15:07,560 --> 00:15:03,610

little in it has worked very well and in

389
00:15:09,600 --> 00:15:07,570
fact we we were using that to try to get

390
00:15:11,910 --> 00:15:09,610
us out of the sandpit originally before

391
00:15:13,290 --> 00:15:11,920
we realized we had these other potential

392
00:15:15,230 --> 00:15:13,300
hazards and needed to stop and

393
00:15:17,280 --> 00:15:15,240
reevaluate and that was actually working

394
00:15:20,730 --> 00:15:17,290
somewhat we were moving several

395
00:15:23,070 --> 00:15:20,740
centimeters each day it is there any

396
00:15:24,720 --> 00:15:23,080
similarity between what's happening to

397
00:15:26,790 --> 00:15:24,730
spirit right now and what happened to

398
00:15:27,840 --> 00:15:26,800
opportunity way back when when it was

399
00:15:30,570 --> 00:15:27,850
going through the dunes

400
00:15:32,550 --> 00:15:30,580
sure purgatory ripple is what you're

401
00:15:35,040 --> 00:15:32,560
talking about opportunity got fairly

402
00:15:37,140 --> 00:15:35,050
deeply embedded in a in a sand ripple

403
00:15:39,570 --> 00:15:37,150
and yes there are some similarities the

404
00:15:40,900 --> 00:15:39,580
soil there was a little bit fluffy we

405
00:15:43,000 --> 00:15:40,910
did get the wheels barians

406
00:15:44,440 --> 00:15:43,010
we had very little traction we would try

407
00:15:47,050 --> 00:15:44,450
to drive a long distance and we'd only

408
00:15:48,790 --> 00:15:47,060
move a few millimeters so in some ways

409
00:15:52,440 --> 00:15:48,800
the soil that we're in is is kind of

410
00:15:54,760 --> 00:15:52,450
similar the difference is is that

411
00:15:56,140 --> 00:15:54,770
opportunity was going uphill over a

412
00:15:58,030 --> 00:15:56,150
ripple and could then kind of use

413
00:15:59,920 --> 00:15:58,040

gravity to back straight down the hill

414
00:16:03,400 --> 00:15:59,930
through our tracks we unfortunately

415
00:16:04,990 --> 00:16:03,410
spirits at a roll so we follow out our

416
00:16:07,330 --> 00:16:05,000
tracks we don't get that extra little

417
00:16:09,640 --> 00:16:07,340
advantage of gravity helping to pull us

418
00:16:11,380 --> 00:16:09,650
down the hill so we have a slightly more

419
00:16:14,440 --> 00:16:11,390
complicated geometry but a similar

420
00:16:18,520 --> 00:16:14,450
problem is spirit more dug in though

421
00:16:20,560 --> 00:16:18,530
also well actually opportunity was

422
00:16:23,010 --> 00:16:20,570
pretty much as deeply dug in at

423
00:16:25,870 --> 00:16:23,020
purgatory part of the problem was

424
00:16:29,110 --> 00:16:25,880
opportunity drove about 40 or 50 meters

425
00:16:30,370 --> 00:16:29,120
before we were before she realized that

426
00:16:31,750 --> 00:16:30,380
she was slipping because she wasn't

427
00:16:33,190 --> 00:16:31,760
looking where she was going at that

428
00:16:35,140 --> 00:16:33,200
point that's very common to do when

429
00:16:36,760 --> 00:16:35,150
there are no obstacles around we just

430
00:16:39,190 --> 00:16:36,770
let the rover drive and what we think is

431
00:16:41,020 --> 00:16:39,200
a safe area so it continued to spin the

432
00:16:42,970 --> 00:16:41,030
wheels after she stopped making progress

433
00:16:46,780 --> 00:16:42,980
for a long time and it actually dug in

434
00:16:49,660 --> 00:16:46,790
quite significantly so so the rear

435
00:16:51,640 --> 00:16:49,670
wheels and the in the middle wheels were

436
00:16:53,380 --> 00:16:51,650
about as dug in is what we've seen on

437
00:16:56,290 --> 00:16:53,390
spirit but the front wheels were not as

438
00:16:57,970 --> 00:16:56,300

bad um something that lots of folks

439
00:17:01,120 --> 00:16:57,980
aren't familiar with is the fact that

440
00:17:03,180 --> 00:17:01,130
the rover's do kind of operate on its

441
00:17:06,550 --> 00:17:03,190
own with their own brains and

442
00:17:09,520 --> 00:17:06,560
autonomously were they operating at

443
00:17:12,820 --> 00:17:09,530
autonomously automatism autonomously

444
00:17:14,800 --> 00:17:12,830
tirelessly um with spirit doing that and

445
00:17:16,330 --> 00:17:14,810
in fact some spirit was we had given her

446
00:17:18,100 --> 00:17:16,340
a path to follow and she was

447
00:17:20,770 --> 00:17:18,110
autonomously trying to follow that path

448
00:17:23,110 --> 00:17:20,780
and in fact slipped off that path to

449
00:17:26,410 --> 00:17:23,120
some extent and stopped the drive as a

450
00:17:28,750 --> 00:17:26,420
result of failing uh one of the own

451
00:17:30,370 --> 00:17:28,760
safety checks that she had in there she

452
00:17:33,400 --> 00:17:30,380
realized she was off course and stopped

453
00:17:35,200 --> 00:17:33,410
so yes she was driving autonomously when

454
00:17:37,690 --> 00:17:35,210
this happened they had their own

455
00:17:39,370 --> 00:17:37,700
intended it from getting even further

456
00:17:42,880 --> 00:17:39,380
embedded and perhaps into a much worse

457
00:17:45,460 --> 00:17:42,890
situation okay back to the questions can

458
00:17:49,720 --> 00:17:45,470
the science team conduct tests while you

459
00:17:52,270 --> 00:17:49,730
all attempt to help spirit escape yes we

460
00:17:54,310 --> 00:17:52,280
have been doing a very extensive science

461
00:17:56,379 --> 00:17:54,320
campaign while we have been sitting

462
00:17:57,999 --> 00:17:56,389
in this location we have tons of power

463
00:17:59,919 --> 00:17:58,009

thanks to the wind cleaning everything

464
00:18:01,690 --> 00:17:59,929
off so we've been doing all kinds of

465
00:18:03,940 --> 00:18:01,700
science experiments we have at least

466
00:18:06,490 --> 00:18:03,950
four different soil types that we can

467
00:18:08,499 --> 00:18:06,500
reach with robotic arm and we have done

468
00:18:09,310 --> 00:18:08,509
detailed analyses of all four of these

469
00:18:11,769 --> 00:18:09,320
soil types

470
00:18:15,090 --> 00:18:11,779
we're continuing some further

471
00:18:17,560 --> 00:18:15,100
investigations today in fact we have

472
00:18:19,269 --> 00:18:17,570
brushed away the surface soil in one

473
00:18:21,789 --> 00:18:19,279
location and we've actually gone down

474
00:18:23,649 --> 00:18:21,799
and seen that the soil changes like

475
00:18:25,149 --> 00:18:23,659
about a centimeter down so we're

476
00:18:27,460 --> 00:18:25,159
actually investigating to see what that

477
00:18:29,289 --> 00:18:27,470
slightly deeper soil is and we've

478
00:18:30,759 --> 00:18:29,299
learned that this soil is a little bit

479
00:18:33,610 --> 00:18:30,769
different than what we have seen

480
00:18:35,919 --> 00:18:33,620
elsewhere on Mars it has a lot of sulfur

481
00:18:37,210 --> 00:18:35,929
in it a little bit of silica and I'm

482
00:18:39,789 --> 00:18:37,220
sure scientists could tell you better

483
00:18:41,619 --> 00:18:39,799
what makes that unique but it it's it's

484
00:18:43,810 --> 00:18:41,629
a very interesting discovery that we

485
00:18:46,180 --> 00:18:43,820
have not seen anywhere else on Mars and

486
00:18:48,009 --> 00:18:46,190
any signature that would lend you to

487
00:18:49,960 --> 00:18:48,019
believe that water may be involved in it

488
00:18:53,230 --> 00:18:49,970

absolutely whenever we find many of

489
00:18:57,039 --> 00:18:53,240
these mineral compounds many of them are

490
00:18:58,659 --> 00:18:57,049
the result of of water transporting

491
00:19:01,180 --> 00:18:58,669
these minerals to these locations and

492
00:19:03,639 --> 00:19:01,190
then evaporating away and we've seen

493
00:19:06,310 --> 00:19:03,649
that at many locations all around home

494
00:19:08,440 --> 00:19:06,320
plate and in fact this is an interesting

495
00:19:10,269 --> 00:19:08,450
thing is that we wouldn't have have

496
00:19:11,560 --> 00:19:10,279
found nearly as much of the stuff and

497
00:19:13,240 --> 00:19:11,570
known it was nearly this widely

498
00:19:15,460 --> 00:19:13,250
distributed without the broken right

499
00:19:17,919 --> 00:19:15,470
front wheel because it's mostly buried

500
00:19:19,450 --> 00:19:17,929
under the surface and only by digging a

501
00:19:22,450 --> 00:19:19,460
hole which the right front wheel does

502
00:19:25,360 --> 00:19:22,460
for us naturally most of the time we've

503
00:19:26,919 --> 00:19:25,370
been finding this these mineral deposits

504
00:19:28,600 --> 00:19:26,929
and salts in our tracks almost

505
00:19:30,220 --> 00:19:28,610
everywhere we go that's interesting

506
00:19:32,289 --> 00:19:30,230
because here's another question what

507
00:19:35,499 --> 00:19:32,299
have you learned from this this set of

508
00:19:37,690 --> 00:19:35,509
difficulties in the design of new Rovers

509
00:19:41,080 --> 00:19:37,700
what have you learned that will help you

510
00:19:43,480 --> 00:19:41,090
design the next rover right that's an

511
00:19:46,119 --> 00:19:43,490
excellent question and I know one thing

512
00:19:48,100 --> 00:19:46,129
that I would like to see on a future

513
00:19:49,930 --> 00:19:48,110

Rover would be able to steer those

514
00:19:51,249 --> 00:19:49,940
middle wheels if we could steer those

515
00:19:53,230 --> 00:19:51,259
middle wheels and have all the wheels

516
00:19:55,480 --> 00:19:53,240
help pull us sideways out of this stuff

517
00:19:58,419 --> 00:19:55,490
that would be a nice thing that we could

518
00:20:01,960 --> 00:19:58,429
do that would certainly be a big help

519
00:20:03,639 --> 00:20:01,970
right about now other than that I can't

520
00:20:05,379 --> 00:20:03,649
possibly imagine what we could do to

521
00:20:06,190 --> 00:20:05,389
improve these Rovers they've lasted five

522
00:20:07,570 --> 00:20:06,200
and a half years

523
00:20:09,550 --> 00:20:07,580
they were designed for three months

524
00:20:10,870 --> 00:20:09,560
they've been able to climb slopes much

525
00:20:12,730 --> 00:20:10,880
steeper than they were supposed to be

526
00:20:15,100 --> 00:20:12,740
able to climb they've been able to cross

527
00:20:16,780 --> 00:20:15,110
sand dunes which they were never and to

528
00:20:19,270 --> 00:20:16,790
to climb over

529
00:20:22,390 --> 00:20:19,280
they've with it was stood massive

530
00:20:24,610 --> 00:20:22,400
sandstorms and been cleaned off the

531
00:20:27,280 --> 00:20:24,620
people who design and built this Rover

532
00:20:29,620 --> 00:20:27,290
who many of whom are friends of mine and

533
00:20:31,540 --> 00:20:29,630
colleagues of mine they did an amazing

534
00:20:32,590 --> 00:20:31,550
job I can't really imagine what else we

535
00:20:34,000 --> 00:20:32,600
could do to improve them they're

536
00:20:36,940 --> 00:20:34,010
fabulous machines would they ever

537
00:20:40,480 --> 00:20:36,950
consider putting say like a hoe that

538
00:20:42,430 --> 00:20:40,490

would drag behind and dig soil up just

539
00:20:44,680 --> 00:20:42,440
like this broken wheel would well in

540
00:20:46,570 --> 00:20:44,690
fact the next Rover the Mars Science

541
00:20:48,850 --> 00:20:46,580
Laboratory is actually specifically

542
00:20:50,380 --> 00:20:48,860
designed to be able to core down even

543
00:20:52,180 --> 00:20:50,390
deeper than we can dig with spirits

544
00:20:54,730 --> 00:20:52,190
wheels and look at what's what's

545
00:20:56,380 --> 00:20:54,740
underneath the soil so yes in fact we

546
00:20:57,450 --> 00:20:56,390
have learned how important it is to be

547
00:21:00,130 --> 00:20:57,460
able to get down below the surface

548
00:21:02,440 --> 00:21:00,140
Phoenix our recent lander mission was

549
00:21:05,920 --> 00:21:02,450
designed to be able to dig down as is

550
00:21:08,890 --> 00:21:05,930
the Mars Science Laboratory ok here's a

551
00:21:11,290 --> 00:21:08,900
question why worry about damaging the

552
00:21:14,830 --> 00:21:11,300
science instruments on the arm if the

553
00:21:16,360 --> 00:21:14,840
rover would otherwise be stuck well you

554
00:21:16,840 --> 00:21:16,370
know that's that's a that's a good

555
00:21:18,340 --> 00:21:16,850
question

556
00:21:20,710 --> 00:21:18,350
I mean the real answer is we are a

557
00:21:22,870 --> 00:21:20,720
science mission and if we can't continue

558
00:21:25,510 --> 00:21:22,880
to fulfill our science objectives by

559
00:21:29,530 --> 00:21:25,520
taking measurements and analyzing rocks

560
00:21:31,030 --> 00:21:29,540
and soil then then you really have to

561
00:21:32,830 --> 00:21:31,040
ask yourself is it worth driving

562
00:21:35,620 --> 00:21:32,840
somewhere new when you you can't do much

563
00:21:37,150 --> 00:21:35,630

other than take pictures so I don't know

564
00:21:39,760 --> 00:21:37,160
and that that's certainly a question

565
00:21:41,680 --> 00:21:39,770
well above my paygrade it comes to that

566
00:21:45,220 --> 00:21:41,690
I'm sure somebody else will be making

567
00:21:46,780 --> 00:21:45,230
that call but I certainly hope it

568
00:21:48,610 --> 00:21:46,790
doesn't come to that all right well we

569
00:21:50,320 --> 00:21:48,620
only have about five minutes left so

570
00:21:51,600 --> 00:21:50,330
I'll try to go through a few more

571
00:21:54,610 --> 00:21:51,610
questions a little bit more quickly

572
00:21:57,850 --> 00:21:54,620
wasn't there some indication of the soil

573
00:22:00,160 --> 00:21:57,860
changed through wheel resistance and why

574
00:22:03,910 --> 00:22:00,170
wasn't spirit stopped as it entered this

575
00:22:06,100 --> 00:22:03,920
soil actually there was no significant

576
00:22:07,930 --> 00:22:06,110
difference in we looked very carefully

577
00:22:09,760 --> 00:22:07,940
at the currents on the wheels and all of

578
00:22:13,060 --> 00:22:09,770
this after we drove into the spot and

579
00:22:15,450 --> 00:22:13,070
there was no obvious change in the

580
00:22:18,370 --> 00:22:15,460
telemetry that we could monitor

581
00:22:20,400 --> 00:22:18,380
unfortunately because the resistance of

582
00:22:22,750 --> 00:22:20,410
the soil went down

583
00:22:23,830 --> 00:22:22,760
but there were big piles of it around

584
00:22:24,940 --> 00:22:23,840
there we're not getting a lot of

585
00:22:27,100 --> 00:22:24,950
traction but the wheels are still

586
00:22:29,110 --> 00:22:27,110
experiencing some resistance so that

587
00:22:31,750 --> 00:22:29,120
unfortunately we couldn't really measure

588
00:22:33,070 --> 00:22:31,760

that autonomously on board but it did

589
00:22:34,810 --> 00:22:33,080
notice that it was slipping and

590
00:22:37,180 --> 00:22:34,820
off-course and it stopped for that

591
00:22:40,180 --> 00:22:37,190
reason can all the wheels be turned

592
00:22:42,370 --> 00:22:40,190
independently well you sort of right so

593
00:22:44,260 --> 00:22:42,380
the four steerable wheels can absolutely

594
00:22:47,200 --> 00:22:44,270
be turned completely independently and

595
00:22:49,570 --> 00:22:47,210
also can be driven independently but one

596
00:22:51,640 --> 00:22:49,580
of the four that could be moved

597
00:22:53,650 --> 00:22:51,650
independently is stuck is it right well

598
00:22:56,380 --> 00:22:53,660
we can steer it just can't drive yeah

599
00:22:58,450 --> 00:22:56,390
okay all right and the rest of the

600
00:23:01,030 --> 00:22:58,460
question so doesn't that give you a huge

601
00:23:03,490 --> 00:23:01,040
range of motions to try to get out other

602
00:23:04,780 --> 00:23:03,500
than forward and backward well we have

603
00:23:06,310 --> 00:23:04,790
done a lot more than forward and

604
00:23:07,570 --> 00:23:06,320
backward we have steered the wheels to

605
00:23:09,550 --> 00:23:07,580
the right at a couple of different

606
00:23:11,170 --> 00:23:09,560
angles and tried to climb up hill we've

607
00:23:14,230 --> 00:23:11,180
steered the wheels to the left and tried

608
00:23:16,090 --> 00:23:14,240
to climb downhill we and we've done the

609
00:23:18,070 --> 00:23:16,100
reverse going backwards doing that same

610
00:23:20,440 --> 00:23:18,080
thing both trying to climb uphill and

611
00:23:22,210 --> 00:23:20,450
downhill and we've even steered the

612
00:23:23,890 --> 00:23:22,220
wheels in a circle around the right

613
00:23:25,780 --> 00:23:23,900

front wheel which kind of can act as an

614
00:23:28,150 --> 00:23:25,790
anchor in an attempt to try to pivot

615
00:23:30,160 --> 00:23:28,160
around that wheel and see if we can move

616
00:23:32,880 --> 00:23:30,170
the rover that way and all of these

617
00:23:35,290 --> 00:23:32,890
things have shown some amount of motion

618
00:23:38,200 --> 00:23:35,300
so there is potentials that any of these

619
00:23:40,450 --> 00:23:38,210
things might be able to help us and in

620
00:23:42,010 --> 00:23:40,460
fact we we are going to be discussing

621
00:23:43,360 --> 00:23:42,020
that today and tomorrow we're going to

622
00:23:45,040 --> 00:23:43,370
look at all of our data and figure out

623
00:23:47,980 --> 00:23:45,050
exactly what the next things we want to

624
00:23:50,830 --> 00:23:47,990
test are alright how about turning the

625
00:23:53,050 --> 00:23:50,840
wheel somewhere around 90 degrees from

626
00:23:56,800 --> 00:23:53,060
the front back axis of the rover and

627
00:23:58,570 --> 00:23:56,810
trying to go out sideways right well the

628
00:24:01,270 --> 00:23:58,580
wheels can only steer to about 60

629
00:24:03,640 --> 00:24:01,280
degrees so we can't quite get to 90 but

630
00:24:05,200 --> 00:24:03,650
we have done that testing and that

631
00:24:07,870 --> 00:24:05,210
testing actually looks very promising

632
00:24:09,460 --> 00:24:07,880
and right now at least that's on my

633
00:24:11,590 --> 00:24:09,470
personal short list of things that I

634
00:24:13,780 --> 00:24:11,600
would like to be trying on Mars because

635
00:24:15,610 --> 00:24:13,790
yeah that can help us not only climb

636
00:24:17,830 --> 00:24:15,620
uphill away from the sand pit it might

637
00:24:19,480 --> 00:24:17,840
help pull the left wheels out of the

638
00:24:23,200 --> 00:24:19,490

fluffy stuff and onto the firmer stuff

639
00:24:25,480 --> 00:24:23,210
that we see on the right side so yes

640
00:24:26,980 --> 00:24:25,490
that that is a very good idea and that

641
00:24:28,900 --> 00:24:26,990
is certainly on my short list of things

642
00:24:31,150 --> 00:24:28,910
to do here's a little bit more of a

643
00:24:33,400 --> 00:24:31,160
personal question and we get this all

644
00:24:38,430 --> 00:24:33,410
the time how does one get a

645
00:24:41,460 --> 00:24:38,440
as a rover driver well me personally I

646
00:24:43,720 --> 00:24:41,470
came to JPL right before we landed and

647
00:24:44,890 --> 00:24:43,730
never had any hopes of being able to

648
00:24:46,900 --> 00:24:44,900
work on this mission it was supposed to

649
00:24:49,360 --> 00:24:46,910
be long over before anybody would let me

650
00:24:51,220 --> 00:24:49,370
anywhere close to flight equipment but

651
00:24:52,870 --> 00:24:51,230
they lasted so long and we're doing so

652
00:24:57,340 --> 00:24:52,880
well they had to start hiring new people

653
00:25:00,220 --> 00:24:57,350
and I'm a PhD in robotics robots are

654
00:25:01,750 --> 00:25:00,230
what I do and I have to say there's a

655
00:25:03,970 --> 00:25:01,760
little bit of luck involved my boss at

656
00:25:07,210 --> 00:25:03,980
the time was doing the rover driver job

657
00:25:09,270 --> 00:25:07,220
and so he recommended me as one of the

658
00:25:13,480 --> 00:25:09,280
new people to come in and start training

659
00:25:15,730 --> 00:25:13,490
and where does one major in robotics

660
00:25:17,950 --> 00:25:15,740
well there are two places in the country

661
00:25:19,330 --> 00:25:17,960
right now that offer PhDs in robotics

662
00:25:21,460 --> 00:25:19,340
one is Carnegie Mellon which is where I

663
00:25:23,890 --> 00:25:21,470

went and the other is Georgia Tech but a

664
00:25:25,390 --> 00:25:23,900
lot of places either in the mechanical

665
00:25:26,980 --> 00:25:25,400
or electrical or computer science

666
00:25:28,540 --> 00:25:26,990
department have a lot of Robotics

667
00:25:30,400 --> 00:25:28,550
researchers so there are lots of places

668
00:25:32,050 --> 00:25:30,410
you can go and study robotics here's

669
00:25:34,240 --> 00:25:32,060
another one this is cute has NASA

670
00:25:37,410 --> 00:25:34,250
considered contracting some dune buggy

671
00:25:40,030 --> 00:25:37,420
drivers and racers for their suggestions

672
00:25:42,160 --> 00:25:40,040
well we have certainly solicited you

673
00:25:43,990 --> 00:25:42,170
know suggestions from anybody out there

674
00:25:45,460 --> 00:25:44,000
who wants to listen unfortunately what

675
00:25:48,340 --> 00:25:45,470
the dune buggy drivers have that we

676
00:25:50,770 --> 00:25:48,350
don't is acceleration these Rovers go at

677
00:25:53,320 --> 00:25:50,780
something like one twentieth of a mile

678
00:25:55,270 --> 00:25:53,330
an hour and you just can't build up any

679
00:25:56,470 --> 00:25:55,280
momentum like you would like to do when

680
00:25:58,690 --> 00:25:56,480
you're when you're in one of these stuck

681
00:26:02,350 --> 00:25:58,700
situations you can't get it and muscle

682
00:26:05,490 --> 00:26:02,360
got it gonna get is is is a very very

683
00:26:08,530 --> 00:26:05,500
slow can spirit survived the winter

684
00:26:10,990 --> 00:26:08,540
right now we've gotten the solar panels

685
00:26:13,480 --> 00:26:11,000
nearly completely clean and right now it

686
00:26:14,770 --> 00:26:13,490
looks like if if nothing's significantly

687
00:26:17,080 --> 00:26:14,780
changes if we don't have another major

688
00:26:18,970 --> 00:26:17,090

dust storm that spirit will be able to

689
00:26:21,910 --> 00:26:18,980
survive the winter and probably won't

690
00:26:23,710 --> 00:26:21,920
even have to park great in the simulator

691
00:26:26,080 --> 00:26:23,720
have you tried to back out

692
00:26:28,540 --> 00:26:26,090
we have tried going both backwards and

693
00:26:30,670 --> 00:26:28,550
forwards the difficulty was going

694
00:26:32,590 --> 00:26:30,680
backwards on Mars is actually not too

695
00:26:34,810 --> 00:26:32,600
far behind the rover which is almost

696
00:26:36,610 --> 00:26:34,820
level the the slope significantly

697
00:26:38,200 --> 00:26:36,620
increases so we'd actually before we go

698
00:26:40,630 --> 00:26:38,210
too far we'd actually be climbing uphill

699
00:26:42,520 --> 00:26:40,640
so we might try to back up a little bit

700
00:26:44,710 --> 00:26:42,530
to get away from whatever hazards might

701
00:26:46,360 --> 00:26:44,720
be around the wheels and then go forward

702
00:26:47,350 --> 00:26:46,370
again but yes we have been trying

703
00:26:49,750 --> 00:26:47,360
forward backward

704
00:26:51,700 --> 00:26:49,760
uphill downhill everything we can we can

705
00:26:53,260 --> 00:26:51,710
reasonably get the vehicle to do all

706
00:26:55,990 --> 00:26:53,270
right well we've reached the top of the

707
00:26:57,940 --> 00:26:56,000
hour but one more question what's the

708
00:27:01,540 --> 00:26:57,950
timeframe for trying all these great

709
00:27:03,790 --> 00:27:01,550
ideas on spirit well we we want to try

710
00:27:05,470 --> 00:27:03,800
these combinations of maneuvers first to

711
00:27:07,030 --> 00:27:05,480
see if there's any set of motions that

712
00:27:08,860 --> 00:27:07,040
seem to really be able to pull the rover

713
00:27:12,220 --> 00:27:08,870

out of this and we may be doing that in

714
00:27:14,380 --> 00:27:12,230
a slightly different soil simulant but

715
00:27:17,470 --> 00:27:14,390
we're hoping possibly as early as the

716
00:27:18,970 --> 00:27:17,480
end of the week of August 3rd so towards

717
00:27:21,040 --> 00:27:18,980
the beginning to the middle of August is

718
00:27:24,310 --> 00:27:21,050
when we really think we'll be starting

719
00:27:26,230 --> 00:27:24,320
to work on Mars again so we may be

720
00:27:28,630 --> 00:27:26,240
trying this out in just a few weeks just

721
00:27:28,930 --> 00:27:28,640
a few weeks and it's you know not soon

722
00:27:31,450 --> 00:27:28,940
enough

723
00:27:32,890 --> 00:27:31,460
we need spirit what is ready to go well

724
00:27:34,900 --> 00:27:32,900
good luck to you and thank you for

725
00:27:37,180 --> 00:27:34,910
joining us and thanks for joining us

726
00:27:38,440 --> 00:27:37,190
in the cosmic lounge here at the Jet

727
00:27:41,440 --> 00:27:38,450
Propulsion Laboratory in Pasadena

728
00:27:46,930 --> 00:27:41,450
California if you do wish to get updates

729
00:27:49,780 --> 00:27:46,940
just go to our website wwlp.com sign up

730
00:27:52,360 --> 00:27:49,790
to some of our feeds and also Twitter

731
00:27:54,220 --> 00:27:52,370
Facebook Ustream they're all there