1
00:00:09,049 --> 00:00:07,490
welcome to the cosmic lounge live on

2
00:00:12,110 --> 00:00:09,059
ustream from NASA's Jet Propulsion

3
00:00:15,379 --> 00:00:12,120
Laboratory I'm gayi hill and today's

4
00:00:18,890 --> 00:00:15,389
topic on this webcast freeing spirit the

5
00:00:22,130 --> 00:00:18,900
Mars rover has been stuck in up to its

6
00:00:25,130 --> 00:00:22,140
hubcaps basically in soil very loose

7
00:00:27,259 --> 00:00:25,140
soil on Mars and the team down here on

8
00:00:29,349 --> 00:00:27,269
earth has been trying to figure out a

9
00:00:32,150 --> 00:00:29,359
way to get the rover out of its

10
00:00:34,639 --> 00:00:32,160
predicament with me right now is the

11
00:00:36,979 --> 00:00:34,649
project manager John callous and he's

12
00:00:39,170 --> 00:00:36,989
going to fill us in on details on what

13
00:00:41,750 --> 00:00:39,180

exactly the team is doing first of all

14
00:00:43,479 --> 00:00:41,760
John set the scene what happened to

15
00:00:46,069 --> 00:00:43,489
spirit to get it into this predicament

16
00:00:48,950 --> 00:00:46,079
well about two months ago spirit was

17
00:00:51,080 --> 00:00:48,960
driving around the west side of this

18
00:00:53,270 --> 00:00:51,090
feature on Mars we called home plate it

19
00:00:56,270 --> 00:00:53,280
was heading to a location to the south

20
00:00:59,180 --> 00:00:56,280
to get set up for the winter and it

21
00:01:00,709 --> 00:00:59,190
began to bog down in loose soil Spirit

22
00:01:02,720 --> 00:01:00,719
is the rover that has only five

23
00:01:04,490 --> 00:01:02,730
operating wheels so we dragged that six

24
00:01:06,740 --> 00:01:04,500
wheel so we have you know degraded

25
00:01:09,679 --> 00:01:06,750
mobility over the other overall

26
00:01:11,870 --> 00:01:09,689
opportunity so to help viewers see

27
00:01:14,210 --> 00:01:11,880
exactly where Spirit is we have a

28
00:01:18,200 --> 00:01:14,220
photograph that spirit took itself right

29
00:01:21,679 --> 00:01:18,210
that's right we have some imagery that

30
00:01:25,039 --> 00:01:21,689
we took over the surface and it's a

31
00:01:27,350 --> 00:01:25,049
panorama well this is a front has cam

32
00:01:28,580 --> 00:01:27,360
image that shows the embedding and you

33
00:01:30,560 --> 00:01:28,590
can see on the left side of the screen

34
00:01:32,480 --> 00:01:30,570
there you can see the left front wheel

35
00:01:34,640 --> 00:01:32,490
and you can see that it's buried down to

36
00:01:37,609 --> 00:01:34,650
its hub cap and notice a light loose

37
00:01:41,240 --> 00:01:37,619
material that's around it the other five

38
00:01:43,789 --> 00:01:41,250

wheels are also buried like this so this

39
00:01:45,380 --> 00:01:43,799
is the the worst embedding event that

40
00:01:48,109 --> 00:01:45,390
either over has seen in there five years

41
00:01:50,389 --> 00:01:48,119
on Mars and it's particularly bad

42
00:01:53,270 --> 00:01:50,399
because it's a five wheeled over now

43
00:01:54,770 --> 00:01:53,280
it's tilted slightly to the left and

44
00:01:57,950 --> 00:01:54,780
there's even some rocks underneath that

45
00:02:00,319 --> 00:01:57,960
are complicating the problem so what

46
00:02:03,410 --> 00:02:00,329
exactly was spirit doing at the time it

47
00:02:06,670 --> 00:02:03,420
got stuck well it was driving and it

48
00:02:09,139 --> 00:02:06,680
started to bog down and we continue to

49
00:02:10,639 --> 00:02:09,149
drive it a few more songs and things

50
00:02:12,530 --> 00:02:10,649
just got worse and worse and finally we

51
00:02:14,990 --> 00:02:12,540
said we'll wait a minute then this is

52
00:02:17,569 --> 00:02:15,000
not going the right way and we stopped

53
00:02:19,160 --> 00:02:17,579
and we took a careful look at how

54
00:02:21,259 --> 00:02:19,170
serious the situation was and we decided

55
00:02:24,050 --> 00:02:21,269
at that point before we do anything more

56
00:02:27,170 --> 00:02:24,060
on Mars we better recreate this here on

57
00:02:30,309 --> 00:02:27,180
earth test it out and decide what's the

58
00:02:34,039 --> 00:02:30,319
best thing to try for spirit so we have

59
00:02:36,860 --> 00:02:34,049
videotape of exactly that the the test

60
00:02:40,069 --> 00:02:36,870
bed that we've created we basically are

61
00:02:42,679 --> 00:02:40,079
recreating Mars right here on earth

62
00:02:44,599 --> 00:02:42,689
right that's right the rover is stuck we

63
00:02:46,670 --> 00:02:44,609

can't call triple-a so we have to bring

64
00:02:49,220 --> 00:02:46,680
earth down of Mars down to earth and

65
00:02:50,960 --> 00:02:49,230
what you see here is the preparation of

66
00:02:52,970 --> 00:02:50,970
the material that we use to simulate

67
00:02:55,369 --> 00:02:52,980
Mars what we want to do is create a

68
00:02:57,710 --> 00:02:55,379
little bit of Martian landscape in our

69
00:02:59,780 --> 00:02:57,720
test facility so we needed some special

70
00:03:01,670 --> 00:02:59,790
material first we had to figure out what

71
00:03:04,759 --> 00:03:01,680
kind of material then we had to mix it

72
00:03:07,520 --> 00:03:04,769
and we have 50 400 pounds of that

73
00:03:10,849 --> 00:03:07,530
material so there was a lot of mixing

74
00:03:13,699 --> 00:03:10,859
it's it's gritty dirty hard labor to put

75
00:03:15,379 --> 00:03:13,709
this together we had to mix barrel after

76
00:03:17,930 --> 00:03:15,389
barrel of it and then pour it into our

77
00:03:20,390 --> 00:03:17,940
sandbox and you can see here and then we

78
00:03:22,759 --> 00:03:20,400
had to rake and groom it landscape it

79
00:03:25,039 --> 00:03:22,769
just like the terrain on Mar so it has

80
00:03:26,539 --> 00:03:25,049
the right slope here we're compacting

81
00:03:29,569 --> 00:03:26,549
the soil so it exhibits the right

82
00:03:32,330 --> 00:03:29,579
physical properties that we observe on

83
00:03:35,119 --> 00:03:32,340
Mars and then once it's ready once we

84
00:03:36,530 --> 00:03:35,129
have the special form set up then you

85
00:03:39,770 --> 00:03:36,540
know we have to make sure that we have

86
00:03:42,229 --> 00:03:39,780
enough of it that's deep enough and then

87
00:03:44,059 --> 00:03:42,239
once it's all set we drive our test

88
00:03:46,159 --> 00:03:44,069

Rover which is just like the real roller

89
00:03:48,710 --> 00:03:46,169
drive our tester over into this and

90
00:03:51,259 --> 00:03:48,720
begin what we call the extraction

91
00:03:53,960 --> 00:03:51,269
testing begin to experiment with what

92
00:03:56,240 --> 00:03:53,970
motions will work best and you can see

93
00:03:58,819 --> 00:03:56,250
that even in this short amount of

94
00:04:01,129 --> 00:03:58,829
driving that the wheels k-cup that the

95
00:04:03,080 --> 00:04:01,139
wheels sink in so it's very very

96
00:04:05,569 --> 00:04:03,090
difficult material it's almost like

97
00:04:07,009 --> 00:04:05,579
flour and so it has very little bearing

98
00:04:10,550 --> 00:04:07,019
strength the very little ability to

99
00:04:13,249 --> 00:04:10,560
support the rover now I wanted to at

100
00:04:16,279 --> 00:04:13,259
least talk about the fact that we

101
00:04:18,409 --> 00:04:16,289
originally had promised to go live from

102
00:04:20,599 --> 00:04:18,419
the test bed and I know many of the

103
00:04:22,430 --> 00:04:20,609
viewers expected that but what happened

104
00:04:24,860 --> 00:04:22,440
was there was no testing today correct

105
00:04:25,940 --> 00:04:24,870
that's right we completed a whole series

106
00:04:28,190 --> 00:04:25,950
of tasks and

107
00:04:30,230 --> 00:04:28,200
we decided we need to change the test to

108
00:04:32,660 --> 00:04:30,240
make it more mars-like and so we're in

109
00:04:35,300 --> 00:04:32,670
the process of deciding what that new

110
00:04:36,710 --> 00:04:35,310
change would be and it turns out it's

111
00:04:40,190 --> 00:04:36,720
going to be some new material we need to

112
00:04:41,990 --> 00:04:40,200
put in and we need time to develop that

113
00:04:43,250 --> 00:04:42,000

material put it into the sandbox and put

114
00:04:45,440 --> 00:04:43,260
the rover back in so it'll be a couple

115
00:04:47,510 --> 00:04:45,450
days before our test rover is back in

116
00:04:49,580 --> 00:04:47,520
testing a new set of things in new

117
00:04:51,740 --> 00:04:49,590
conditions so we really didn't have

118
00:04:54,260 --> 00:04:51,750
anything to show anyone from the test

119
00:04:56,240 --> 00:04:54,270
bed and we weren't able to roll tape

120
00:04:58,490 --> 00:04:56,250
from a remote location so we brought it

121
00:05:01,340 --> 00:04:58,500
back to the cosmic lounge and we can

122
00:05:04,520 --> 00:05:01,350
show you at least clips of what's been

123
00:05:06,800 --> 00:05:04,530
going on so far with spirit okay so i

124
00:05:09,140 --> 00:05:06,810
have to say we have been inundated with

125
00:05:11,300 --> 00:05:09,150
questions i have a list of questions

126
00:05:13,310 --> 00:05:11,310
that were emailed to us we have

127
00:05:16,100 --> 00:05:13,320
questions from Facebook and Twitter and

128
00:05:17,600 --> 00:05:16,110
we of course have the ustream questions

129
00:05:20,870 --> 00:05:17,610
and let's just go ahead and get started

130
00:05:23,740 --> 00:05:20,880
okay first question is am i right that

131
00:05:26,510 --> 00:05:23,750
the spirit was the rover with the

132
00:05:29,540 --> 00:05:26,520
completely stuck right foot front wheel

133
00:05:30,920 --> 00:05:29,550
that's right about three years ago the

134
00:05:32,960 --> 00:05:30,930
right front wheel stopped working it

135
00:05:35,120 --> 00:05:32,970
doesn't freely spin and that's been one

136
00:05:36,230 --> 00:05:35,130
of the complications with driving spirit

137
00:05:37,940 --> 00:05:36,240
and that's what makes this particular

138
00:05:39,680 --> 00:05:37,950

embedding so difficult because we now

139
00:05:42,890 --> 00:05:39,690
only have five wheels to try to get us

140
00:05:45,530 --> 00:05:42,900
out another question how many people are

141
00:05:47,420 --> 00:05:45,540
involved with this rescue effort well

142
00:05:49,310 --> 00:05:47,430
everyone on the project which includes a

143
00:05:51,500 --> 00:05:49,320
couple of hundred people are worried and

144
00:05:53,450 --> 00:05:51,510
are participating in this effort but at

145
00:05:55,940 --> 00:05:53,460
any given day we have only about a dozen

146
00:05:58,400 --> 00:05:55,950
people that are actively working on the

147
00:06:01,190 --> 00:05:58,410
recovery effort what's interesting and

148
00:06:03,680 --> 00:06:01,200
this is an aside when I go down to the

149
00:06:06,140 --> 00:06:03,690
test bed it's interesting because you

150
00:06:08,270 --> 00:06:06,150
get to see all sorts of people on the

151
00:06:10,700 --> 00:06:08,280
team different members of the team the

152
00:06:12,350 --> 00:06:10,710
rover drivers everybody seems to come

153
00:06:14,390 --> 00:06:12,360
out of the woodwork whenever one of the

154
00:06:17,000 --> 00:06:14,400
rover's is in trouble that's right

155
00:06:19,370 --> 00:06:17,010
everyone from scientist engineers from

156
00:06:21,830 --> 00:06:19,380
technicians to management or all helping

157
00:06:23,390 --> 00:06:21,840
out and doing gritty hard work down on

158
00:06:25,850 --> 00:06:23,400
the test bed and putting on the suits

159
00:06:29,840 --> 00:06:25,860
and that's right getting hot and sweaty

160
00:06:32,300 --> 00:06:29,850
dirty all right how many times per day

161
00:06:36,200 --> 00:06:32,310
our command sent to spirit and do all

162
00:06:39,279 --> 00:06:36,210
commands originate from JPL we command

163
00:06:41,320 --> 00:06:39,289

each Rover every single day so

164
00:06:42,999 --> 00:06:41,330
we operate actually the rover's operated

165
00:06:44,920 --> 00:06:43,009
on Mars time which is just about 40

166
00:06:47,019 --> 00:06:44,930
minutes longer than an earth day so

167
00:06:49,839 --> 00:06:47,029
typically each day we send a set of

168
00:06:52,179 --> 00:06:49,849
commands to spirit and yes all commands

169
00:06:53,439 --> 00:06:52,189
to originate here at JPL we're going to

170
00:06:55,659 --> 00:06:53,449
talk a little bit about that because

171
00:06:57,249 --> 00:06:55,669
Ashley Stroupe is one of the rover

172
00:06:59,320 --> 00:06:57,259
drivers and so she's one of the

173
00:07:01,689 --> 00:06:59,330
programmers and she'll be here in the

174
00:07:03,670 --> 00:07:01,699
second half hour telling us exactly how

175
00:07:06,519 --> 00:07:03,680
they operate the Rovers on Mars how do

176
00:07:08,619 --> 00:07:06,529
they send the commands how they plan the

177
00:07:10,540 --> 00:07:08,629
duties of the rover for the next day and

178
00:07:14,709 --> 00:07:10,550
we'll be doing that in the second half

179
00:07:17,679 --> 00:07:14,719
hour one more question from ustream from

180
00:07:22,179 --> 00:07:17,689
russ plays guitar can two of the wheels

181
00:07:25,329 --> 00:07:22,189
be lifted no the rover has a passive

182
00:07:26,619 --> 00:07:25,339
suspension system so that we can't lift

183
00:07:28,149 --> 00:07:26,629
a wheel we can't move them out of the

184
00:07:30,189 --> 00:07:28,159
way the only thing we can do is we can

185
00:07:32,109 --> 00:07:30,199
steer the front wheels of the rear

186
00:07:35,260 --> 00:07:32,119
wheels and then drive the five operating

187
00:07:37,089 --> 00:07:35,270
wheels so that's the limit of what we

188
00:07:38,980 --> 00:07:37,099

can work with to get the rover out

189
00:07:41,290 --> 00:07:38,990
because the point that russ was trying

190
00:07:43,480 --> 00:07:41,300
to make was he thought that that might

191
00:07:45,459 --> 00:07:43,490
give more weight to the other wheels to

192
00:07:47,889 --> 00:07:45,469
create better traction is there a way to

193
00:07:50,469 --> 00:07:47,899
give better traction well that certainly

194
00:07:53,829 --> 00:07:50,479
is one of the issues that we want to try

195
00:07:55,719 --> 00:07:53,839
to maximize is to get traction to the

196
00:07:57,639 --> 00:07:55,729
wheels but there's really not a way we

197
00:08:00,610 --> 00:07:57,649
can shift the weight of the rover around

198
00:08:02,679 --> 00:08:00,620
it is tilted to the side one of the

199
00:08:04,869 --> 00:08:02,689
techniques we might try to do is to try

200
00:08:07,119 --> 00:08:04,879
to aggressively turn the rover which

201
00:08:09,040 --> 00:08:07,129
might shift the tilt of the rover a

202
00:08:10,570 --> 00:08:09,050
little bit changing the distribution of

203
00:08:12,429 --> 00:08:10,580
the way but there's nothing actively we

204
00:08:13,839 --> 00:08:12,439
can do on the rover itself you know it

205
00:08:15,040 --> 00:08:13,849
isn't like we can take you know all the

206
00:08:18,040 --> 00:08:15,050
newspapers out of the trunk of your car

207
00:08:22,179 --> 00:08:18,050
to the liteon load or two heavy increase

208
00:08:25,899 --> 00:08:22,189
load okay Mike the guy wants to know why

209
00:08:28,389 --> 00:08:25,909
not misuse the camera arm to leverage

210
00:08:31,449 --> 00:08:28,399
the rover a little bit since it was able

211
00:08:32,829 --> 00:08:31,459
to look beneath the rover the arm well

212
00:08:34,750 --> 00:08:32,839
we do have a robotic arm in the rover

213
00:08:36,819 --> 00:08:34,760

it's about the size of your own arm and

214
00:08:38,920 --> 00:08:36,829
it has the same level of dexterity but

215
00:08:41,379 --> 00:08:38,930
it doesn't have much strength through it

216
00:08:43,719 --> 00:08:41,389
about the the most we can push with that

217
00:08:46,840 --> 00:08:43,729
arm is about 16 Newton's so it's about

218
00:08:49,870 --> 00:08:46,850
14 pounds and our Rover weighs about 150

219
00:08:52,660 --> 00:08:49,880
pounds on the surface of Mars so it's

220
00:08:55,870 --> 00:08:52,670
really not a viable technique

221
00:08:57,640 --> 00:08:55,880
um we're going to exhaust all the

222
00:08:59,080 --> 00:08:57,650
conventional things that we can do with

223
00:09:01,870 --> 00:08:59,090
the rover to try to get it out before we

224
00:09:04,540 --> 00:09:01,880
have to consider anything exotic the

225
00:09:09,070 --> 00:09:04,550
spirit have the ability to tilt itself

226
00:09:11,050 --> 00:09:09,080
to lean into the slope no not really not

227
00:09:12,970 --> 00:09:11,060
much moves on the rover so there's not

228
00:09:14,950 --> 00:09:12,980
really a way to distribute the weight

229
00:09:17,650 --> 00:09:14,960
and it's really all about spinning the

230
00:09:21,070 --> 00:09:17,660
wheels and turning the wheels are you

231
00:09:26,170 --> 00:09:21,080
able to modify its center of gravity you

232
00:09:28,780 --> 00:09:26,180
know okay uh let's see let's go ahead

233
00:09:33,160 --> 00:09:28,790
and give equal time now to the Facebook

234
00:09:35,590 --> 00:09:33,170
people when my car got stuck in the sand

235
00:09:37,600 --> 00:09:35,600
I reduce the tire pressure enough to

236
00:09:39,280 --> 00:09:37,610
drive it out is there something that you

237
00:09:42,790 --> 00:09:39,290
could do here and this is from Omer

238
00:09:45,340 --> 00:09:42,800

divers well the rover has solid wheels

239
00:09:46,810 --> 00:09:45,350
they're made out of a single cast of

240
00:09:48,700 --> 00:09:46,820
aluminum so there's nothing we can

241
00:09:51,010 --> 00:09:48,710
change on the wheels but it's important

242
00:09:52,840 --> 00:09:51,020
to remember that our Mars the the

243
00:09:54,190 --> 00:09:52,850
embedding is very very different from

244
00:09:56,470 --> 00:09:54,200
here on earth where you might get your

245
00:09:59,170 --> 00:09:56,480
car stuck in the mud or the snow one of

246
00:10:01,510 --> 00:09:59,180
the reasons it's very dry on mar so

247
00:10:02,890 --> 00:10:01,520
water doesn't play a role here or

248
00:10:05,500 --> 00:10:02,900
moisture doesn't play a role in

249
00:10:07,780 --> 00:10:05,510
affecting the nature of the soil that

250
00:10:09,250 --> 00:10:07,790
were currently stuck you know I

251
00:10:12,040 --> 00:10:09,260
sometimes answer some of the questions

252
00:10:14,440 --> 00:10:12,050
on YouTube we we post our videos on

253
00:10:17,470 --> 00:10:14,450
YouTube and people are forever sending

254
00:10:19,990 --> 00:10:17,480
in suggestions a few people have asked

255
00:10:22,360 --> 00:10:20,000
about the tread on the rover wheels that

256
00:10:24,070 --> 00:10:22,370
if we had a different tread that would

257
00:10:25,300 --> 00:10:24,080
have made a difference well it's

258
00:10:27,400 --> 00:10:25,310
possible that a different tread would

259
00:10:29,020 --> 00:10:27,410
make a difference remember the the

260
00:10:31,120 --> 00:10:29,030
Rovers have been driving beautifully

261
00:10:32,860 --> 00:10:31,130
when they had all six wheels operating

262
00:10:34,870 --> 00:10:32,870
and they were only designed to drive a

263
00:10:37,810 --> 00:10:34,880

kilometer on Mars about six tenths of a

264
00:10:40,510 --> 00:10:37,820
mile and yet spirit has driven seven

265
00:10:42,400 --> 00:10:40,520
kilometers and opportunities driven 17

266
00:10:45,010 --> 00:10:42,410
kilometers so they've done really really

267
00:10:46,900 --> 00:10:45,020
well exceeding all expectations but also

268
00:10:50,440 --> 00:10:46,910
the design of the tread on the wheel was

269
00:10:52,090 --> 00:10:50,450
also a compromise between safely getting

270
00:10:54,550 --> 00:10:52,100
off the lander and being able to drive

271
00:10:57,460 --> 00:10:54,560
over our air bags that took us safely to

272
00:11:00,490 --> 00:10:57,470
the surface of Mars as well as to drive

273
00:11:02,440 --> 00:11:00,500
on the surface of Mars so if we had to

274
00:11:04,090 --> 00:11:02,450
aggressive at red we might have gotten

275
00:11:06,340 --> 00:11:04,100
tangled in our own air bags and never

276
00:11:08,380 --> 00:11:06,350
have gotten off the lander so it was

277
00:11:10,980 --> 00:11:08,390
differing priorities well it's something

278
00:11:13,660 --> 00:11:10,990
we have to balance all the requirements

279
00:11:15,970 --> 00:11:13,670
for the rover when we design something

280
00:11:19,090 --> 00:11:15,980
okay another Facebook questions this is

281
00:11:21,880 --> 00:11:19,100
this one's from George smite rums be is

282
00:11:24,070 --> 00:11:21,890
it possible that by simply turning the

283
00:11:26,170 --> 00:11:24,080
wheels the rover might dig itself so

284
00:11:28,600 --> 00:11:26,180
deep into the ground that it would hit

285
00:11:30,550 --> 00:11:28,610
bedrock and then be able to get some

286
00:11:32,650 --> 00:11:30,560
traction that's a very interesting

287
00:11:35,590 --> 00:11:32,660
question because we're wondering about

288
00:11:37,600 --> 00:11:35,600

that the geology in this area may

289
00:11:39,850 --> 00:11:37,610
suggest that this loose fine material

290
00:11:41,230 --> 00:11:39,860
has sort of been blown in overtime and

291
00:11:44,200 --> 00:11:41,240
that there may be solid bedrock

292
00:11:46,360 --> 00:11:44,210
underneath but the concern is that if

293
00:11:48,100 --> 00:11:46,370
it's too deep you could sink the wheels

294
00:11:49,690 --> 00:11:48,110
all the way in and then put the belly

295
00:11:52,210 --> 00:11:49,700
pan of the rover on top of the surface

296
00:11:53,920 --> 00:11:52,220
we which we call high centering and

297
00:11:56,140 --> 00:11:53,930
there you would then have no weight on

298
00:11:58,300 --> 00:11:56,150
the wheels and you'd never get out all

299
00:12:01,570 --> 00:11:58,310
right equal time again now I'm going

300
00:12:04,930 --> 00:12:01,580
over to the email questions and this is

301
00:12:07,030 --> 00:12:04,940
from Salvador Trent Acosta I wanted to

302
00:12:08,680 --> 00:12:07,040
know if the sensor boom is strong enough

303
00:12:11,040 --> 00:12:08,690
to use to lift the rover that must be

304
00:12:15,160 --> 00:12:11,050
the same thing using the camera arm

305
00:12:17,170 --> 00:12:15,170
let's go to James Giovanna Glee does the

306
00:12:19,360 --> 00:12:17,180
test rover take into account the

307
00:12:22,270 --> 00:12:19,370
difference in weight here on earth and

308
00:12:24,730 --> 00:12:22,280
that of the rover on Mars that's

309
00:12:26,980 --> 00:12:24,740
actually a very interesting question

310
00:12:29,710 --> 00:12:26,990
because it's something that we deal with

311
00:12:33,430 --> 00:12:29,720
all the time when we're testing the

312
00:12:35,110 --> 00:12:33,440
rover here on earth weighs more than the

313
00:12:37,240 --> 00:12:35,120

rover on Mars because Mars has a lower

314
00:12:39,550 --> 00:12:37,250
gravity is only about three eighths the

315
00:12:41,380 --> 00:12:39,560
way three-eighths the the strength of

316
00:12:43,420 --> 00:12:41,390
here on earth so a rover on Mars weighs

317
00:12:46,300 --> 00:12:43,430
about 150 pounds here on earth it weighs

318
00:12:48,100 --> 00:12:46,310
over 400 pounds we gave that

319
00:12:49,780 --> 00:12:48,110
consideration when we were doing testing

320
00:12:52,660 --> 00:12:49,790
and we actually have a test Rover that's

321
00:12:54,850 --> 00:12:52,670
lighter that's more Mars way but we find

322
00:12:58,720 --> 00:12:54,860
that it doesn't perform and behave the

323
00:13:00,880 --> 00:12:58,730
way we want the rover to were so we

324
00:13:04,600 --> 00:13:00,890
actually deliberately use our heavier

325
00:13:06,850 --> 00:13:04,610
Rover because it embeds better like the

326
00:13:09,670 --> 00:13:06,860
one on Mars so it's a difference between

327
00:13:11,200 --> 00:13:09,680
the soil and the gravity and those two

328
00:13:13,120 --> 00:13:11,210
effects kind of work against each other

329
00:13:14,920 --> 00:13:13,130
and so that's why we're using the

330
00:13:17,320 --> 00:13:14,930
heavier over in this particular soil

331
00:13:20,050 --> 00:13:17,330
let's talk a little bit about the soil

332
00:13:22,030 --> 00:13:20,060
for a second the the spot that

333
00:13:23,920 --> 00:13:22,040
spirit is in right now first of all they

334
00:13:26,830 --> 00:13:23,930
call it Troy why do they call it Troy

335
00:13:29,200 --> 00:13:26,840
well we have a naming convention for as

336
00:13:31,480 --> 00:13:29,210
we explore Mars we certain naming themes

337
00:13:34,840 --> 00:13:31,490
whether the great explorers or different

338
00:13:37,960 --> 00:13:34,850

geologic geographic locations at this

339
00:13:40,840 --> 00:13:37,970
location we're actually using names that

340
00:13:42,940 --> 00:13:40,850
are described in Homer's works so the

341
00:13:45,430 --> 00:13:42,950
Iliad and the Odyssey in Troy was one of

342
00:13:47,860 --> 00:13:45,440
those names and so we named the site

343
00:13:51,070 --> 00:13:47,870
Troy it's also consistent with the other

344
00:13:53,680 --> 00:13:51,080
difficult places that spirit has had

345
00:13:56,350 --> 00:13:53,690
like Tartarus and Tyrone which are two

346
00:13:58,270 --> 00:13:56,360
previous locations where spirit had

347
00:14:02,470 --> 00:13:58,280
trouble so that's why it's called Troy

348
00:14:04,720 --> 00:14:02,480
so what if spirit can't get out of the

349
00:14:08,050 --> 00:14:04,730
situation in Troy what if spirit is

350
00:14:11,170 --> 00:14:08,060
stuck in Troy well if spirit truly is

351
00:14:13,510 --> 00:14:11,180
stuck and it would be really really hard

352
00:14:15,760 --> 00:14:13,520
to know for sure if she's stuck but if

353
00:14:17,500 --> 00:14:15,770
she is truly stuck then we become a

354
00:14:19,090 --> 00:14:17,510
lander mission like any other mars

355
00:14:20,800 --> 00:14:19,100
lander mission and there's a whole suite

356
00:14:22,630 --> 00:14:20,810
of science investigations that we would

357
00:14:25,240 --> 00:14:22,640
continue to do because we have a healthy

358
00:14:27,460 --> 00:14:25,250
Rover we can monitor the weather we can

359
00:14:30,150 --> 00:14:27,470
do detailed analysis of the rocks and

360
00:14:32,890 --> 00:14:30,160
soils around us we can do

361
00:14:34,780 --> 00:14:32,900
high-resolution panoramas and they

362
00:14:36,220 --> 00:14:34,790
change with the seasons the terrain

363
00:14:37,630 --> 00:14:36,230

changes of the season so we would

364
00:14:39,850 --> 00:14:37,640
probably do that for at least a Martian

365
00:14:43,300 --> 00:14:39,860
year so let's look at this spot we have

366
00:14:46,090 --> 00:14:43,310
a visual this is where Spirit is right

367
00:14:48,040 --> 00:14:46,100
now and there's the turned up soil what

368
00:14:50,620 --> 00:14:48,050
do you see there yeah this is a color

369
00:14:52,420 --> 00:14:50,630
camera image of the soil right in front

370
00:14:55,030 --> 00:14:52,430
of the rover that's been churned up and

371
00:14:56,920 --> 00:14:55,040
you see the traditional Mars red dust

372
00:14:57,910 --> 00:14:56,930
soil sort of the perimeter of the

373
00:14:59,680 --> 00:14:57,920
picture and then you see the light

374
00:15:01,480 --> 00:14:59,690
colored material that's been churned up

375
00:15:02,980 --> 00:15:01,490
now this is a false color image so we

376
00:15:04,840 --> 00:15:02,990
stretch the colors a little bit but it

377
00:15:07,840 --> 00:15:04,850
does illustrate the difference of the

378
00:15:10,060 --> 00:15:07,850
subsurface material and this is very

379
00:15:13,960 --> 00:15:10,070
exciting for the geologist because this

380
00:15:16,540 --> 00:15:13,970
material is suggestive of what they call

381
00:15:19,210 --> 00:15:16,550
Remo belies minerals meaning that these

382
00:15:22,350 --> 00:15:19,220
minerals were emplaced somewhere else

383
00:15:24,940 --> 00:15:22,360
and then some process perhaps even water

384
00:15:27,070 --> 00:15:24,950
transported them to this location and

385
00:15:29,110 --> 00:15:27,080
there's even some suggestion that this

386
00:15:32,950 --> 00:15:29,120
process might have been more recent than

387
00:15:33,879 --> 00:15:32,960
the geology around home plate so then

388
00:15:35,439 --> 00:15:33,889

maybe there's some reason

389
00:15:37,509 --> 00:15:35,449
water action amorous and when I say

390
00:15:39,910 --> 00:15:37,519
recent I mean in a geologic scale we're

391
00:15:41,530 --> 00:15:39,920
talking millions of years perhaps but

392
00:15:44,470 --> 00:15:41,540
that's different from billions of years

393
00:15:47,590 --> 00:15:44,480
so if water could have carried those

394
00:15:50,499 --> 00:15:47,600
elements there that would be an

395
00:15:52,809 --> 00:15:50,509
excellent spot to study oh it is and the

396
00:15:54,999 --> 00:15:52,819
science team actually wants to stay here

397
00:15:56,590 --> 00:15:55,009
it's almost like that you know we're on

398
00:15:59,139 --> 00:15:56,600
a family vacation in our car and we

399
00:16:00,970 --> 00:15:59,149
break down next to Disneyland and so we

400
00:16:02,829 --> 00:16:00,980
all go on and spend our time at

401
00:16:05,049 --> 00:16:02,839
Disneyland all right well let's go back

402
00:16:07,479 --> 00:16:05,059
to some of the ustream questions here's

403
00:16:11,650 --> 00:16:07,489
a new one how long will spirit survive

404
00:16:13,929 --> 00:16:11,660
and be viable asked I will be a viable

405
00:16:18,009 --> 00:16:13,939
asset I believe if she never moves again

406
00:16:20,409 --> 00:16:18,019
was sort of dabbling on this the the

407
00:16:22,449 --> 00:16:20,419
fact that this is a good spot but what

408
00:16:25,449 --> 00:16:22,459
about the survival question how long

409
00:16:29,229 --> 00:16:25,459
could spirit survived there well spirit

410
00:16:31,179 --> 00:16:29,239
has been blessed recently with the wind

411
00:16:33,129 --> 00:16:31,189
blowing dust off the solar rays and so

412
00:16:35,519 --> 00:16:33,139
she has an ample amount of energy and

413
00:16:37,689 --> 00:16:35,529

our estimates right now is that she can

414
00:16:40,090 --> 00:16:37,699
survive through the next Martian winter

415
00:16:41,829 --> 00:16:40,100
so that said this Rover could be here

416
00:16:44,139 --> 00:16:41,839
for years and years and years surviving

417
00:16:45,970 --> 00:16:44,149
four years more on the surface and

418
00:16:48,309 --> 00:16:45,980
continuing to explore and even if we

419
00:16:49,840 --> 00:16:48,319
don't move from this location you know

420
00:16:51,100 --> 00:16:49,850
long-term monitoring of the weather and

421
00:16:52,720 --> 00:16:51,110
the environment on Mars is

422
00:16:54,669 --> 00:16:52,730
scientifically very productive and very

423
00:16:57,309 --> 00:16:54,679
interesting and that's interesting the

424
00:17:00,280 --> 00:16:57,319
fact that the solar arrays have been

425
00:17:02,919 --> 00:17:00,290
cleaned off we've got some images of the

426
00:17:06,669 --> 00:17:02,929
dust devils that go through the area and

427
00:17:10,199 --> 00:17:06,679
people can actually see that that these

428
00:17:13,090 --> 00:17:10,209
dust devils that's right how's your um a

429
00:17:15,129 --> 00:17:13,100
some dust devils in the distance this is

430
00:17:17,100 --> 00:17:15,139
the time of year on Mars the season in

431
00:17:19,929 --> 00:17:17,110
which you get a lot of it's summertime

432
00:17:21,610 --> 00:17:19,939
the sunlight heats the air close to the

433
00:17:23,439 --> 00:17:21,620
ground it Wells up making these dust

434
00:17:24,939 --> 00:17:23,449
devils just like here on earth and these

435
00:17:26,500 --> 00:17:24,949
things blow through and they've been

436
00:17:29,320 --> 00:17:26,510
blowing the dust off the arrays for

437
00:17:31,090 --> 00:17:29,330
spirit which is a great benefit to us

438
00:17:32,830 --> 00:17:31,100

because it allows the rover's to

439
00:17:35,710 --> 00:17:32,840
continue operating on the surface so

440
00:17:39,070 --> 00:17:35,720
how's spirits energy level then it's at

441
00:17:41,049 --> 00:17:39,080
the highest it's ever been for the rover

442
00:17:42,669 --> 00:17:41,059
in fact we have too much energy right

443
00:17:45,610 --> 00:17:42,679
now we actually have to turn things on

444
00:17:47,560 --> 00:17:45,620
at night to use up the extra energy well

445
00:17:50,139 --> 00:17:47,570
it's interesting because spirit has been

446
00:17:52,570 --> 00:17:50,149
in bynes before and one of them has been

447
00:17:54,580 --> 00:17:52,580
the fact that at one time it could begin

448
00:17:56,830 --> 00:17:54,590
enough energy because there was too much

449
00:17:58,509 --> 00:17:56,840
dust on the solar arrays that's right

450
00:17:59,710 --> 00:17:58,519
the last winter there was so much dust

451
00:18:01,480 --> 00:17:59,720
in the arrays we were only getting about

452
00:18:03,610 --> 00:18:01,490
twenty-five percent performance on the

453
00:18:05,320 --> 00:18:03,620
array so either this Rover was so dusty

454
00:18:07,930 --> 00:18:05,330
was actually camouflaged against the

455
00:18:09,879 --> 00:18:07,940
background and we just made it through

456
00:18:11,680 --> 00:18:09,889
the third Martian winter and we had to

457
00:18:13,810 --> 00:18:11,690
be very careful about how we use the

458
00:18:16,450 --> 00:18:13,820
energy that we had to be very mais early

459
00:18:18,999 --> 00:18:16,460
but now we have an abundance of riches

460
00:18:20,680 --> 00:18:19,009
in terms of power for for spirit so

461
00:18:22,330 --> 00:18:20,690
spirits very healthy can't get out of

462
00:18:24,070 --> 00:18:22,340
this bind but very healthy and that's

463
00:18:25,779 --> 00:18:24,080

good news for the extraction because it

464
00:18:27,759 --> 00:18:25,789
means when we start to drive the rover

465
00:18:30,820 --> 00:18:27,769
out that we can drive for a long time

466
00:18:33,279 --> 00:18:30,830
each day many many hours okay another

467
00:18:35,860 --> 00:18:33,289
question what elements will be added to

468
00:18:40,360 --> 00:18:35,870
the test bed so I guess this question

469
00:18:43,060 --> 00:18:40,370
deals with how did you know what to put

470
00:18:46,779 --> 00:18:43,070
in that test bed to mimic the situation

471
00:18:49,629 --> 00:18:46,789
in in the on Mars well what we wanted

472
00:18:52,480 --> 00:18:49,639
was oil that has very little cohesion

473
00:18:54,519 --> 00:18:52,490
meaning it's very loose and it has very

474
00:18:56,379 --> 00:18:54,529
little bearing strengthening it's pretty

475
00:18:59,529 --> 00:18:56,389
soft and things would sink into it and

476
00:19:01,749 --> 00:18:59,539
that it would cling to the wheels and so

477
00:19:02,889 --> 00:19:01,759
we from prior experience knew that there

478
00:19:05,320 --> 00:19:02,899
was probably a combination of

479
00:19:07,119 --> 00:19:05,330
diatomaceous earth and clay and so

480
00:19:09,639 --> 00:19:07,129
that's what this mixture is it's half

481
00:19:11,320 --> 00:19:09,649
diatomaceous earth and half clay but

482
00:19:13,450 --> 00:19:11,330
what we see on Mars is a slight

483
00:19:14,799 --> 00:19:13,460
difference between the soil on the left

484
00:19:16,570 --> 00:19:14,809
side of the rover and the soil on the

485
00:19:17,919 --> 00:19:16,580
right side of the rover and that's

486
00:19:19,210 --> 00:19:17,929
important because it looks like we get a

487
00:19:21,340 --> 00:19:19,220
little bit more traction on the right

488
00:19:23,950 --> 00:19:21,350

side with spirit so we want to replicate

489
00:19:25,389 --> 00:19:23,960
that in our test bed and so what we're

490
00:19:26,919 --> 00:19:25,399
going to do now is we're going to change

491
00:19:29,230 --> 00:19:26,929
out the material on the right side of

492
00:19:30,850 --> 00:19:29,240
the rover on the test rover and put in

493
00:19:33,039 --> 00:19:30,860
some soil that gives it a little bit

494
00:19:35,159 --> 00:19:33,049
more traction and then experiment with

495
00:19:38,169 --> 00:19:35,169
that because that'll be more Mars like

496
00:19:40,509 --> 00:19:38,179
how are you able to figure that out were

497
00:19:43,389 --> 00:19:40,519
you able to use the arm and be able to

498
00:19:45,549 --> 00:19:43,399
get a chemical analysis or a spectra of

499
00:19:49,330 --> 00:19:45,559
what was there or did you just sort of

500
00:19:52,090 --> 00:19:49,340
eyeball the the soil and figure out what

501
00:19:53,440 --> 00:19:52,100
that was it's mainly from the images we

502
00:19:56,110 --> 00:19:53,450
have of the soil of how the rover is

503
00:19:58,720 --> 00:19:56,120
embedded and how the rover performed

504
00:20:00,970 --> 00:19:58,730
when it was last driving we saw this as

505
00:20:03,190 --> 00:20:00,980
the rover was attempting to try to get

506
00:20:06,909 --> 00:20:03,200
out of this difficult spot before we

507
00:20:09,340 --> 00:20:06,919
stopped and so that information is

508
00:20:11,140 --> 00:20:09,350
mainly what we're using to de stablished

509
00:20:13,060 --> 00:20:11,150
what we do here on the ground but

510
00:20:14,770 --> 00:20:13,070
subsequently we have been using all the

511
00:20:16,870 --> 00:20:14,780
rover instruments to try to analyze the

512
00:20:18,250 --> 00:20:16,880
soil to understand it better what is its

513
00:20:20,380 --> 00:20:18,260

chemical composition mineralogical

514
00:20:22,570 --> 00:20:20,390
composition but that's more for the

515
00:20:25,060 --> 00:20:22,580
science that we that's very exciting at

516
00:20:28,150 --> 00:20:25,070
this site okay here's another question

517
00:20:30,220 --> 00:20:28,160
and I was going to pull this image and I

518
00:20:34,690 --> 00:20:30,230
should have it's about this rock

519
00:20:36,669 --> 00:20:34,700
touching the underside of spirit and the

520
00:20:39,430 --> 00:20:36,679
question is is the rock touching the

521
00:20:41,730 --> 00:20:39,440
rover yes there is a rock underneath the

522
00:20:45,100 --> 00:20:41,740
rover that's touching the the underbelly

523
00:20:47,409 --> 00:20:45,110
we suspected this because when we look

524
00:20:49,090 --> 00:20:47,419
at images of this site before the rover

525
00:20:51,430 --> 00:20:49,100
drove into it we knew there was a pile

526
00:20:53,890 --> 00:20:51,440
of rocks and now the rover is on top of

527
00:20:55,450 --> 00:20:53,900
the site dug in and so our concern was

528
00:20:57,760 --> 00:20:55,460
as the rover doug and that it would high

529
00:20:59,560 --> 00:20:57,770
Center on those rocks so what we did is

530
00:21:01,419 --> 00:20:59,570
we did something we never did before and

531
00:21:03,250 --> 00:21:01,429
this is actually where opportunity

532
00:21:05,860 --> 00:21:03,260
helped us we first saw an opportunity

533
00:21:07,570 --> 00:21:05,870
use the robotic arm to look underneath

534
00:21:09,370 --> 00:21:07,580
the rover and use the camera on the end

535
00:21:11,080 --> 00:21:09,380
of the arm now this camera is meant as a

536
00:21:13,330 --> 00:21:11,090
microscope so the images are going to be

537
00:21:15,610 --> 00:21:13,340
out of focus but we're still able to see

538
00:21:17,560 --> 00:21:15,620

enough detail and we look under under

539
00:21:19,480 --> 00:21:17,570
spirit and we did see this rock that was

540
00:21:21,610 --> 00:21:19,490
touching the the underbelly just

541
00:21:22,930 --> 00:21:21,620
touching in one spot but the rock looks

542
00:21:25,840 --> 00:21:22,940
like it's just sort of sitting or

543
00:21:27,580 --> 00:21:25,850
floating on top of the soil so it's a

544
00:21:29,470 --> 00:21:27,590
concern but right now we don't think

545
00:21:32,530 --> 00:21:29,480
it's too much of a complication so it's

546
00:21:34,930 --> 00:21:32,540
not as though it's wedged on top of them

547
00:21:37,750 --> 00:21:34,940
it certainly looks like it's touching

548
00:21:40,120 --> 00:21:37,760
but we it doesn't look like it's bearing

549
00:21:42,280 --> 00:21:40,130
any of the rover weight and the

550
00:21:44,080 --> 00:21:42,290
suggestion is is that as we try to move

551
00:21:46,840 --> 00:21:44,090
spirit that that rock will kind of move

552
00:21:50,289 --> 00:21:46,850
our slide away an interesting question

553
00:21:52,000 --> 00:21:50,299
can you do a tank turn yes we can and

554
00:21:54,190 --> 00:21:52,010
that's one of the techniques will try

555
00:21:55,630 --> 00:21:54,200
that's where the wheels on one side of

556
00:21:56,799 --> 00:21:55,640
the rover we run in the opposite

557
00:21:58,539 --> 00:21:56,809
direction from the other side of the

558
00:22:00,370 --> 00:21:58,549
rover to turn the road this is something

559
00:22:02,350 --> 00:22:00,380
we do normally when we want to maneuver

560
00:22:04,870 --> 00:22:02,360
the rover and that may be a technique

561
00:22:06,430 --> 00:22:04,880
that will explore we should talk about

562
00:22:08,650 --> 00:22:06,440
that and I don't know if there's time to

563
00:22:11,620 --> 00:22:08,660

rerun some of the video that we showed

564
00:22:14,300 --> 00:22:11,630
from the test bed what sorts of

565
00:22:16,340 --> 00:22:14,310
maneuvers have you tried thus far

566
00:22:18,080 --> 00:22:16,350
well the simplest most obvious and the

567
00:22:20,300 --> 00:22:18,090
thing we're likely to try first is just

568
00:22:21,680 --> 00:22:20,310
to drive straight forward is when spirit

569
00:22:23,240 --> 00:22:21,690
got into this trouble we were driving

570
00:22:25,670 --> 00:22:23,250
backwards so we kind of backed into it

571
00:22:27,650 --> 00:22:25,680
so the obvious thing is to just go back

572
00:22:29,390 --> 00:22:27,660
out the way you came in so that'll be

573
00:22:32,600 --> 00:22:29,400
one of the techniques that will explore

574
00:22:35,330 --> 00:22:32,610
but because the rover is tilted in the

575
00:22:37,340 --> 00:22:35,340
soil gravity is kind of moving to the

576
00:22:39,950 --> 00:22:37,350
left and so we might try going down

577
00:22:42,820 --> 00:22:39,960
slope in to take advantage of gravity to

578
00:22:45,500 --> 00:22:42,830
to assist us so you see here the testbed

579
00:22:47,600 --> 00:22:45,510
yeah you can see here the rover's you

580
00:22:50,060 --> 00:22:47,610
can see how it's buried the wheels are

581
00:22:51,170 --> 00:22:50,070
deeply buried in this material and we

582
00:22:52,790 --> 00:22:51,180
spin the wheels and you can see you

583
00:22:55,160 --> 00:22:52,800
don't get much traction the rover's are

584
00:22:58,100 --> 00:22:55,170
caked so they don't have that their

585
00:23:01,610 --> 00:22:58,110
treads won't have much traction and they

586
00:23:03,260 --> 00:23:01,620
just sink into this stuff but what we

587
00:23:05,030 --> 00:23:03,270
notice that all these tests the rover

588
00:23:06,710 --> 00:23:05,040

moves although moves you know even if

589
00:23:08,780 --> 00:23:06,720
it's moving just a little bit we'll just

590
00:23:10,880 --> 00:23:08,790
do a lot a lot of wheel spinning and

591
00:23:13,040 --> 00:23:10,890
eventually take advantage of that to get

592
00:23:15,140 --> 00:23:13,050
us out and it's interesting so have you

593
00:23:17,840 --> 00:23:15,150
tried you know going forward going

594
00:23:19,850 --> 00:23:17,850
backwards sideways yes we've pretty much

595
00:23:24,050 --> 00:23:19,860
done all the directions to see which one

596
00:23:27,230 --> 00:23:24,060
works best in combinations of them and

597
00:23:28,910 --> 00:23:27,240
then that will do more testing where we

598
00:23:30,440 --> 00:23:28,920
have the difference in the soil between

599
00:23:34,670 --> 00:23:30,450
the left and right and repeat some of

600
00:23:38,090 --> 00:23:34,680
those another question can the arm scoop

601
00:23:41,120 --> 00:23:38,100
some of the rocks over the tires well

602
00:23:43,730 --> 00:23:41,130
the arm doesn't have a scoop or a way of

603
00:23:46,430 --> 00:23:43,740
grabbing things it's not inconceivable

604
00:23:49,790 --> 00:23:46,440
that you could use the arm to push some

605
00:23:53,060 --> 00:23:49,800
material in front of or away from some

606
00:23:55,550 --> 00:23:53,070
of the wheels and we fought about that

607
00:23:58,160 --> 00:23:55,560
and right now it's not very likely but

608
00:24:00,680 --> 00:23:58,170
you know we'll hold that in our toolkit

609
00:24:01,670 --> 00:24:00,690
if we still need to try some things but

610
00:24:03,230 --> 00:24:01,680
we're going to do the more conventional

611
00:24:04,970 --> 00:24:03,240
things to begin with because we think

612
00:24:06,620 --> 00:24:04,980
those are the ones that are most likely

613
00:24:08,660 --> 00:24:06,630

will get the rover out we have about

614
00:24:11,300 --> 00:24:08,670
five minutes more so let me get through

615
00:24:14,780 --> 00:24:11,310
more questions don't feel bad if I'm

616
00:24:17,030 --> 00:24:14,790
just peppering you in these has mro Mars

617
00:24:19,490 --> 00:24:17,040
Reconnaissance Orbiter it's an orbiter

618
00:24:22,190 --> 00:24:19,500
that takes pictures around Mars just to

619
00:24:24,950 --> 00:24:22,200
let people know has mro been able to

620
00:24:26,210 --> 00:24:24,960
image spirit yes we have a recent

621
00:24:29,360 --> 00:24:26,220
picture of

622
00:24:32,960 --> 00:24:29,370
spirit from mro using the hi-rise camera

623
00:24:35,390 --> 00:24:32,970
and the rover only appears as a few

624
00:24:37,370 --> 00:24:35,400
pixels in that image but we do see it at

625
00:24:39,350 --> 00:24:37,380
our current location and we actually can

626
00:24:41,120 --> 00:24:39,360
think we see a little bit of this bright

627
00:24:43,029 --> 00:24:41,130
soil that's been churned up because the

628
00:24:46,610 --> 00:24:43,039
image is quite bright around the rover

629
00:24:48,860 --> 00:24:46,620
question how much potential damage could

630
00:24:51,710 --> 00:24:48,870
there be to the underside of the rover

631
00:24:54,350 --> 00:24:51,720
from this rock and from the rover moving

632
00:24:55,940 --> 00:24:54,360
over this rock well when the rover roots

633
00:24:58,190 --> 00:24:55,950
were designed one of the things we were

634
00:24:59,840 --> 00:24:58,200
worried about is climbing off our land

635
00:25:01,820 --> 00:24:59,850
or that would bring a safely to the

636
00:25:03,409 --> 00:25:01,830
surface and there was always the risk

637
00:25:04,970 --> 00:25:03,419
that some piece of hardware in the

638
00:25:06,740 --> 00:25:04,980

lander might scrape the underbelly of

639
00:25:08,690 --> 00:25:06,750
the rover as its driving off onto Mars

640
00:25:10,580 --> 00:25:08,700
so when they built their over they kind

641
00:25:11,630 --> 00:25:10,590
of armoured the underside of it and

642
00:25:14,630 --> 00:25:11,640
there's about an inch of clearance

643
00:25:17,600 --> 00:25:14,640
between the outer skin of the rover and

644
00:25:19,190 --> 00:25:17,610
any of the sensitive internals so we're

645
00:25:21,289 --> 00:25:19,200
not so concerned that something

646
00:25:23,090 --> 00:25:21,299
underneath would damage the rover here's

647
00:25:26,360 --> 00:25:23,100
an interesting one we're driving at

648
00:25:27,409 --> 00:25:26,370
night or driving in winter help that's

649
00:25:29,419 --> 00:25:27,419
an interesting question whether

650
00:25:33,230 --> 00:25:29,429
temperature affects any of the physical

651
00:25:34,789 --> 00:25:33,240
properties of the soil I would say right

652
00:25:37,100 --> 00:25:34,799
now that because we've turned everything

653
00:25:38,899 --> 00:25:37,110
up so much it probably doesn't have an

654
00:25:42,200 --> 00:25:38,909
effect but we still think about those

655
00:25:45,230 --> 00:25:42,210
kinds of possibilities could you retract

656
00:25:49,310 --> 00:25:45,240
any of the wheels to the original stowed

657
00:25:51,740 --> 00:25:49,320
position you know it landed on Mars sort

658
00:25:53,779 --> 00:25:51,750
of like a little origami all folded up

659
00:25:55,700 --> 00:25:53,789
and then it unfolded itself would it

660
00:25:58,640 --> 00:25:55,710
still be able to do that no the

661
00:26:00,590 --> 00:25:58,650
deployments that we had on landing are

662
00:26:03,080 --> 00:26:00,600
all single deployments and the rover

663
00:26:05,120 --> 00:26:03,090

wheels when they deploy latch into place

664
00:26:08,060 --> 00:26:05,130
so there's no way to unlatch them and

665
00:26:10,490 --> 00:26:08,070
fold them up so we're stuck with a rover

666
00:26:13,100 --> 00:26:10,500
in its configuration alright we have

667
00:26:15,110 --> 00:26:13,110
three minutes left here's a question it

668
00:26:17,960 --> 00:26:15,120
was an e-mailed question and i love this

669
00:26:20,870 --> 00:26:17,970
one from when why not send opportunity

670
00:26:22,640 --> 00:26:20,880
to the rescue well opportunity is a long

671
00:26:24,860 --> 00:26:22,650
way away it's completely on the other

672
00:26:27,980 --> 00:26:24,870
side of the planet 12 Martian time zones

673
00:26:30,020 --> 00:26:27,990
away and so it would take a lot of

674
00:26:32,990 --> 00:26:30,030
driving to ever get there it's not

675
00:26:36,620 --> 00:26:33,000
possible I'm afraid can the arm slightly

676
00:26:39,110 --> 00:26:36,630
tap the soil in front of the wheels this

677
00:26:39,950 --> 00:26:39,120
is a book does the arm have access to

678
00:26:45,440 --> 00:26:39,960
all the wheels

679
00:26:47,980 --> 00:26:45,450
it could reach the two front wheels and

680
00:26:50,570 --> 00:26:47,990
that's something that we could consider

681
00:26:53,450 --> 00:26:50,580
down the road if we run successful with

682
00:26:55,100 --> 00:26:53,460
extracting the rover because someone

683
00:26:58,670 --> 00:26:55,110
else here on ustream asked could you

684
00:27:01,040 --> 00:26:58,680
scoop the wheels to move the dirt could

685
00:27:04,250 --> 00:27:01,050
you scoop away some of the dirt using

686
00:27:05,930 --> 00:27:04,260
the arm or pushing we could but it's you

687
00:27:08,690 --> 00:27:05,940
know unlike having your car stuck in

688
00:27:10,430 --> 00:27:08,700

snow or mud it's not so much affected by

689
00:27:12,560 --> 00:27:10,440
the loose material that's in front of

690
00:27:14,360 --> 00:27:12,570
the wheels it's really more about what's

691
00:27:16,160 --> 00:27:14,370
directly under the wheel and how much

692
00:27:19,910 --> 00:27:16,170
traction the wheels will have on that

693
00:27:23,660 --> 00:27:19,920
material would NASA be willing to

694
00:27:25,820 --> 00:27:23,670
sacrifice the arm to free spirit I'm not

695
00:27:27,470 --> 00:27:25,830
sure how that could actually free spirit

696
00:27:29,630 --> 00:27:27,480
if you sacrifice their own well some

697
00:27:31,640 --> 00:27:29,640
people we've gotten suggestions from the

698
00:27:33,590 --> 00:27:31,650
public of why don't you just take the

699
00:27:35,570 --> 00:27:33,600
arm and wedge it under a wheel and use

700
00:27:37,700 --> 00:27:35,580
the wheel to drive over it to give you

701
00:27:39,950 --> 00:27:37,710
traction and and that might damage the

702
00:27:42,950 --> 00:27:39,960
end of the arm again those are some of

703
00:27:45,080 --> 00:27:42,960
the exotic things that of course we

704
00:27:48,110 --> 00:27:45,090
think about but we're a long way from

705
00:27:50,090 --> 00:27:48,120
that we think that the best thing to do

706
00:27:51,530 --> 00:27:50,100
is to drive the rover as we have been

707
00:27:53,690 --> 00:27:51,540
driving but it's just going to take a

708
00:27:56,060 --> 00:27:53,700
long time I mean it's going to take once

709
00:27:57,260 --> 00:27:56,070
we start driving many many weeks before

710
00:27:59,210 --> 00:27:57,270
we get out it's going to be a slow

711
00:28:01,880 --> 00:27:59,220
process no matter what well we're just

712
00:28:04,700 --> 00:28:01,890
about done with our time so what's next

713
00:28:07,400 --> 00:28:04,710

then how much when do you foresee us

714
00:28:09,560 --> 00:28:07,410
really trying some of these maneuvers on

715
00:28:10,970 --> 00:28:09,570
Mars well we have about another week of

716
00:28:12,950 --> 00:28:10,980
testing first we have to make the change

717
00:28:15,590 --> 00:28:12,960
to our test bed okay which we will do

718
00:28:19,220 --> 00:28:15,600
this week in part of next week and then

719
00:28:20,780 --> 00:28:19,230
we will do a set of new tests that we

720
00:28:23,000 --> 00:28:20,790
want to do with a different material and

721
00:28:26,000 --> 00:28:23,010
so we're targeting maybe towards the end

722
00:28:28,460 --> 00:28:26,010
of the first week of August would be

723
00:28:31,190 --> 00:28:28,470
when we try things for real on Mars and

724
00:28:33,890 --> 00:28:31,200
no worries about Martian winter coming

725
00:28:35,540 --> 00:28:33,900
and jeopardizing things or no we're

726
00:28:38,210 --> 00:28:35,550
fortunate because the solar rays were

727
00:28:39,470 --> 00:28:38,220
cleaned off that we have almost all the

728
00:28:41,840 --> 00:28:39,480
time in the world are all the time on

729
00:28:43,610 --> 00:28:41,850
Mars to get spirit out so we're taking

730
00:28:45,560 --> 00:28:43,620
our time and we're doing due diligence

731
00:28:47,540 --> 00:28:45,570
here to explore all the possibilities

732
00:28:49,760 --> 00:28:47,550
here on the ground before we do them for

733
00:28:51,470 --> 00:28:49,770
real alright well John thank you for

734
00:28:53,299 --> 00:28:51,480
joining us as you can see there's a

735
00:28:56,330 --> 00:28:53,309
tremendous following for

736
00:28:59,119 --> 00:28:56,340
these Rovers tremendous affection and we

737
00:29:01,249 --> 00:28:59,129
have lots more questions we'll shift

738
00:29:03,560 --> 00:29:01,259

things now over to Ashley Stroupe but

739
00:29:06,680 --> 00:29:03,570
before we go we're going to run our

740
00:29:09,200 --> 00:29:06,690
latest edition of the free free spirit

741
00:29:16,009 --> 00:29:09,210
update we do these every week so if you

742
00:29:18,799 --> 00:29:16,019
stay and and go to our website w JP nasa

743
00:29:20,690 --> 00:29:18,809
gov you can see our updates every week

744
00:29:22,730 --> 00:29:20,700
their video updates from the test bed

745
00:29:33,440 --> 00:29:22,740
let's go to our most recent one from ash

746
00:29:35,210 --> 00:29:33,450
ash least root here it is I'm Ashley

747
00:29:37,100 --> 00:29:35,220
stupid i'm one of the rover drivers here

748
00:29:38,989 --> 00:29:37,110
at the Jet Propulsion Laboratory and i'm

749
00:29:41,659 --> 00:29:38,999
here with the latest free spirit update

750
00:29:43,609 --> 00:29:41,669
this week we're continuing crab driving

751
00:29:45,680 --> 00:29:43,619
testing that means we're steering the

752
00:29:47,899 --> 00:29:45,690
wheels to different angles and trying to

753
00:29:50,060 --> 00:29:47,909
get the rover to move sideways along the

754
00:29:51,649 --> 00:29:50,070
hill we've done some testing both with

755
00:29:53,840 --> 00:29:51,659
forward crabbing and now we're doing

756
00:29:55,399 --> 00:29:53,850
backward crabbing and we've now got the

757
00:29:57,680 --> 00:29:55,409
wheel scared to several different angles

758
00:29:59,690 --> 00:29:57,690
the test you can see behind me we've got

759
00:30:01,999 --> 00:29:59,700
the wheels all scared to 20 degrees and

760
00:30:04,940 --> 00:30:02,009
they're all driving backwards to try to

761
00:30:06,769 --> 00:30:04,950
pull the rover backward and uphill away

762
00:30:08,720 --> 00:30:06,779
from these potential obstacles that we

763
00:30:11,090 --> 00:30:08,730

seem to have run into in our first

764
00:30:13,009 --> 00:30:11,100
attempt to get out of the sand trap we

765
00:30:14,899 --> 00:30:13,019
break each test into several smaller

766
00:30:17,330 --> 00:30:14,909
pieces so that we can measure the

767
00:30:19,070 --> 00:30:17,340
rover's progress along the way that way

768
00:30:21,619 --> 00:30:19,080
we can tell whether the rover is making

769
00:30:23,539 --> 00:30:21,629
steady progress throughout the test or

770
00:30:25,039 --> 00:30:23,549
whether it may come up against a wall

771
00:30:26,659 --> 00:30:25,049
and only make good progress at the

772
00:30:28,369 --> 00:30:26,669
beginning in which case then we know

773
00:30:30,289 --> 00:30:28,379
that extra wheel turns are not going to

774
00:30:31,820 --> 00:30:30,299
make much of a difference one of the

775
00:30:34,009 --> 00:30:31,830
great things that's happened along with

776
00:30:35,810 --> 00:30:34,019
spirit sitting still for so long is of

777
00:30:37,940 --> 00:30:35,820
course we've been parked in a really

778
00:30:39,799 --> 00:30:37,950
windy location and the winds have come

779
00:30:42,200 --> 00:30:39,809
along and cleaned off the solar panels

780
00:30:44,359 --> 00:30:42,210
tremendously so now we have lots of

781
00:30:45,859 --> 00:30:44,369
powers which not only gives us many

782
00:30:48,200 --> 00:30:45,869
hours a day where we can conduct

783
00:30:50,509 --> 00:30:48,210
scientific experiments and do our

784
00:30:53,359 --> 00:30:50,519
mobility tests on Mars to try to get the

785
00:30:55,369 --> 00:30:53,369
rover out but we've bought ourselves a

786
00:30:57,080 --> 00:30:55,379
lot more time before Spirit will even

787
00:30:59,600 --> 00:30:57,090
have to consider parking for the next

788
00:31:04,070 --> 00:30:59,610

Martian winter so I'm ashley's troop and

789
00:31:06,529 --> 00:31:04,080
this was your free spirit update alright

790
00:31:06,790 --> 00:31:06,539
with us now is Ashley Stroupe she's one

791
00:31:09,880 --> 00:31:06,800
of her

792
00:31:12,520 --> 00:31:09,890
over drivers and lots of people have no

793
00:31:14,620 --> 00:31:12,530
idea how these Rovers are operated on

794
00:31:17,410 --> 00:31:14,630
Mars Spirit and Opportunity you're not

795
00:31:21,100 --> 00:31:17,420
driving them with a joystick and you

796
00:31:24,310 --> 00:31:21,110
know okay avoid that rock you know you

797
00:31:26,980 --> 00:31:24,320
actually have to program it so before we

798
00:31:29,920 --> 00:31:26,990
go any further let's just explain to

799
00:31:32,980 --> 00:31:29,930
folks exactly what a robo driver does

800
00:31:35,830 --> 00:31:32,990
sure well it is like driving a car with

801
00:31:39,160 --> 00:31:35,840
a computer program so every day we have

802
00:31:41,080 --> 00:31:39,170
to sit down and look at the images of

803
00:31:43,480 --> 00:31:41,090
the world around us and figure out where

804
00:31:45,670 --> 00:31:43,490
the rover is going to go and then we

805
00:31:47,680 --> 00:31:45,680
have to build a program essentially that

806
00:31:50,650 --> 00:31:47,690
will guide the rover along that desired

807
00:31:54,120 --> 00:31:50,660
path let's go to the video and you can

808
00:31:56,830 --> 00:31:54,130
write shell folks can show some examples

809
00:32:00,820 --> 00:31:56,840
let's go to the videotape and this is

810
00:32:02,650 --> 00:32:00,830
the rover driving so you are in a room

811
00:32:05,080 --> 00:32:02,660
essential right we sit in a room at a

812
00:32:07,240 --> 00:32:05,090
computer terminal where we can pull up

813
00:32:10,390 --> 00:32:07,250

all the images here you can see two of

814
00:32:13,150 --> 00:32:10,400
my colleagues evaluating some terrain

815
00:32:15,550 --> 00:32:13,160
from opportunity and they're looking at

816
00:32:17,320 --> 00:32:15,560
the potential hazards they're looking

817
00:32:18,970 --> 00:32:17,330
for any rocks and he kills any loose

818
00:32:23,530 --> 00:32:18,980
soil that they would want to avoid

819
00:32:27,790 --> 00:32:23,540
driving into we can also look at these

820
00:32:29,410 --> 00:32:27,800
images in 3d and so we can see mars the

821
00:32:30,820 --> 00:32:29,420
way the rover would see it or the way we

822
00:32:32,710 --> 00:32:30,830
would see it if we were there so we can

823
00:32:35,890 --> 00:32:32,720
get a better of assessment there you can

824
00:32:37,930 --> 00:32:35,900
actually see the 3d glasses that we use

825
00:32:40,120 --> 00:32:37,940
to be able to look at the terrain and

826
00:32:42,580 --> 00:32:40,130
predict what rocks are dangerous and

827
00:32:43,930 --> 00:32:42,590
what rocks are safe to go over and we

828
00:32:45,970 --> 00:32:43,940
also have tools where we can measure

829
00:32:47,770 --> 00:32:45,980
things in the image using the stereo

830
00:32:49,810 --> 00:32:47,780
models that the rover has built for us

831
00:32:51,700 --> 00:32:49,820
so we can see if there any rocks that

832
00:32:54,610 --> 00:32:51,710
are dangerous for the rover to drive

833
00:32:56,470 --> 00:32:54,620
over unless we've assembled the the plan

834
00:32:57,970 --> 00:32:56,480
of what we wanted to do we sit down and

835
00:33:00,070 --> 00:32:57,980
we write the program and build the

836
00:33:01,990 --> 00:33:00,080
sequence of commands and then we

837
00:33:05,200 --> 00:33:02,000
simulate those commands we play them

838
00:33:07,870 --> 00:33:05,210

back in a full model of the rover and

839
00:33:10,180 --> 00:33:07,880
the terrain so we can see how the rover

840
00:33:11,740 --> 00:33:10,190
is going to interact with the terrain we

841
00:33:13,480 --> 00:33:11,750
do that both for driving or as you can

842
00:33:17,350 --> 00:33:13,490
see in the video this is an example of

843
00:33:19,540 --> 00:33:17,360
testing out the robotic arm the idd and

844
00:33:20,110 --> 00:33:19,550
a sequence of commands replacing an

845
00:33:23,320 --> 00:33:20,120
instrument

846
00:33:25,930 --> 00:33:23,330
how involved is that do you meet you

847
00:33:27,730 --> 00:33:25,940
know once a day and figure out the

848
00:33:30,280 --> 00:33:27,740
marching orders for the rover's everyday

849
00:33:32,680 --> 00:33:30,290
or right so pretty much once a day we

850
00:33:34,930 --> 00:33:32,690
sit down with all the engineers and all

851
00:33:36,850 --> 00:33:34,940
the scientists and we come up with the

852
00:33:38,380 --> 00:33:36,860
general plan of what the robots going to

853
00:33:40,420 --> 00:33:38,390
do for that day where it's going to draw

854
00:33:42,340 --> 00:33:40,430
over what targets it's going to look at

855
00:33:44,500 --> 00:33:42,350
with its science instruments and then

856
00:33:46,420 --> 00:33:44,510
each sub team goes off and builds their

857
00:33:48,340 --> 00:33:46,430
part of the program and then we come

858
00:33:50,650 --> 00:33:48,350
back together and we walk through every

859
00:33:53,170 --> 00:33:50,660
line of the program that's going to go

860
00:33:55,930 --> 00:33:53,180
up to the rover twice before we then

861
00:33:58,240 --> 00:33:55,940
send it to the rover on Mars so we then

862
00:33:59,980 --> 00:33:58,250
send the plan up the rover then execute

863
00:34:02,140 --> 00:33:59,990

the plan and then at the end of the day

864
00:34:04,090 --> 00:34:02,150
she calls back home and lets us know how

865
00:34:05,620 --> 00:34:04,100
everything went so we have to often wait

866
00:34:07,960 --> 00:34:05,630
a long time before we know how things

867
00:34:10,570 --> 00:34:07,970
went on Mars and and what's involved in

868
00:34:13,240 --> 00:34:10,580
the planning you know isn't it mostly

869
00:34:14,980 --> 00:34:13,250
scientists saying boy that rock over

870
00:34:16,930 --> 00:34:14,990
there to the right really looks

871
00:34:20,020 --> 00:34:16,940
interesting could you get us over there

872
00:34:21,910 --> 00:34:20,030
right that's we are science mission as

873
00:34:24,070 --> 00:34:21,920
exciting as the engineering is we really

874
00:34:25,900 --> 00:34:24,080
are a science mission so it all begins

875
00:34:27,400 --> 00:34:25,910
with what the scientists sit down and

876
00:34:29,110 --> 00:34:27,410
they say this is what we want to do here

877
00:34:30,430 --> 00:34:29,120
are the interesting things around here

878
00:34:33,250 --> 00:34:30,440
and we want to go look at these things

879
00:34:34,990 --> 00:34:33,260
and then we try to evaluate all of those

880
00:34:37,240 --> 00:34:35,000
different places they want to go and

881
00:34:38,590 --> 00:34:37,250
hopefully we can accommodate all of them

882
00:34:40,300 --> 00:34:38,600
but sometimes something might be too

883
00:34:42,040 --> 00:34:40,310
dangerous or too difficult to reach and

884
00:34:43,960 --> 00:34:42,050
we have to tell them but we can't quite

885
00:34:46,360 --> 00:34:43,970
do that how about this and so there's a

886
00:34:48,280 --> 00:34:46,370
little bit of negotiation going on but

887
00:34:50,800 --> 00:34:48,290
we do start with the science first and

888
00:34:52,270 --> 00:34:50,810

we really try to to get the scientists

889
00:34:54,550 --> 00:34:52,280
what they need because ultimately that's

890
00:34:57,760 --> 00:34:54,560
what we're trying to do well the purpose

891
00:35:00,670 --> 00:34:57,770
of our talk today is figuring out ways

892
00:35:05,010 --> 00:35:00,680
to free spirit right and here we have a

893
00:35:08,440 --> 00:35:05,020
suggestion here from someone on ustream

894
00:35:11,560 --> 00:35:08,450
why don't you use a harness to make the

895
00:35:14,850 --> 00:35:11,570
test rover weigh the same on Mars do you

896
00:35:17,830 --> 00:35:14,860
really need to do that though well

897
00:35:19,450 --> 00:35:17,840
sometimes we do have to do testing and

898
00:35:21,520 --> 00:35:19,460
in fact you know when we're first

899
00:35:23,860 --> 00:35:21,530
building a robot we often do that kind

900
00:35:26,290 --> 00:35:23,870
of testing to exactly exactly simulate

901
00:35:28,210 --> 00:35:26,300
what Mars gravity would have but our our

902
00:35:30,190 --> 00:35:28,220
test over is actually lighter weight

903
00:35:32,440 --> 00:35:30,200
than the one on Mars so it's not quite

904
00:35:33,500 --> 00:35:32,450
down to Mars gravity but it's part of

905
00:35:35,990 --> 00:35:33,510
the way there

906
00:35:37,460 --> 00:35:36,000
and actually that is a close enough

907
00:35:39,560 --> 00:35:37,470
model for the kinds of things we're

908
00:35:41,600 --> 00:35:39,570
trying to do actually the rover being a

909
00:35:43,400 --> 00:35:41,610
little bit heavier actually makes

910
00:35:45,110 --> 00:35:43,410
driving in this stuff a little bit

911
00:35:47,780 --> 00:35:45,120
harder so we're sort of modeling the

912
00:35:49,490 --> 00:35:47,790
worst case if you like by letting the

913
00:35:51,560 --> 00:35:49,500

rover be a little bit too heavy for Mars

914
00:35:53,660 --> 00:35:51,570
I think a lot of people are learning

915
00:35:56,540 --> 00:35:53,670
about that for the first time that we

916
00:35:58,400 --> 00:35:56,550
have two different Rovers there's a test

917
00:36:01,310 --> 00:35:58,410
rover that's the same weight as the

918
00:36:02,870 --> 00:36:01,320
rover on Mars almost almost like it's

919
00:36:04,550 --> 00:36:02,880
missing some of the batteries and the

920
00:36:07,070 --> 00:36:04,560
solar panels and some of the other heavy

921
00:36:09,800 --> 00:36:07,080
components but it's very close to the

922
00:36:11,420 --> 00:36:09,810
weight of the rover on Mars and I'm not

923
00:36:13,430 --> 00:36:11,430
sure very many people realize that

924
00:36:15,560 --> 00:36:13,440
there's a difference and having to

925
00:36:18,500 --> 00:36:15,570
factor in gravity that's right of course

926
00:36:20,390 --> 00:36:18,510
the gravity of Mars is a little under

927
00:36:22,160 --> 00:36:20,400
forty percent that over so things weigh

928
00:36:24,650 --> 00:36:22,170
about a third there that they do on

929
00:36:26,360 --> 00:36:24,660
earth and of course how you interact

930
00:36:28,910 --> 00:36:26,370
with the ground is very dependent on

931
00:36:30,320 --> 00:36:28,920
your weight so sometimes you really do

932
00:36:32,360 --> 00:36:30,330
need to take that into account when

933
00:36:34,550 --> 00:36:32,370
you're modeling things alright we're

934
00:36:37,370 --> 00:36:34,560
going to some of the email questions now

935
00:36:40,010 --> 00:36:37,380
this one's from mark park mark parker

936
00:36:42,800 --> 00:36:40,020
could the denser material be placed

937
00:36:46,100 --> 00:36:42,810
under one wheel at a time on the soft

938
00:36:49,430 --> 00:36:46,110

side to raise that side enough to clear

939
00:36:51,380 --> 00:36:49,440
the object underneath you know that's a

940
00:36:52,670 --> 00:36:51,390
good suggestion a lot of people have

941
00:36:54,320 --> 00:36:52,680
been thinking about that kind of thing

942
00:36:56,710 --> 00:36:54,330
but unfortunately we don't have any way

943
00:36:59,780 --> 00:36:56,720
to transport material under the wheels

944
00:37:01,790 --> 00:36:59,790
the arm could only reach the front wheel

945
00:37:04,060 --> 00:37:01,800
anyway but it also isn't really strong

946
00:37:06,410 --> 00:37:04,070
enough to move large amounts of material

947
00:37:07,970 --> 00:37:06,420
particularly we also be at risk of

948
00:37:09,560 --> 00:37:07,980
damaging some of the science instruments

949
00:37:11,600 --> 00:37:09,570
if we actually try to interact with the

950
00:37:13,280 --> 00:37:11,610
ground in that way so unfortunately we

951
00:37:16,010 --> 00:37:13,290
don't have a good way to actually change

952
00:37:18,190 --> 00:37:16,020
the soil or add rocks or add more soil

953
00:37:21,740 --> 00:37:18,200
with traction underneath the left side

954
00:37:23,720 --> 00:37:21,750
okay this one's from Rogers silber does

955
00:37:26,780 --> 00:37:23,730
the rover instrument arm have enough

956
00:37:30,110 --> 00:37:26,790
strength to provide a useful force

957
00:37:32,780 --> 00:37:30,120
vector to free the rover unfortunately

958
00:37:36,080 --> 00:37:32,790
not the arm can only exert about 15 to

959
00:37:38,210 --> 00:37:36,090
20 pounds of force it really can't do

960
00:37:40,250 --> 00:37:38,220
anything approximating lifting the rover

961
00:37:42,680 --> 00:37:40,260
or move any large rocks or anything like

962
00:37:45,320 --> 00:37:42,690
that it's really only designed to just

963
00:37:47,240 --> 00:37:45,330

sort of gently contact the ground it was

964
00:37:50,480 --> 00:37:47,250
never designed to actually really exert

965
00:37:53,090 --> 00:37:50,490
force how much force could the arm exert

966
00:37:55,940 --> 00:37:53,100
if used in such an emergency sort of

967
00:37:58,370 --> 00:37:55,950
push assist scenario right probably only

968
00:38:00,230 --> 00:37:58,380
about 20 pounds of force so in a real

969
00:38:01,820 --> 00:38:00,240
emergency we might give it a try that

970
00:38:04,100 --> 00:38:01,830
might be the little bit of a difference

971
00:38:06,770 --> 00:38:04,110
that we need but because that is such a

972
00:38:08,780 --> 00:38:06,780
risk to possibly damaging the arm that's

973
00:38:10,670 --> 00:38:08,790
a long way off before we try that but

974
00:38:12,380 --> 00:38:10,680
you know as a last-ditch effort we might

975
00:38:14,030 --> 00:38:12,390
give something like that a try but it

976
00:38:17,240 --> 00:38:14,040
won't be much of a help just a little

977
00:38:19,880 --> 00:38:17,250
okay this is an email question from Lee

978
00:38:21,980 --> 00:38:19,890
Wilkerson the current position of the

979
00:38:24,800 --> 00:38:21,990
Spirit rover shows the right wheels on

980
00:38:27,260 --> 00:38:24,810
what appears to be a firm surface with

981
00:38:29,990 --> 00:38:27,270
the left wheels mired in the soft soil

982
00:38:32,780 --> 00:38:30,000
layer however the rover in the test

983
00:38:35,810 --> 00:38:32,790
sandbox has all wheels embedded in the

984
00:38:38,480 --> 00:38:35,820
soft soil why was this scenario chosen

985
00:38:41,150 --> 00:38:38,490
for the simulation that's a really good

986
00:38:44,000 --> 00:38:41,160
question so the particular simulant that

987
00:38:46,550 --> 00:38:44,010
we picked has some interesting material

988
00:38:48,890 --> 00:38:46,560

properties if you pack it down tightly

989
00:38:51,320 --> 00:38:48,900
it actually stays kind of firm and

990
00:38:53,570 --> 00:38:51,330
strong but if you fluff it up then it

991
00:38:55,340 --> 00:38:53,580
becomes loose and fluffy like what we

992
00:38:56,660 --> 00:38:55,350
see under the left side and we had

993
00:38:59,240 --> 00:38:56,670
really hopes that we'd be able to use

994
00:39:01,970 --> 00:38:59,250
one material compact it differently and

995
00:39:04,100 --> 00:39:01,980
have that work for both of the different

996
00:39:06,620 --> 00:39:04,110
types of soils we see on Mars right now

997
00:39:08,750 --> 00:39:06,630
in fact today we're having a big meeting

998
00:39:10,100 --> 00:39:08,760
with the engineers and the scientist to

999
00:39:12,950 --> 00:39:10,110
look at the tests that we've already

1000
00:39:15,200 --> 00:39:12,960
done and see if that assumption holds up

1001
00:39:17,840 --> 00:39:15,210
we are seeing some differences and as a

1002
00:39:19,940 --> 00:39:17,850
result of that we may likely change that

1003
00:39:21,440 --> 00:39:19,950
soil that's under the right wheels so

1004
00:39:23,450 --> 00:39:21,450
excellent question and we may be

1005
00:39:25,430 --> 00:39:23,460
changing that for our next set of tests

1006
00:39:28,040 --> 00:39:25,440
well here's another question regarding

1007
00:39:31,070 --> 00:39:28,050
opportunity can opportunity help and

1008
00:39:33,490 --> 00:39:31,080
what is opportunity doing and we have

1009
00:39:35,660 --> 00:39:33,500
some videos yeah sure great question the

1010
00:39:37,760 --> 00:39:35,670
opportunity is unfortunately on the

1011
00:39:40,490 --> 00:39:37,770
complete opposite side of the planet and

1012
00:39:44,330 --> 00:39:40,500
given that they you know have driven at

1013
00:39:46,670 --> 00:39:44,340

most about 10 miles in five and a half

1014
00:39:49,070 --> 00:39:46,680
years they probably will never meet each

1015
00:39:53,360 --> 00:39:49,080
other so unfortunately opportunity can't

1016
00:39:54,920 --> 00:39:53,370
help but opportunity we've now got a

1017
00:39:58,970 --> 00:39:54,930
video up that's showing basically

1018
00:40:00,200 --> 00:39:58,980
opportunities entire a ten mile plus

1019
00:40:02,329 --> 00:40:00,210
trek

1020
00:40:04,550 --> 00:40:02,339
she started at a little tiny crater

1021
00:40:08,000 --> 00:40:04,560
called eagle and then visited a larger

1022
00:40:11,030 --> 00:40:08,010
crater called an endurance and then

1023
00:40:13,220 --> 00:40:11,040
drove several miles across some sandy

1024
00:40:14,750 --> 00:40:13,230
plains to hit Erebus which are just

1025
00:40:16,849 --> 00:40:14,760
about to see the video catch up there

1026
00:40:19,190 --> 00:40:16,859
and then headed off to a really large

1027
00:40:21,980 --> 00:40:19,200
crater called victoria which we spent

1028
00:40:24,620 --> 00:40:21,990
about a year exploring victoria and now

1029
00:40:28,280 --> 00:40:24,630
we're actually heading towards the south

1030
00:40:31,160 --> 00:40:28,290
towards a about a huge crater that's

1031
00:40:33,680 --> 00:40:31,170
miles across called endeavour and that

1032
00:40:35,359 --> 00:40:33,690
is opportunities next goal we're really

1033
00:40:37,190 --> 00:40:35,369
hoping this is a very old crater it's

1034
00:40:39,560 --> 00:40:37,200
very deep but it's very eroded so the

1035
00:40:41,450 --> 00:40:39,570
sides are gentle slopes so we're hoping

1036
00:40:43,160 --> 00:40:41,460
we can drive deeply into that crater and

1037
00:40:44,839 --> 00:40:43,170
see some really old layers that are

1038
00:40:47,950 --> 00:40:44,849

exposed nowhere else that the Rovers

1039
00:40:52,370 --> 00:40:47,960
have been did anyone ever imagine that

1040
00:40:55,060 --> 00:40:52,380
opportunity would be going that far no I

1041
00:40:58,099 --> 00:40:55,070
don't think anybody imagined that

1042
00:40:59,870 --> 00:40:58,109
certainly we all sort of hoped and even

1043
00:41:03,260 --> 00:40:59,880
maybe a little expected that we'd go far

1044
00:41:06,320 --> 00:41:03,270
beyond our 300 meter design guideline

1045
00:41:08,150 --> 00:41:06,330
but in terms of ten plus miles no I

1046
00:41:12,020 --> 00:41:08,160
don't think that was in anybody's

1047
00:41:13,520 --> 00:41:12,030
wildest dreams but we long since gave up

1048
00:41:15,650 --> 00:41:13,530
trying to bed on when it would end

1049
00:41:17,359 --> 00:41:15,660
because if you bet against the rover's

1050
00:41:19,220 --> 00:41:17,369
you're just going to lose they just keep

1051
00:41:21,170 --> 00:41:19,230
going but I guess we have to keep in

1052
00:41:23,120 --> 00:41:21,180
mind that the Rovers are getting older

1053
00:41:26,150 --> 00:41:23,130
so Rovers are getting older they each

1054
00:41:28,609 --> 00:41:26,160
have some faulty joints now spirit has a

1055
00:41:30,380 --> 00:41:28,619
broken right front drive wheel but

1056
00:41:32,540 --> 00:41:30,390
opportunity also has a steering wheel

1057
00:41:34,579 --> 00:41:32,550
that a steering motor on the right front

1058
00:41:36,670 --> 00:41:34,589
wheel that's broken and one of the

1059
00:41:39,650 --> 00:41:36,680
shoulder joints is also broken now

1060
00:41:41,329 --> 00:41:39,660
gratefully these these have not done

1061
00:41:43,910 --> 00:41:41,339
anything other than slightly slow them

1062
00:41:46,490 --> 00:41:43,920
down they certainly are still able to do

1063
00:41:48,500 --> 00:41:46,500

much of their normal capabilities but

1064
00:41:51,170 --> 00:41:48,510
they are aging we're sort of creating a

1065
00:41:53,000 --> 00:41:51,180
new field robot gerontology because

1066
00:41:55,040 --> 00:41:53,010
robots on earth when this happens you

1067
00:41:56,510 --> 00:41:55,050
just fix them we run this is the first

1068
00:41:58,970 --> 00:41:56,520
time we've ever been an experience where

1069
00:42:01,670 --> 00:41:58,980
we've had to continue operations with

1070
00:42:04,070 --> 00:42:01,680
continually changing performance and

1071
00:42:06,710 --> 00:42:04,080
degradation over over this many years

1072
00:42:08,790 --> 00:42:06,720
well you know the subject of opportunity

1073
00:42:11,550 --> 00:42:08,800
keeps coming up and

1074
00:42:14,220 --> 00:42:11,560
and they're asking can opportunity help

1075
00:42:16,650 --> 00:42:14,230
well opportunity has helped well

1076
00:42:18,300 --> 00:42:16,660
actually yes opportunity did help we

1077
00:42:20,520 --> 00:42:18,310
wanted to do something a little bit

1078
00:42:22,980 --> 00:42:20,530
risky with spirit to help diagnose her

1079
00:42:24,330 --> 00:42:22,990
situation we wanted to take out the

1080
00:42:27,120 --> 00:42:24,340
robotic arm and take a picture

1081
00:42:28,620 --> 00:42:27,130
underneath the rover's belly so we could

1082
00:42:31,230 --> 00:42:28,630
see the middle wheels which we normally

1083
00:42:33,120 --> 00:42:31,240
can't see see how very they were see if

1084
00:42:35,340 --> 00:42:33,130
there were rocks hung up on the rover

1085
00:42:37,920 --> 00:42:35,350
and because we were in some very

1086
00:42:41,070 --> 00:42:37,930
complicated geometry we didn't want to

1087
00:42:42,360 --> 00:42:41,080
pull spirits arm out if we didn't think

1088
00:42:43,800 --> 00:42:42,370

that this would actually be helpful

1089
00:42:46,140 --> 00:42:43,810
there was a risk of hitting it against

1090
00:42:49,140 --> 00:42:46,150
iraq so opportunity actually did that

1091
00:42:51,150 --> 00:42:49,150
first we had opportunity deploy your arm

1092
00:42:53,730 --> 00:42:51,160
and take a picture underneath herself

1093
00:42:56,130 --> 00:42:53,740
and we got fabulous results we could

1094
00:42:57,150 --> 00:42:56,140
really see a lot of detail so after we

1095
00:42:58,860 --> 00:42:57,160
knew that it was going to be a

1096
00:43:00,600 --> 00:42:58,870
worthwhile pursuit we then figured out

1097
00:43:02,670 --> 00:43:00,610
how to get the arm safely out and did

1098
00:43:04,530 --> 00:43:02,680
take a picture which has told us a lot

1099
00:43:07,410 --> 00:43:04,540
we in fact do have a rock that may well

1100
00:43:09,840 --> 00:43:07,420
be touching the bottom of spirit we can

1101
00:43:11,670 --> 00:43:09,850
see how buried the middle wheels are

1102
00:43:13,320 --> 00:43:11,680
which we couldn't see any other way and

1103
00:43:16,590 --> 00:43:13,330
so that has really helped our our

1104
00:43:18,510 --> 00:43:16,600
diagnostic problem will opportunity be

1105
00:43:20,670 --> 00:43:18,520
called upon again in the future do you

1106
00:43:22,530 --> 00:43:20,680
think if there's another risky thing

1107
00:43:24,660 --> 00:43:22,540
that we have to do we may test it on

1108
00:43:26,790 --> 00:43:24,670
opportunity first because opportunity is

1109
00:43:29,010 --> 00:43:26,800
in a much more benign terrain it's much

1110
00:43:31,650 --> 00:43:29,020
safer for her to try out new and

1111
00:43:34,140 --> 00:43:31,660
different things so and so certainly

1112
00:43:36,510 --> 00:43:34,150
that could happen alright so here's

1113
00:43:39,720 --> 00:43:36,520

another question another suggestion from

1114
00:43:43,530 --> 00:43:39,730
our viewers what about using very slow

1115
00:43:46,470 --> 00:43:43,540
wheels continuously would that help get

1116
00:43:48,540 --> 00:43:46,480
out of this soil that is an excellent

1117
00:43:51,510 --> 00:43:48,550
question that is one of the things we

1118
00:43:53,850 --> 00:43:51,520
are considering if you if you slow down

1119
00:43:55,560 --> 00:43:53,860
the wheels you you might be able to get

1120
00:43:57,300 --> 00:43:55,570
slightly better traction if you're

1121
00:43:59,610 --> 00:43:57,310
spinning fast you're more likely to slip

1122
00:44:01,500 --> 00:43:59,620
and so that is certainly one of the

1123
00:44:04,230 --> 00:44:01,510
things that in the next round of testing

1124
00:44:05,790 --> 00:44:04,240
we are considering looking at we don't

1125
00:44:07,380 --> 00:44:05,800
know yet how well that will work but

1126
00:44:08,880 --> 00:44:07,390
that is that is an excellent suggestion

1127
00:44:12,060 --> 00:44:08,890
and we are thinking about giving that a

1128
00:44:14,490 --> 00:44:12,070
try so how has the testing been going

1129
00:44:16,440 --> 00:44:14,500
you know are you seeing certain things

1130
00:44:19,020 --> 00:44:16,450
working certain things not working at

1131
00:44:21,930 --> 00:44:19,030
all right so we've we've done a bunch of

1132
00:44:22,560 --> 00:44:21,940
testing I we've done for we're driving

1133
00:44:24,150 --> 00:44:22,570
backward dry

1134
00:44:26,490 --> 00:44:24,160
we've done even some sort of side words

1135
00:44:29,070 --> 00:44:26,500
crab driving as we saw in the video a

1136
00:44:30,690 --> 00:44:29,080
little while ago and we are seeing that

1137
00:44:33,150 --> 00:44:30,700
the good news is even though we think

1138
00:44:34,800 --> 00:44:33,160

this is sort of a worst-case model with

1139
00:44:36,300 --> 00:44:34,810
really slippery soil and the wheels

1140
00:44:38,640 --> 00:44:36,310
buried a little bit more than they are

1141
00:44:40,980 --> 00:44:38,650
on Mars we are seeing that the rover

1142
00:44:42,930 --> 00:44:40,990
rover is able to move at least a little

1143
00:44:45,570 --> 00:44:42,940
bit even under these very adverse

1144
00:44:47,250 --> 00:44:45,580
conditions and so that has told us that

1145
00:44:50,190 --> 00:44:47,260
we actually do have a good chance of

1146
00:44:53,550 --> 00:44:50,200
spirit being able to get out once we

1147
00:44:57,630 --> 00:44:53,560
start this on Mars at the moment it

1148
00:44:59,370 --> 00:44:57,640
looks like that we don't have quite

1149
00:45:01,020 --> 00:44:59,380
enough data to really distinguish which

1150
00:45:03,060 --> 00:45:01,030
individual things are going to be the

1151
00:45:04,830 --> 00:45:03,070
best but all of the things we've tried

1152
00:45:07,590 --> 00:45:04,840
have have moved there over a little bit

1153
00:45:09,510 --> 00:45:07,600
we're very optimistic about this idea of

1154
00:45:13,380 --> 00:45:09,520
possibly being able to crab and go

1155
00:45:14,910 --> 00:45:13,390
slightly uphill we do have unfortunately

1156
00:45:16,560 --> 00:45:14,920
we'd like to rely on gravity in these

1157
00:45:18,600 --> 00:45:16,570
situations but downhill from us is an

1158
00:45:20,730 --> 00:45:18,610
even worse sandpit than the one we're in

1159
00:45:23,550 --> 00:45:20,740
so we could get up hill and away from

1160
00:45:25,830 --> 00:45:23,560
these possible hazards that would be a

1161
00:45:27,030 --> 00:45:25,840
really good thing so that's one of the

1162
00:45:28,700 --> 00:45:27,040
things that we're definitely going to be

1163
00:45:31,920 --> 00:45:28,710

looking at as well and once again

1164
00:45:33,960 --> 00:45:31,930
explain crabbing it's going crabbing so

1165
00:45:35,970 --> 00:45:33,970
only the front and rear wheels on the

1166
00:45:38,730 --> 00:45:35,980
rover steer but what we can do is we can

1167
00:45:39,990 --> 00:45:38,740
steer those wheels at an angle and then

1168
00:45:42,030 --> 00:45:40,000
drive them forward and they're all

1169
00:45:44,730 --> 00:45:42,040
driving in the same direction which kind

1170
00:45:48,000 --> 00:45:44,740
of pulls the rover to the side a little

1171
00:45:50,400 --> 00:45:48,010
bit and we have used that before to try

1172
00:45:51,900 --> 00:45:50,410
to approach cyan't argh science targets

1173
00:45:54,570 --> 00:45:51,910
when they were off to the side of us a

1174
00:45:58,530 --> 00:45:54,580
little in it has worked very well and in

1175
00:46:00,330 --> 00:45:58,540
fact we we were using that to try to get

1176
00:46:02,820 --> 00:46:00,340
us out of the sand pit originally before

1177
00:46:04,200 --> 00:46:02,830
we realized we had these other potential

1178
00:46:06,080 --> 00:46:04,210
hazards and needed to stop and

1179
00:46:08,130 --> 00:46:06,090
reevaluate and that was actually working

1180
00:46:11,580 --> 00:46:08,140
somewhat we were moving several

1181
00:46:13,890 --> 00:46:11,590
centimeters each day it is there any

1182
00:46:15,540 --> 00:46:13,900
similarity between what's happening to

1183
00:46:17,580 --> 00:46:15,550
spirit right now and what happened to

1184
00:46:19,910 --> 00:46:17,590
opportunity way back when when it was

1185
00:46:21,750 --> 00:46:19,920
going through the news sure purgatory

1186
00:46:24,150 --> 00:46:21,760
ripple is what you're talking about

1187
00:46:24,930 --> 00:46:24,160
opportunity got fairly deeply embedded

1188
00:46:26,970 --> 00:46:24,940

in

1189
00:46:29,160 --> 00:46:26,980
Sandra pool and yes there are some

1190
00:46:31,349 --> 00:46:29,170
similarities the soil there was a little

1191
00:46:32,730 --> 00:46:31,359
bit fluffy we did get the wheels buried

1192
00:46:34,380 --> 00:46:32,740
in very deep and we had very little

1193
00:46:35,730 --> 00:46:34,390
traction we would try to drive a long

1194
00:46:38,190 --> 00:46:35,740
distance and we'd only move a few

1195
00:46:41,099 --> 00:46:38,200
millimeters so in some ways the soil

1196
00:46:44,220 --> 00:46:41,109
that we're in is kind of similar the

1197
00:46:46,230 --> 00:46:44,230
difference is is that opportunity was

1198
00:46:47,640 --> 00:46:46,240
going uphill over a ripple and could

1199
00:46:50,010 --> 00:46:47,650
then kind of use gravity to back

1200
00:46:52,829 --> 00:46:50,020
straight down the hill through tracks we

1201
00:46:54,870 --> 00:46:52,839
unfortunately spirits at a roll so we

1202
00:46:57,089 --> 00:46:54,880
follow out our tracks we don't get that

1203
00:46:59,460 --> 00:46:57,099
extra little advantage of gravity

1204
00:47:00,510 --> 00:46:59,470
helping to pull us down the hill so we

1205
00:47:03,870 --> 00:47:00,520
have a slightly more complicated

1206
00:47:07,950 --> 00:47:03,880
geometry but a similar problem is spirit

1207
00:47:10,230 --> 00:47:07,960
more dug in though also well actually

1208
00:47:12,599 --> 00:47:10,240
opportunity was pretty much as deeply

1209
00:47:16,079 --> 00:47:12,609
dug in on purgatory part of the problem

1210
00:47:19,319 --> 00:47:16,089
was opportunity drove about 40 or 50

1211
00:47:20,760 --> 00:47:19,329
meters before we before she realized

1212
00:47:22,109 --> 00:47:20,770
that she was slipping because she wasn't

1213
00:47:23,550 --> 00:47:22,119

looking where she was going at that

1214
00:47:25,349 --> 00:47:23,560
point that's very common to do when

1215
00:47:27,120 --> 00:47:25,359
there are no obstacles around we just

1216
00:47:29,490 --> 00:47:27,130
let the rover drive and what we think is

1217
00:47:31,319 --> 00:47:29,500
a safe area so it continued to spin the

1218
00:47:33,270 --> 00:47:31,329
wheels after she stopped making progress

1219
00:47:37,020 --> 00:47:33,280
for a long time and it actually dug in

1220
00:47:39,690 --> 00:47:37,030
quite significantly so so the rear

1221
00:47:41,700 --> 00:47:39,700
wheels and the and the middle wheels

1222
00:47:43,349 --> 00:47:41,710
were about as Duggan is what we've seen

1223
00:47:46,650 --> 00:47:43,359
on spirit but the front wheels were not

1224
00:47:48,180 --> 00:47:46,660
as bad um something that lots of folks

1225
00:47:51,540 --> 00:47:48,190
aren't familiar with is the fact that

1226
00:47:54,410 --> 00:47:51,550
the Rovers do kind of operate on its own

1227
00:47:57,710 --> 00:47:54,420
with their own brains and autonomously

1228
00:48:00,660 --> 00:47:57,720
were they operating autonomously

1229
00:48:03,450 --> 00:48:00,670
automatism autonomously tirelessly um

1230
00:48:05,550 --> 00:48:03,460
was spirit doing that and in fact so

1231
00:48:07,349 --> 00:48:05,560
spirit was we had given her a path to

1232
00:48:09,720 --> 00:48:07,359
follow and she was autonomously trying

1233
00:48:12,270 --> 00:48:09,730
to follow that path and in fact slipped

1234
00:48:16,140 --> 00:48:12,280
off that path to some extent and stopped

1235
00:48:18,240 --> 00:48:16,150
the drive as a result of failing uh one

1236
00:48:19,800 --> 00:48:18,250
of them safety checks that she had in

1237
00:48:22,319 --> 00:48:19,810
there she realized she was off course

1238
00:48:24,900 --> 00:48:22,329

and stopped so yes she was driving

1239
00:48:26,940 --> 00:48:24,910
autonomously when this happened they had

1240
00:48:28,890 --> 00:48:26,950
their own and that ended it from getting

1241
00:48:31,410 --> 00:48:28,900
even further embedded and perhaps into a

1242
00:48:34,319 --> 00:48:31,420
much worse situation okay back to the

1243
00:48:36,809 --> 00:48:34,329
questions can the science team conduct

1244
00:48:38,490 --> 00:48:36,819
tests while you all attempt to help

1245
00:48:41,460 --> 00:48:38,500
spirit escape

1246
00:48:43,770 --> 00:48:41,470
yes we have been doing a very extensive

1247
00:48:45,930 --> 00:48:43,780
science campaign while we have been

1248
00:48:47,580 --> 00:48:45,940
sitting in this location we have tons of

1249
00:48:49,290 --> 00:48:47,590
power thanks to the wind cleaning

1250
00:48:51,210 --> 00:48:49,300
everything off so we've been doing all

1251
00:48:53,490 --> 00:48:51,220
kinds of science experiments we have at

1252
00:48:55,890 --> 00:48:53,500
least four different soil types that we

1253
00:48:57,990 --> 00:48:55,900
can reach with the robotic arm and we

1254
00:49:00,210 --> 00:48:58,000
have done detailed analyses of all four

1255
00:49:03,060 --> 00:49:00,220
of these soil types we're continuing

1256
00:49:06,630 --> 00:49:03,070
some further investigations today in

1257
00:49:08,460 --> 00:49:06,640
fact we have brushed away the surface

1258
00:49:11,040 --> 00:49:08,470
soil in one location and we've actually

1259
00:49:13,260 --> 00:49:11,050
gone down and seen that the soil changes

1260
00:49:14,760 --> 00:49:13,270
about a centimeter down so we're

1261
00:49:17,070 --> 00:49:14,770
actually investigating to see what that

1262
00:49:18,840 --> 00:49:17,080
slightly deeper soil is and we've

1263
00:49:20,490 --> 00:49:18,850

learned that this soil is a little bit

1264
00:49:23,160 --> 00:49:20,500
different than what we have seen

1265
00:49:25,440 --> 00:49:23,170
elsewhere on Mars it has a lot of sulfur

1266
00:49:26,760 --> 00:49:25,450
in it a little bit of silica and I'm

1267
00:49:29,490 --> 00:49:26,770
sure scientists could tell you better

1268
00:49:31,350 --> 00:49:29,500
what makes that unique but it's it's a

1269
00:49:33,900 --> 00:49:31,360
very interesting discovery that we have

1270
00:49:35,910 --> 00:49:33,910
not seen anywhere else on Mars and any

1271
00:49:37,410 --> 00:49:35,920
signature that would lend you to believe

1272
00:49:39,390 --> 00:49:37,420
that water may be involved in it

1273
00:49:42,630 --> 00:49:39,400
absolutely whenever we find many of

1274
00:49:46,530 --> 00:49:42,640
these mineral compounds many of them are

1275
00:49:48,180 --> 00:49:46,540
the result of water transporting these

1276
00:49:50,820 --> 00:49:48,190
minerals to these locations and then

1277
00:49:53,670 --> 00:49:50,830
evaporating away and we've seen that at

1278
00:49:56,220 --> 00:49:53,680
many locations all around home plate and

1279
00:49:58,560 --> 00:49:56,230
in fact this is an interesting thing is

1280
00:49:59,940 --> 00:49:58,570
that we wouldn't have have found nearly

1281
00:50:01,560 --> 00:49:59,950
as much of the stuff and known it was

1282
00:50:03,780 --> 00:50:01,570
nearly this widely distributed without

1283
00:50:05,850 --> 00:50:03,790
the broken right front wheel because

1284
00:50:08,070 --> 00:50:05,860
it's mostly buried under the surface and

1285
00:50:10,050 --> 00:50:08,080
only by digging a hole which the right

1286
00:50:12,690 --> 00:50:10,060
front wheel does for us naturally most

1287
00:50:15,360 --> 00:50:12,700
of the time we've been finding this

1288
00:50:17,280 --> 00:50:15,370

these mineral deposits and salts in our

1289
00:50:18,450 --> 00:50:17,290
tracks almost everywhere we go that's

1290
00:50:20,640 --> 00:50:18,460
interesting because here's another

1291
00:50:24,180 --> 00:50:20,650
question what have you learned from this

1292
00:50:26,220 --> 00:50:24,190
set of difficulties in the design of new

1293
00:50:29,730 --> 00:50:26,230
rovers what have you learned that will

1294
00:50:31,950 --> 00:50:29,740
help you design the next Rover right

1295
00:50:34,650 --> 00:50:31,960
that's an excellent question and I know

1296
00:50:36,900 --> 00:50:34,660
one thing that I would like to see on a

1297
00:50:38,760 --> 00:50:36,910
future Rover would be able to steer

1298
00:50:40,110 --> 00:50:38,770
those middle wheels if we could steer

1299
00:50:41,970 --> 00:50:40,120
those middle wheels and have all the

1300
00:50:44,280 --> 00:50:41,980
wheels help pull a sideways out of this

1301
00:50:47,130 --> 00:50:44,290
stuff that would be a nice thing that we

1302
00:50:50,370 --> 00:50:47,140
could do that would certainly be a big

1303
00:50:51,940 --> 00:50:50,380
help right about now other than that I

1304
00:50:53,319 --> 00:50:51,950
can't possibly imagine

1305
00:50:54,760 --> 00:50:53,329
what we could do to improve these Rovers

1306
00:50:56,470 --> 00:50:54,770
they've lasted five and a half years

1307
00:50:58,420 --> 00:50:56,480
when they were designed for three months

1308
00:50:59,740 --> 00:50:58,430
they've been able to climb slopes much

1309
00:51:01,630 --> 00:50:59,750
steeper than they were supposed to be

1310
00:51:04,599 --> 00:51:01,640
able to climb they've been able to cross

1311
00:51:07,150 --> 00:51:04,609
sand dunes which they were never to to

1312
00:51:10,500 --> 00:51:07,160
climb over they've with it was stood

1313
00:51:13,000 --> 00:51:10,510

massive sand storms and been cleaned off

1314
00:51:15,700 --> 00:51:13,010
the people who design and built this

1315
00:51:18,040 --> 00:51:15,710
Rover who many of whom are our friends

1316
00:51:19,660 --> 00:51:18,050
of mine and colleagues of mine they did

1317
00:51:21,099 --> 00:51:19,670
an amazing job I can't really imagine

1318
00:51:22,720 --> 00:51:21,109
what else we could do to improve them

1319
00:51:26,079 --> 00:51:22,730
there fabulous machine would they ever

1320
00:51:29,170 --> 00:51:26,089
consider putting say like a hoe that

1321
00:51:31,120 --> 00:51:29,180
would drag behind and dig soil up just

1322
00:51:33,190 --> 00:51:31,130
like this broken wheel would well in

1323
00:51:35,109 --> 00:51:33,200
fact the next Rover the Mars Science

1324
00:51:37,480 --> 00:51:35,119
Laboratory is actually specifically

1325
00:51:38,980 --> 00:51:37,490
designed to be able to cordon even

1326
00:51:40,780 --> 00:51:38,990
deeper than we can dig with spirits

1327
00:51:43,300 --> 00:51:40,790
wheels and look at what's what's

1328
00:51:44,950 --> 00:51:43,310
underneath the soil so yes in fact we

1329
00:51:46,089 --> 00:51:44,960
have learned how important it is to be

1330
00:51:48,700 --> 00:51:46,099
able to get down below the surface

1331
00:51:50,980 --> 00:51:48,710
Phoenix our recent lander mission was

1332
00:51:54,400 --> 00:51:50,990
designed to be able to dig down as is

1333
00:51:57,370 --> 00:51:54,410
the Mars Science Laboratory okay here's

1334
00:51:59,740 --> 00:51:57,380
a question why worry about damaging the

1335
00:52:03,280 --> 00:51:59,750
science instruments on the arm if the

1336
00:52:04,839 --> 00:52:03,290
rover would otherwise be stuck well you

1337
00:52:06,609 --> 00:52:04,849
know that that's a that's a good

1338
00:52:08,680 --> 00:52:06,619

question I mean the real answer is we

1339
00:52:10,569 --> 00:52:08,690
are a science mission and if we can't

1340
00:52:12,400 --> 00:52:10,579
continue to fulfill our science

1341
00:52:17,380 --> 00:52:12,410
objectives by taking measurements and

1342
00:52:18,880 --> 00:52:17,390
analyzing rocks and soil then then you

1343
00:52:20,800 --> 00:52:18,890
really have to ask yourself is it worth

1344
00:52:23,230 --> 00:52:20,810
driving somewhere new when you you can't

1345
00:52:25,000 --> 00:52:23,240
do much other than take pictures so I

1346
00:52:27,490 --> 00:52:25,010
don't know and that that's certainly a

1347
00:52:29,020 --> 00:52:27,500
question well above my pay grade it

1348
00:52:32,859 --> 00:52:29,030
comes to that I'm sure somebody else

1349
00:52:34,720 --> 00:52:32,869
will be making that call but I certainly

1350
00:52:36,040 --> 00:52:34,730
hope it doesn't come to that all right

1351
00:52:38,349 --> 00:52:36,050
well we only have about five minutes

1352
00:52:39,819 --> 00:52:38,359
left so I'll try to go through a few

1353
00:52:42,790 --> 00:52:39,829
more questions a little bit more quickly

1354
00:52:46,000 --> 00:52:42,800
wasn't there some indication of the soil

1355
00:52:48,280 --> 00:52:46,010
change through wheel resistance and why

1356
00:52:52,059 --> 00:52:48,290
wasn't spirit stopped as it entered this

1357
00:52:54,190 --> 00:52:52,069
soil actually there was no significant

1358
00:52:56,020 --> 00:52:54,200
difference in we looked very carefully

1359
00:52:57,819 --> 00:52:56,030
at the currents on the wheels and all of

1360
00:53:00,610 --> 00:52:57,829
this after we drove into the spot and

1361
00:53:03,480 --> 00:53:00,620
there was no obvious change

1362
00:53:06,370 --> 00:53:03,490
in the telemetry that we could monitor

1363
00:53:09,820 --> 00:53:06,380

unfortunately because the resistance of

1364
00:53:11,200 --> 00:53:09,830
the soil went down but there were big

1365
00:53:12,610 --> 00:53:11,210
piles of it around there we're not

1366
00:53:14,230 --> 00:53:12,620
getting a lot of traction but the wheels

1367
00:53:16,450 --> 00:53:14,240
are still experiencing some resistance

1368
00:53:19,240 --> 00:53:16,460
so that unfortunately we couldn't really

1369
00:53:21,010 --> 00:53:19,250
measure that autonomously on board but

1370
00:53:22,720 --> 00:53:21,020
it did notice that it was slipping and

1371
00:53:25,090 --> 00:53:22,730
off course and it stopped for that

1372
00:53:28,060 --> 00:53:25,100
reason can all the wheels be turned

1373
00:53:30,070 --> 00:53:28,070
independently will you sort of right so

1374
00:53:32,110 --> 00:53:30,080
the force terrible wheels can absolutely

1375
00:53:35,050 --> 00:53:32,120
be turned completely independently and

1376
00:53:37,390 --> 00:53:35,060
also can be driven independently but one

1377
00:53:39,460 --> 00:53:37,400
of the four that could be moved

1378
00:53:41,440 --> 00:53:39,470
independently you stuck is it right well

1379
00:53:44,170 --> 00:53:41,450
we can steer it just can't drive yeah

1380
00:53:46,210 --> 00:53:44,180
okay all right and the rest of the

1381
00:53:48,760 --> 00:53:46,220
question so doesn't that give you a huge

1382
00:53:51,220 --> 00:53:48,770
range of motions to try to get out other

1383
00:53:52,480 --> 00:53:51,230
than forward and backward well we have

1384
00:53:54,010 --> 00:53:52,490
done a lot more than forward and

1385
00:53:55,240 --> 00:53:54,020
backward we have steered the wheels to

1386
00:53:57,220 --> 00:53:55,250
the right at a couple of different

1387
00:53:58,840 --> 00:53:57,230
angles and tried to climb uphill we've

1388
00:54:01,870 --> 00:53:58,850

steered the wheels to the left and tried

1389
00:54:03,730 --> 00:54:01,880
to climb down hill we and we've done the

1390
00:54:05,710 --> 00:54:03,740
reverse going backwards doing that same

1391
00:54:08,050 --> 00:54:05,720
thing both trying to climb uphill and

1392
00:54:09,790 --> 00:54:08,060
downhill and we've even steered the

1393
00:54:11,470 --> 00:54:09,800
wheels in a circle around the right

1394
00:54:13,510 --> 00:54:11,480
front wheel which kind of can act as an

1395
00:54:15,760 --> 00:54:13,520
anchor in an attempt to try to pivot

1396
00:54:17,740 --> 00:54:15,770
around that wheel and see if we can move

1397
00:54:20,370 --> 00:54:17,750
the rover that way and all of these

1398
00:54:22,780 --> 00:54:20,380
things have shown some amount of motion

1399
00:54:25,690 --> 00:54:22,790
so there is potentials that any of these

1400
00:54:27,910 --> 00:54:25,700
things might be able to help us and in

1401
00:54:29,470 --> 00:54:27,920
fact we we are going to be discussing

1402
00:54:30,820 --> 00:54:29,480
that today and tomorrow we're going to

1403
00:54:32,500 --> 00:54:30,830
look at all of our data and figure out

1404
00:54:35,290 --> 00:54:32,510
exactly what the next things we want to

1405
00:54:38,260 --> 00:54:35,300
test are all right how about turning the

1406
00:54:40,510 --> 00:54:38,270
wheels somewhere around 90 degrees from

1407
00:54:44,140 --> 00:54:40,520
the front back access of the rover and

1408
00:54:45,940 --> 00:54:44,150
trying to go out sideways right well the

1409
00:54:48,580 --> 00:54:45,950
wheels can only steer to about 60

1410
00:54:50,980 --> 00:54:48,590
degrees so we can't quite get to 90 but

1411
00:54:52,480 --> 00:54:50,990
we have done that testing and that

1412
00:54:55,150 --> 00:54:52,490
testing actually looks very promising

1413
00:54:56,740 --> 00:54:55,160

and right now at least that's on my

1414
00:54:59,020 --> 00:54:56,750
personal short list of things that I

1415
00:55:01,030 --> 00:54:59,030
would like to be trying on Mars because

1416
00:55:02,830 --> 00:55:01,040
yeah that can help us not only climb

1417
00:55:05,050 --> 00:55:02,840
uphill away from the sandpit it might

1418
00:55:06,700 --> 00:55:05,060
help pull the left wheels out of the

1419
00:55:10,390 --> 00:55:06,710
fluffy stuff and onto the firmer stuff

1420
00:55:12,910 --> 00:55:10,400
that we see on the right side so yes

1421
00:55:13,150 --> 00:55:12,920
that is that is a very good idea not is

1422
00:55:14,559 --> 00:55:13,160
there

1423
00:55:16,450 --> 00:55:14,569
we on my short list of things to do

1424
00:55:18,460 --> 00:55:16,460
here's a little bit more of a personal

1425
00:55:22,319 --> 00:55:18,470
question and we get this all the time

1426
00:55:27,279 --> 00:55:22,329
how does one get a job as a rover driver

1427
00:55:30,160 --> 00:55:27,289
well me personally I came to JPL right

1428
00:55:31,569 --> 00:55:30,170
before we landed and never had any hopes

1429
00:55:32,710 --> 00:55:31,579
of being able to work on this mission it

1430
00:55:34,599 --> 00:55:32,720
was supposed to be long over before

1431
00:55:37,120 --> 00:55:34,609
anybody would let me anywhere close to

1432
00:55:38,740 --> 00:55:37,130
flight equipment but they lasted so long

1433
00:55:42,039 --> 00:55:38,750
and we're doing so well they had to

1434
00:55:46,660 --> 00:55:42,049
start hiring new people and I'm a PhD in

1435
00:55:47,650 --> 00:55:46,670
robotics robots are what i do and i have

1436
00:55:49,750 --> 00:55:47,660
to say there's a little bit of luck

1437
00:55:52,270 --> 00:55:49,760
involved my boss at the time was doing

1438
00:55:54,549 --> 00:55:52,280

the rover driver job and so he

1439
00:55:56,770 --> 00:55:54,559
recommended me as one of the new people

1440
00:56:00,849 --> 00:55:56,780
to come in and start training you know

1441
00:56:02,559 --> 00:56:00,859
and word is one major in robotics well

1442
00:56:04,750 --> 00:56:02,569
there are two places in the country

1443
00:56:06,130 --> 00:56:04,760
right now that offer PhDs in robotics

1444
00:56:08,230 --> 00:56:06,140
one is Carnegie Mellon which is where I

1445
00:56:10,420 --> 00:56:08,240
went and the other is Georgia Tech but a

1446
00:56:12,160 --> 00:56:10,430
lot of places either in the mechanical

1447
00:56:13,870 --> 00:56:12,170
or electrical or computer science

1448
00:56:15,220 --> 00:56:13,880
department have a lot of Robotics

1449
00:56:17,109 --> 00:56:15,230
researchers so there are lots of places

1450
00:56:18,760 --> 00:56:17,119
you can go to study robotics here's

1451
00:56:20,950 --> 00:56:18,770
another one this is cute has NASA

1452
00:56:24,089 --> 00:56:20,960
considered contracting some dune buggy

1453
00:56:26,829 --> 00:56:24,099
drivers and racers for their suggestions

1454
00:56:28,990 --> 00:56:26,839
well we have certainly solicited you

1455
00:56:30,640 --> 00:56:29,000
know suggestions from anybody out there

1456
00:56:32,109 --> 00:56:30,650
who wants to listen unfortunately what

1457
00:56:34,960 --> 00:56:32,119
the dune buggy drivers have that we

1458
00:56:37,359 --> 00:56:34,970
don't is acceleration these Rovers go at

1459
00:56:39,880 --> 00:56:37,369
something like one twentieth of a mile

1460
00:56:41,799 --> 00:56:39,890
an hour and you just can't build up any

1461
00:56:43,029 --> 00:56:41,809
momentum like you would like to do when

1462
00:56:45,130 --> 00:56:43,039
you're when you're in one of these stuck

1463
00:56:48,849 --> 00:56:45,140

situations you can't get it and mostly

1464
00:56:52,990 --> 00:56:48,859
about it gunning it is is is a very very

1465
00:56:55,240 --> 00:56:53,000
slow kin spirit survive the winter right

1466
00:56:57,609 --> 00:56:55,250
now we've gotten the solar panels nearly

1467
00:57:00,339 --> 00:56:57,619
completely clean and right now it looks

1468
00:57:01,420 --> 00:57:00,349
like if nothing's significantly changes

1469
00:57:03,490 --> 00:57:01,430
if we don't have another major dust

1470
00:57:05,380 --> 00:57:03,500
storm that spirit will be able to

1471
00:57:08,319 --> 00:57:05,390
survive the winter and probably won't

1472
00:57:11,049 --> 00:57:08,329
even have to park great in the simulator

1473
00:57:13,960 --> 00:57:11,059
have you tried to back out we have tried

1474
00:57:15,700 --> 00:57:13,970
going both backwards and forwards the

1475
00:57:18,309 --> 00:57:15,710
difficulty was going backwards on Mars

1476
00:57:20,410 --> 00:57:18,319
is actually not too far behind the rover

1477
00:57:22,150 --> 00:57:20,420
which is almost level that the slope

1478
00:57:23,829 --> 00:57:22,160
significantly increases so we'd actually

1479
00:57:26,230 --> 00:57:23,839
before we go too far we'd actually be

1480
00:57:26,589 --> 00:57:26,240
climbing uphill so we might try to back

1481
00:57:27,700 --> 00:57:26,599
up a

1482
00:57:29,950 --> 00:57:27,710
little bit to get away from whatever

1483
00:57:32,079 --> 00:57:29,960
hazards might be around the wheels and

1484
00:57:33,849 --> 00:57:32,089
then go forward again but yes we have

1485
00:57:35,950 --> 00:57:33,859
been tribbing forward backward uphill

1486
00:57:38,079 --> 00:57:35,960
downhill everything we can we can

1487
00:57:39,609 --> 00:57:38,089
reasonably get the vehicle to do alright

1488
00:57:42,370 --> 00:57:39,619

well we've reached the top of the hour

1489
00:57:44,529 --> 00:57:42,380
but one more question what's the time

1490
00:57:47,710 --> 00:57:44,539
frame for trying all these great ideas

1491
00:57:50,079 --> 00:57:47,720
on spirit well we we want to try these

1492
00:57:51,759 --> 00:57:50,089
combinations of maneuvers first to see

1493
00:57:53,229 --> 00:57:51,769
if there's any set of motions that seem

1494
00:57:54,999 --> 00:57:53,239
to really be able to pull the rover out

1495
00:57:58,269 --> 00:57:55,009
of this and we may be doing that in a

1496
00:58:00,400 --> 00:57:58,279
slightly different soil simulant but

1497
00:58:03,430 --> 00:58:00,410
we're hoping possibly as early as the

1498
00:58:04,960 --> 00:58:03,440
end of the week of august 3rd so towards

1499
00:58:07,029 --> 00:58:04,970
the beginning to middle of August is

1500
00:58:10,239 --> 00:58:07,039
when we really think we'll be starting

1501
00:58:12,130 --> 00:58:10,249
to work on Mars again so we may be

1502
00:58:14,529 --> 00:58:12,140
trying this out in just a few weeks just

1503
00:58:16,599 --> 00:58:14,539
a few weeks and it's you know not soon

1504
00:58:18,849 --> 00:58:16,609
enough we spirit what is ready to go

1505
00:58:20,890 --> 00:58:18,859
well good luck to you and thanks for

1506
00:58:23,049 --> 00:58:20,900
joining us and thanks for joining us in

1507
00:58:24,309 --> 00:58:23,059
the cosmic lounge here at the Jet

1508
00:58:27,069 --> 00:58:24,319
Propulsion Laboratory in Pasadena

1509
00:58:31,839 --> 00:58:27,079
California if you do wish to get updates

1510
00:58:35,109 --> 00:58:31,849
just go to our website WWJ PL nasa gov

1511
00:58:37,809 --> 00:58:35,119
sign up to some of our feeds and also

1512
00:58:39,609 --> 00:58:37,819
Twitter Facebook ustream they're all