
InSight
NASA
Thomas Rosenbaum
Deputy Project Manager
Flight System

1
00:00:05,004 --> 00:00:07,874
[dramatic music]

2
00:00:29,995 --> 00:00:32,732
- Welcome to NASA's Jet
Propulsion Laboratory

3
00:00:32,765 --> 00:00:35,968
in Pasadena, California,
I'm Veronica McGregor.

4
00:00:36,001 --> 00:00:40,573
We are just one day away
from our InSight spacecraft

5
00:00:40,606 --> 00:00:42,675
meeting the atmosphere of Mars

6
00:00:42,708 --> 00:00:44,710
to begin the event that we call

7
00:00:44,743 --> 00:00:47,980
entry, descent, and
landing, or EDL.

8
00:00:48,013 --> 00:00:51,584
It's a nail biting,
six and a half minutes

9
00:00:51,617 --> 00:00:54,720
where numerous things have
to take place perfectly

10
00:00:54,753 --> 00:00:57,657
in order for us to go from
thousands of miles an hour

11
00:00:57,690 --> 00:01:00,626
to a gentle, safe landing speed.

12
00:01:00,659 --> 00:01:02,695
Our speakers today are
gonna describe everything

13
00:01:02,728 --> 00:01:04,864
that must go right
during those minutes.

14
00:01:04,897 --> 00:01:06,599
They're also going to talk about

15
00:01:06,632 --> 00:01:08,634
how we'll be getting
our communications back

16
00:01:08,667 --> 00:01:10,837
from InSight down to Earth
so we know the progress

17
00:01:10,870 --> 00:01:13,573
of the spacecraft, and we're
gonna talk a little bit

18
00:01:13,606 --> 00:01:15,741
about the science that
will be the reward

19
00:01:15,774 --> 00:01:18,778
from this mission
getting to Mars.

20
00:01:18,811 --> 00:01:20,580
Now, before we get
to our speakers,

21
00:01:20,613 --> 00:01:22,582
I just want to tell
everybody right now

22
00:01:22,615 --> 00:01:25,651
to please bookmark
a couple websites

23
00:01:25,684 --> 00:01:27,887
so that you can come
back and join us tomorrow

24
00:01:27,920 --> 00:01:29,722
during the landing event.

25
00:01:29,755 --> 00:01:34,027
You can go to
go.nasa.gov/InSightToolkit

26
00:01:37,029 --> 00:01:39,765
to get a list of every platform

27
00:01:39,798 --> 00:01:42,735
where we will be streaming
the commentary live.

28
00:01:42,768 --> 00:01:45,771
We will begin commentary
at 11:00 a.m. Pacific Time,

29
00:01:45,804 --> 00:01:47,740
2:00 p.m. Eastern Time.

30
00:01:47,773 --> 00:01:50,710
That will give you many
ways that you can enjoy

31
00:01:50,743 --> 00:01:52,745
multiple streams
of full commentary,

32
00:01:52,778 --> 00:01:55,848
clean feeds, and even

a 360 degree broadcast

33
00:01:55,881 --> 00:01:58,017
from inside InSight
mission control,

34
00:01:58,050 --> 00:01:59,719
so you can feel
like you're in there

35
00:01:59,752 --> 00:02:01,053
with the rest of the team.

36
00:02:01,086 --> 00:02:05,758
And also, nasa.gov/live,
that's an even simpler URL

37
00:02:05,791 --> 00:02:07,927
to remember, all
of our programming

38
00:02:07,960 --> 00:02:10,830
is always broadcast
to that website.

39
00:02:12,031 --> 00:02:14,700
Now, following our speaker
presentations today,

40
00:02:14,733 --> 00:02:17,036
we are gonna take questions
from the audience here.

41
00:02:17,069 --> 00:02:19,739
We have media, and we also
have social media followers

42
00:02:19,772 --> 00:02:21,941
here today, thank you
so much for joining us.

43
00:02:21,974 --> 00:02:24,677
If you are calling
in on the phone line,

44
00:02:24,710 --> 00:02:27,880
please remember to hit star,
one, and that will put you

45
00:02:27,913 --> 00:02:28,981
in the queue for questions.

46
00:02:29,014 --> 00:02:31,117
If you are joining
us on social media,

47
00:02:31,150 --> 00:02:35,721
you can send us a question
by using hashtag askNASA,

48
00:02:35,754 --> 00:02:36,923
and we'll be going
to those questions

49
00:02:36,956 --> 00:02:38,124
later in the broadcast.

50
00:02:38,157 --> 00:02:39,825
And for now, I'm
going to introduce

51
00:02:39,858 --> 00:02:42,995
our first speaker today,
it is Thomas Zurbuchen

52
00:02:43,028 --> 00:02:46,098
He is the NASA
Associate Administrator

53

00:02:46,131 --> 00:02:47,133
for the Science
Mission Directorate.

54
00:02:47,166 --> 00:02:49,035
Welcome.
[audience applauding]

55
00:02:49,068 --> 00:02:50,136
- Hey, thanks.

56
00:02:54,707 --> 00:02:55,908
What an exciting day.

57
00:02:55,941 --> 00:02:57,810
I mean, I almost can't
wait, I'm really excited

58
00:02:57,843 --> 00:03:00,880
to go land this thing,
but as we do this,

59
00:03:00,913 --> 00:03:03,049
of course, I stand
back, and as the leader

60
00:03:03,082 --> 00:03:05,718
of NASA Science
Mission Directorate,

61
00:03:05,751 --> 00:03:08,788
I think of the risk
and reward that is part

62
00:03:08,821 --> 00:03:10,690
of every one of these missions.

63
00:03:10,723 --> 00:03:13,159
To go to space
always carries risks.

64
00:03:13,192 --> 00:03:16,963
We don't go take that risk
because we're risk junkies

65
00:03:16,996 --> 00:03:18,064
and jump off airplanes.

66
00:03:18,097 --> 00:03:19,832
Some of us do, but,

67
00:03:19,865 --> 00:03:20,967
[audience laughing]

68
00:03:21,000 --> 00:03:22,702
most of us don't,
we take the risk

69
00:03:22,735 --> 00:03:26,105
because it takes that
risk to have that reward,

70
00:03:26,138 --> 00:03:29,909
the reward that has
opened our understanding

71
00:03:29,942 --> 00:03:33,012
of worlds near and
far, the reward

72
00:03:33,045 --> 00:03:35,915
that has transformed not only
how we think about nature,

73
00:03:35,948 --> 00:03:37,917
but has really
opened up the world

74
00:03:37,950 --> 00:03:40,186

in which we live and think in.

75
00:03:40,219 --> 00:03:42,855
And so, whenever we
look at that risk,

76
00:03:42,888 --> 00:03:47,894
kind of, Mars stands tall
in that risk distribution.

77
00:03:48,761 --> 00:03:50,730
And to talk about Mars,

78
00:03:50,763 --> 00:03:54,066
we recognize that we never
take Mars for granted.

79
00:03:54,099 --> 00:03:55,801
Mars is hard.

80
00:03:55,834 --> 00:04:00,907
And so, on the first
chart here are the landers

81
00:04:01,974 --> 00:04:04,043
and rovers that we've
landed here out of NASA.

82
00:04:04,076 --> 00:04:07,813
You see the ones, you
recognize many of them,

83
00:04:07,846 --> 00:04:09,915
and of course, they're
all the landers

84
00:04:09,948 --> 00:04:12,918
that humanities, and
rovers, that humanity

85
00:04:12,951 --> 00:04:16,222
has ever landed
successfully on Mars.

86
00:04:16,255 --> 00:04:18,791
Each one of them with
the same kind of sweat

87
00:04:18,824 --> 00:04:21,894
and worry that I have right
now in my stomach area.

88
00:04:23,062 --> 00:04:25,999
And of course, the one
there at the bottom,

89
00:04:27,900 --> 00:04:31,771
we hope, of course, will
increase our likelihood,

90
00:04:31,804 --> 00:04:35,908
our batting average,
to you, Jeff,

91
00:04:38,811 --> 00:04:40,212
on Mars landers and rovers.

92
00:04:40,245 --> 00:04:42,882
Now, when I think about this,

93
00:04:42,915 --> 00:04:44,950
it's important to look
at this in a context

94
00:04:44,983 --> 00:04:48,087
of all missions that we
see on the second chart.

95
00:04:48,120 --> 00:04:50,022

All missions, you don't
really have to look at

96
00:04:50,055 --> 00:04:52,858
any one of those, but
you see all these names,

97
00:04:52,891 --> 00:04:56,028
that's all the missions that
have ever been sent to Mars,

98
00:04:56,061 --> 00:04:59,999
orbiters, landers, and rovers,

99
00:05:00,032 --> 00:05:04,837
and these are the ones
that were successful.

100
00:05:04,870 --> 00:05:08,040
Less than half of the
words that were there

101
00:05:08,073 --> 00:05:09,842
at the beginning are now there,

102
00:05:09,875 --> 00:05:13,079
so we're, of course, worried,
and what I ask myself,

103
00:05:13,112 --> 00:05:15,281
did we do everything that we
could to support the team,

104
00:05:15,314 --> 00:05:20,119
and having met the team
and meeting with the team,

105
00:05:20,152 --> 00:05:22,254
the answer to that is
yes, and we're pulling

106
00:05:22,287 --> 00:05:23,989
for the team, right now.

107
00:05:24,022 --> 00:05:26,158
For me, the hardest thing
is to sit on my hands,

108
00:05:26,191 --> 00:05:28,127
because there's nothing I can do

109
00:05:28,160 --> 00:05:30,096
to make the team more successful

110
00:05:30,129 --> 00:05:33,899
other than standing there
and hoping and praying

111
00:05:33,932 --> 00:05:35,301
that everything is
gonna be just fine

112
00:05:35,334 --> 00:05:39,271
because they're doing exactly
what they're supposed to do.

113
00:05:39,304 --> 00:05:43,042
And I'm just so excited
to be part of that team,

114
00:05:43,075 --> 00:05:45,044
and hopefully, as we go through

115
00:05:45,077 --> 00:05:47,947
these seven minutes of terror,

116
00:05:47,980 --> 00:05:50,316
kind of increasing
the likelihood

117
00:05:50,349 --> 00:05:53,285
of humanity to
actually land on Mars

118
00:05:53,318 --> 00:05:57,022
with this amazing vehicle
that is out there,

119
00:05:57,055 --> 00:05:59,058
ready to land and
that will, again,

120
00:05:59,091 --> 00:06:03,062
transform our knowledge
of this amazing planet

121
00:06:03,095 --> 00:06:04,163
that's right next to us.

122
00:06:04,196 --> 00:06:07,099
And to introduce
us to this mission,

123
00:06:07,132 --> 00:06:11,036
I'm happy to welcome now,
Tom Hoffman on stage,

124
00:06:11,069 --> 00:06:13,072
a project manager of InSight.

125
00:06:13,105 --> 00:06:17,076
Tom, take it away.
[audience applauding]

126
00:06:21,113 --> 00:06:22,314
- Thank you so much, Thomas.

127
00:06:22,347 --> 00:06:25,951

So, as many people
have, for Thanksgiving,

128
00:06:25,984 --> 00:06:28,221
you have your family
around, and luckily,

129
00:06:29,388 --> 00:06:31,257
I was fortunate enough to have
my three grandsons around,

130
00:06:31,290 --> 00:06:33,359
Connor, Declan,
and Evan, and boy,

131
00:06:33,392 --> 00:06:36,061
when they get excited, they
run around like crazy men,

132
00:06:36,094 --> 00:06:38,130
raising their hands,
yelling, screaming,

133
00:06:38,163 --> 00:06:40,266
carrying on, and I
have to tell you,

134
00:06:40,299 --> 00:06:43,202
inside of me right now, I'm
just about that same way.

135
00:06:43,235 --> 00:06:44,336
[audience laughing]

136
00:06:44,369 --> 00:06:47,039
I'm gonna control
myself as well as I can,

137
00:06:47,072 --> 00:06:49,074
until we get a

first notification

138
00:06:49,107 --> 00:06:52,044
of successful landing,
but just to warn anybody

139
00:06:52,077 --> 00:06:53,379
who's sitting near
me after that,

140
00:06:53,412 --> 00:06:55,314
I'm gonna unleash my inner
four year old on you,

141
00:06:55,347 --> 00:06:57,183
so be careful.
[audience laughing]

142
00:06:57,216 --> 00:07:00,119
So as Thomas said,
though, landing on Mars

143
00:07:00,152 --> 00:07:02,021
is never a foregone conclusion,

144
00:07:02,054 --> 00:07:03,189
and less than half of the times

145
00:07:03,222 --> 00:07:05,191
we've tried to
either get into orbit

146
00:07:05,224 --> 00:07:08,093
or land on Mars, we have
not been successful.

147
00:07:08,126 --> 00:07:09,929
So you might ask
yourself, why is that?

148
00:07:09,962 --> 00:07:12,131
We've tried a lot, why
is this not simple,

149
00:07:12,164 --> 00:07:13,999
easy thing that we
can do every day?

150
00:07:14,032 --> 00:07:15,234
So we go to the first graphic,

151
00:07:15,267 --> 00:07:17,937
I can give you a little
bit of explanation of that.

152
00:07:17,970 --> 00:07:19,371
So on the Earth, we
have a very large

153
00:07:19,404 --> 00:07:22,274
gravitational field, but
we have a thick atmosphere

154
00:07:22,307 --> 00:07:25,044
that's very big, so we
can actually dissipate

155
00:07:25,077 --> 00:07:27,213
the energy for entry
vehicles pretty easily

156
00:07:27,246 --> 00:07:29,248
with that thick
atmosphere, and usually,

157
00:07:29,281 --> 00:07:32,084
can get a good soft landing,
usually in the ocean,

158

00:07:32,117 --> 00:07:34,019
for Apollo, at least.

159
00:07:34,052 --> 00:07:35,254
The Moon, on the other hand,

160
00:07:35,287 --> 00:07:37,223
doesn't have much of
a gravitational pull,

161
00:07:37,256 --> 00:07:39,158
and it has not atmosphere,

162
00:07:39,191 --> 00:07:41,293
so that makes it a little
bit easier, as well,

163
00:07:41,326 --> 00:07:44,997
to land on the Moon using
propulsive technology.

164
00:07:45,030 --> 00:07:48,133
Mars is basically the
worst of both worlds.

165
00:07:48,166 --> 00:07:50,970
We have an atmosphere
that's about 1%

166
00:07:51,003 --> 00:07:52,238
of the Earth's
atmosphere, and yet,

167
00:07:52,271 --> 00:07:54,206
we have a gravitational
field that's about 1/3

168
00:07:54,239 --> 00:07:57,042
of the pull of Earth,
and so what that means

169
00:07:57,075 --> 00:07:59,345
is we have very little
energy in the atmosphere

170
00:07:59,378 --> 00:08:02,414
that we can dissipate as
we enter the atmosphere,

171
00:08:02,447 --> 00:08:05,417
we have very little
ability to slow down

172
00:08:05,450 --> 00:08:06,452
until we get to the surface,

173
00:08:06,485 --> 00:08:08,187
so it makes it very challenging

174
00:08:08,220 --> 00:08:10,422
for us to land on Mars, and
that's one of the main reasons

175
00:08:10,455 --> 00:08:12,458
why it is very challenging.

176
00:08:12,491 --> 00:08:14,460
We've done everything we can,

177
00:08:14,493 --> 00:08:16,161
we've done everything
we can think of

178
00:08:16,194 --> 00:08:18,330
to make sure that we're
gonna be successful tomorrow,

179
00:08:18,363 --> 00:08:20,399
but you just never know

what's gonna happen.

180
00:08:20,432 --> 00:08:22,301
But let's explain
a little bit about

181
00:08:22,334 --> 00:08:24,236
what is gonna happen tomorrow,

182
00:08:24,269 --> 00:08:28,307
but first, we launched in
May, fifth of this year,

183
00:08:28,340 --> 00:08:29,441
from the Vandenberg
Air Force Base,

184
00:08:29,474 --> 00:08:31,410
the very first
time we've launched

185
00:08:31,443 --> 00:08:34,013
inter-planetary mission
from California.

186
00:08:34,046 --> 00:08:35,281
Very exciting, not very visible,

187
00:08:35,314 --> 00:08:37,283
but still very exciting event.

188
00:08:37,316 --> 00:08:39,285
Since then, we've
been doing a series

189
00:08:39,318 --> 00:08:41,120
of checkouts of the engineering,

190
00:08:41,153 --> 00:08:42,288

the science instruments
to make sure

191
00:08:42,321 --> 00:08:45,357
that we're fully ready
once we go through EDL

192
00:08:45,390 --> 00:08:48,093
and once we get to the
surface and start the science.

193
00:08:48,126 --> 00:08:49,395
Everything's ready to
go, all those checkouts

194
00:08:49,428 --> 00:08:53,098
have gone very well, we've
also been doing things

195
00:08:53,131 --> 00:08:55,434
called trajectory correction
maneuvers, or TCMs.

196
00:08:55,467 --> 00:08:58,370
And what those are designed
to do is first get us pointed

197
00:08:58,403 --> 00:09:00,239
at Mars, the first
couple ones that we did

198
00:09:00,272 --> 00:09:02,074
pointed us directly at Mars.

199
00:09:02,107 --> 00:09:04,076
We weren't pointed
there when we launched.

200
00:09:04,109 --> 00:09:06,245
After that, the last

couple have been designed

201
00:09:06,278 --> 00:09:08,047
to get us to a
very specific point

202
00:09:08,080 --> 00:09:10,549
in the upper atmosphere
that will get us

203
00:09:10,582 --> 00:09:13,085
to a very specific
point on the ground.

204
00:09:13,118 --> 00:09:14,420
So let's run the
video, and we can see

205
00:09:14,453 --> 00:09:17,156
what we've been
doing since we, okay,

206
00:09:17,189 --> 00:09:22,194
since we landed, okay, so
here is our target area,

207
00:09:23,295 --> 00:09:25,097
right here, this is
where we wanna land,

208
00:09:25,130 --> 00:09:27,132
at Elysium Planitia,

209
00:09:27,165 --> 00:09:32,171
after our TCM number
five, we were right here.

210
00:09:33,271 --> 00:09:35,374
You can see what
the date is, here,

211
00:09:35,407 --> 00:09:37,076
I'm sorry, this
is after TCM four.

212
00:09:37,109 --> 00:09:38,544
You can see what
the date is here,

213
00:09:38,577 --> 00:09:40,312
and I'm not gonna,
don't run it yet,

214
00:09:40,345 --> 00:09:41,280
but when it starts running,

215
00:09:41,313 --> 00:09:42,414
what you'll see is this ellipse,

216
00:09:42,447 --> 00:09:44,383
this is our landing ellipse,

217
00:09:44,416 --> 00:09:46,452
it's gonna start moving
around just a little bit.

218
00:09:46,485 --> 00:09:49,121
What that is is the
DSN is tracking us,

219
00:09:49,154 --> 00:09:50,322
we're getting very
good information

220
00:09:50,355 --> 00:09:51,557
about where we're gonna land,

221
00:09:53,191 --> 00:09:54,259
so it moves around

just a little bit

222
00:09:54,292 --> 00:09:56,295
as our knowledge improves.

223
00:09:56,328 --> 00:09:59,431
After we did the TCM,
on November 18th,

224
00:09:59,464 --> 00:10:01,300
you'll see that we
suddenly leap up here,

225
00:10:01,333 --> 00:10:04,303
very close to where we
want to be with our target.

226
00:10:04,336 --> 00:10:05,571
What's gonna happen is,
then it's gonna start

227
00:10:05,604 --> 00:10:07,272
moving around a little bit more,

228
00:10:07,305 --> 00:10:09,441
again, as we've gotten
more tracking data,

229
00:10:09,474 --> 00:10:11,443
we know that we're getting
closer and closer to target.

230
00:10:11,476 --> 00:10:13,245
So let's go ahead and run that,

231
00:10:13,278 --> 00:10:14,513
and that's what
you're gonna see.

232

00:10:14,546 --> 00:10:16,215
So you can see it's moving
around just a little bit,

233
00:10:16,248 --> 00:10:17,349
our knowledge is getting better,

234
00:10:17,382 --> 00:10:18,517
it's not really the
spacecraft changing,

235
00:10:18,550 --> 00:10:20,519
it's just our knowledge
getting better.

236
00:10:21,620 --> 00:10:26,392
So after TCM five,
we ended up here,

237
00:10:26,425 --> 00:10:29,361
which is not quite
exactly on the red X.

238
00:10:29,394 --> 00:10:31,130
We're about 11 miles away.

239
00:10:31,163 --> 00:10:34,166
We moved 109 miles
with that TCM five,

240
00:10:34,199 --> 00:10:35,601
we're still about 11 miles away,

241
00:10:35,634 --> 00:10:38,170
so just this morning we
had a decision meeting,

242
00:10:38,203 --> 00:10:40,139
whether we were gonna
perform our last

243
00:10:40,172 --> 00:10:42,141
trajectory correction
maneuver or not,

244
00:10:42,174 --> 00:10:43,442
and we decided at
6:00 a.m. that yes,

245
00:10:43,475 --> 00:10:45,210
indeed, we're gonna do it.

246
00:10:45,243 --> 00:10:48,414
We want to avoid
the area up here.

247
00:10:48,447 --> 00:10:50,349
That's not a great area to land,

248
00:10:50,382 --> 00:10:52,317
so we want to move
down to this target,

249
00:10:52,350 --> 00:10:53,619
so we're gonna be
performing that

250
00:10:53,652 --> 00:10:56,221
a few hours from
now, and hopefully

251
00:10:56,254 --> 00:10:58,290
within a few hours after that,

252
00:10:58,323 --> 00:10:59,491
we're gonna know exactly
where we're landing again,

253
00:10:59,524 --> 00:11:01,560

so things should
be in good shape.

254
00:11:03,261 --> 00:11:06,465
So when we actually get there,
after completing the TCM,

255
00:11:06,498 --> 00:11:09,402
we will be looking
exactly like this.

256
00:11:10,569 --> 00:11:13,205
This is what our spacecraft
looks like today.

257
00:11:13,238 --> 00:11:16,275
We have the cruise stage
here, and the aeroshell

258
00:11:16,308 --> 00:11:18,510
is on this side, we're gonna
be in this configuration

259
00:11:18,543 --> 00:11:22,448
until about seven minutes
before we enter the atmosphere.

260
00:11:22,481 --> 00:11:25,317
At that point, we'll say
goodbye to the cruise stage,

261
00:11:25,350 --> 00:11:26,618
we'll say a thank
you for getting us

262
00:11:26,651 --> 00:11:29,555
a nice ride to Mars,
you're on your own now.

263
00:11:29,588 --> 00:11:32,591

This will go into that Mars
atmosphere and burn up,

264
00:11:32,624 --> 00:11:35,361
and then we will be left
with just the aeroshell,

265
00:11:36,461 --> 00:11:37,663
so this, inside
of this aeroshell

266
00:11:37,696 --> 00:11:40,399
is our lander that's tucked
in there very safely,

267
00:11:40,432 --> 00:11:42,534
we have a heat
shield on this side.

268
00:11:42,567 --> 00:11:45,237
As we enter the atmosphere,
that heat shield

269
00:11:45,270 --> 00:11:47,673
is gonna dissipate about 90%
of the energy that we have

270
00:11:47,706 --> 00:11:51,376
as it enters the atmosphere,
eventually slowing us down

271
00:11:51,409 --> 00:11:54,213
to about 850 miles an
hour, at which point,

272
00:11:54,246 --> 00:11:56,348
we'll pop a parachute,
that parachute

273
00:11:56,381 --> 00:11:59,618

will then slow us about 90%
of the remaining energy down,

274
00:11:59,651 --> 00:12:01,320
and then we will
get to the point

275
00:12:01,353 --> 00:12:03,322
where the lander takes
over, so let's go ahead

276
00:12:03,355 --> 00:12:05,390
and run the video,
and we can show that

277
00:12:05,423 --> 00:12:07,292
a little clearer, so
there's our cruise stage.

278
00:12:07,325 --> 00:12:09,395
Goodbye, cruise stage,
you're on your own.

279
00:12:10,562 --> 00:12:13,232
The rest of the aeroshell
starts to enter the atmosphere,

280
00:12:13,265 --> 00:12:15,400
it heats up to about
3,000 degrees Fahrenheit

281
00:12:15,433 --> 00:12:17,603
in certain areas on
that heat shield.

282
00:12:17,636 --> 00:12:20,405
That's gonna dissipate a
fair amount of the energy,

283
00:12:20,438 --> 00:12:21,707

getting us to the point
where we feel comfortable

284
00:12:21,740 --> 00:12:23,575
popping the parachute,
but we're still doing that

285
00:12:23,608 --> 00:12:26,345
at a supersonic
speed, and so that

286
00:12:26,378 --> 00:12:28,413
is a very exciting
moment for us,

287
00:12:28,446 --> 00:12:30,415
to make sure that we
get that parachute out.

288
00:12:30,448 --> 00:12:32,718
As we descend further, we'll
let go of that heat shield.

289
00:12:32,751 --> 00:12:35,621
You can now see the
lander inside of there.

290
00:12:35,654 --> 00:12:39,291
The legs will deploy, we'll
start collecting radar data

291
00:12:39,324 --> 00:12:41,560
using an F-16 like
radar to figure out

292
00:12:41,593 --> 00:12:44,696
what our altitude and
our relative velocity is.

293
00:12:44,729 --> 00:12:46,498

We'll free fall for
just a little bit,

294
00:12:46,531 --> 00:12:48,667
which is a absolutely
terrifying thought for me,

295
00:12:48,700 --> 00:12:51,603
but, I've been told
our descent thrusters

296
00:12:51,636 --> 00:12:53,739
will then start
firing perfectly well,

297
00:12:53,772 --> 00:12:56,675
slowing us down to about
five miles an hour,

298
00:12:56,708 --> 00:12:58,610
once we finally get to
the surface of Mars.

299
00:12:58,643 --> 00:13:00,546
So, within about six
and a half minutes,

300
00:13:00,579 --> 00:13:03,415
we've gone from
12,300 miles an hour,

301
00:13:03,448 --> 00:13:05,751
as we entered the atmosphere,
to just five miles an hour

302
00:13:05,784 --> 00:13:09,288
as we land safely on
the surface of Mars.

303
00:13:09,321 --> 00:13:10,489

And where we're
gonna land is a place

304
00:13:10,522 --> 00:13:13,492
called Elysium Planitia,
which very roughly translated

305
00:13:13,525 --> 00:13:16,361
means heavenly
plain, and indeed,

306
00:13:16,394 --> 00:13:18,730
it is a very heavenly
plain, and it is very plain,

307
00:13:18,763 --> 00:13:21,400
but it is actually
perfect, it's safe,

308
00:13:21,433 --> 00:13:23,302
it's a great place,
not only to land,

309
00:13:23,335 --> 00:13:25,537
it's a great place to do the
science that we wanna do.

310
00:13:25,570 --> 00:13:27,606
So when we first land, we're
gonna get a picture back,

311
00:13:27,639 --> 00:13:29,641
hopefully right away,
it's probably not gonna be

312
00:13:29,674 --> 00:13:31,643
a very good picture, so
don't get your expectations

313
00:13:31,676 --> 00:13:34,346

up too high, and there'll be
a little bit of the picture

314
00:13:34,379 --> 00:13:36,481
that's actually
missing, the reason is,

315
00:13:36,514 --> 00:13:38,717
is we have a dust cover,
and that dust cover's

316
00:13:38,750 --> 00:13:40,586
gonna be absorbing
a lot of the dust

317
00:13:40,619 --> 00:13:42,454
that gets kicked up
from the landing event,

318
00:13:42,487 --> 00:13:45,457
and then, with our
overflight of MarCO and MRO,

319
00:13:45,490 --> 00:13:47,459
we're only gonna get
a part of that image.

320
00:13:47,492 --> 00:13:49,428
Eventually though, we're
gonna get an image back

321
00:13:49,461 --> 00:13:51,597
that looks something like this.

322
00:13:51,630 --> 00:13:53,699
Not the most
exciting place to be,

323
00:13:53,732 --> 00:13:55,734
but, again, it's

a very safe place,

324
00:13:55,767 --> 00:13:57,569
and in fact, I'm very hopeful

325
00:13:57,602 --> 00:14:00,572
that we have even less
rocks, it's even more sandy,

326
00:14:00,605 --> 00:14:04,409
and even more, dare
I say boring, okay?

327
00:14:04,442 --> 00:14:06,412
But indeed, that's
what I'm hoping for,

328
00:14:07,545 --> 00:14:09,548
but before we get there,
we have to go through

329
00:14:09,581 --> 00:14:11,650
our entry, descent, and
landing, and so we do that

330
00:14:11,683 --> 00:14:13,452
up in the mission support area,

331
00:14:13,485 --> 00:14:15,821
and I have a friend of mine up
in the mission support area,

332
00:14:15,854 --> 00:14:18,590
Julie Wertz Chen,
who is up there now.

333
00:14:18,623 --> 00:14:21,560
Hopefully she can come
on, Julie, are you there?

334
00:14:21,593 --> 00:14:23,562
- I'm here, Tom.
- Okay, great.

335
00:14:23,595 --> 00:14:24,696
- You're in a very
historic place.

336
00:14:24,729 --> 00:14:26,732
Can you tell us a little
bit about where you are?

337
00:14:26,765 --> 00:14:29,835
- Sure, this is the Critical
Events Mission Support Area.

338
00:14:29,868 --> 00:14:34,573
It was originally
built in around 2000,

339
00:14:34,606 --> 00:14:36,675
in order for teams
to come together

340
00:14:36,708 --> 00:14:38,644
to watch critical events.

341
00:14:38,677 --> 00:14:41,546
We first used the room in
2001 for the orbit insertion

342
00:14:41,579 --> 00:14:44,516
for Mars Odyssey,
and we've used it

343
00:14:44,549 --> 00:14:46,585
to watch all critical
or major events

344

00:14:46,618 --> 00:14:48,654
for every outer planets mission

345
00:14:48,687 --> 00:14:50,489
that JPL has flown since then.

346
00:14:50,522 --> 00:14:51,857
You might very well
recognize this room

347
00:14:51,890 --> 00:14:54,860
from the MER landings,
Mars Exploration Rovers,

348
00:14:54,893 --> 00:14:57,763
Spirit and Opportunity,
or from Deep Impact's

349
00:14:57,796 --> 00:15:00,732
comet encounter, or from
the last successful landing

350
00:15:00,765 --> 00:15:03,835
on Mars, Curiosity, six
years ago, or of course,

351
00:15:03,868 --> 00:15:07,773
the very emotional Cassini
Grand Finale, just last year.

352
00:15:07,806 --> 00:15:08,874
This room has been the backdrop

353
00:15:08,907 --> 00:15:12,544
to numerous really
really exciting events

354
00:15:12,577 --> 00:15:14,646
in planetary
exploration history,

355
00:15:14,679 --> 00:15:16,782
and we're really excited
to add to that list

356
00:15:16,815 --> 00:15:19,551
with InSight's landing
on Mars tomorrow.

357
00:15:19,584 --> 00:15:20,786
- Wow, that's great.

358
00:15:20,819 --> 00:15:22,454
Can you tell me a
little bit about

359
00:15:22,487 --> 00:15:23,855
what the people will
be doing in there,

360
00:15:23,888 --> 00:15:25,724
landing day tomorrow?

361
00:15:25,757 --> 00:15:28,593
- Yeah, so the very back row

362
00:15:28,626 --> 00:15:31,830
will have some NASA management
and some project management,

363
00:15:31,863 --> 00:15:34,700
so Tom, yourself
and Bruce and Thomas

364
00:15:34,733 --> 00:15:36,635
will all be in that back row.

365
00:15:36,668 --> 00:15:40,439
Up here in this row will be

more of the project people,

366
00:15:40,472 --> 00:15:43,775
so on the very far end of this
row will be the navigators.

367
00:15:43,808 --> 00:15:44,876
They're the ones
who have told us

368
00:15:44,909 --> 00:15:46,878
how to get to exactly
where we are right now.

369
00:15:46,911 --> 00:15:49,848
Next to them along this
row will be a subset

370
00:15:49,881 --> 00:15:51,516
of the entry,
descent and landing

371
00:15:51,549 --> 00:15:52,918
systems engineering team.

372
00:15:52,951 --> 00:15:54,786
We're the folks who
have really focused in

373
00:15:54,819 --> 00:15:55,887
on this phase of the mission,

374
00:15:55,920 --> 00:15:58,757
have really spent years
getting all the details

375
00:15:58,790 --> 00:16:01,593
of these couple of
minutes just right.

376
00:16:01,626 --> 00:16:03,562
And then, as you come up here,

377
00:16:03,595 --> 00:16:05,831
here, more of the people
who are gonna be focusing

378
00:16:05,864 --> 00:16:08,600
on communication during landing,

379
00:16:08,633 --> 00:16:11,603
so radio science people
will be right there.

380
00:16:11,636 --> 00:16:12,871
They are the ones who
are eavesdropping in

381
00:16:12,904 --> 00:16:14,873
on our signal from all the
way back here on earth,

382
00:16:14,906 --> 00:16:17,542
trying to tell us some very
basic state information,

383
00:16:17,575 --> 00:16:18,877
from all the way back here.

384
00:16:18,910 --> 00:16:20,912
The MarCO engineers,
the CubeSets,

385
00:16:20,945 --> 00:16:23,882
will be over there,
and they'll, of course,

386
00:16:23,915 --> 00:16:27,552
be trying to relay our very

detailed InSight telemetry

387
00:16:27,585 --> 00:16:29,755
to us and then right in
the middle of everybody,

388
00:16:29,788 --> 00:16:31,590
right here, is Sandy Krasner,

389
00:16:31,623 --> 00:16:33,525
he's someone to keep
an eye on tomorrow,

390
00:16:33,558 --> 00:16:35,660
'cause he's our EDL
communications engineer,

391
00:16:35,693 --> 00:16:38,663
and he'll really be the one
who's coordinating everything

392
00:16:38,696 --> 00:16:42,734
to try and get that data from
the lander up to the orbiters,

393
00:16:42,767 --> 00:16:46,538
back here to earth, and onto
these wonderful work stations.

394
00:16:46,571 --> 00:16:47,773
- Oh, that's cool.

395
00:16:47,806 --> 00:16:49,808
Now, since it's just you
and me talking right now.

396
00:16:49,841 --> 00:16:51,510
[audience laughing]

397

00:16:51,543 --> 00:16:54,946
Sh, can you maybe give
me a sneak preview

398
00:16:54,979 --> 00:16:56,581
of some of the data displays

399
00:16:56,614 --> 00:16:58,550
that you're gonna be
looking at tomorrow?

400
00:16:58,583 --> 00:17:01,686
- Sure, just between
you and me, no problem.

401
00:17:01,719 --> 00:17:03,588
We'll be looking at lots
of different things.

402
00:17:03,621 --> 00:17:05,757
I think you're
looking at a snapshot

403
00:17:05,790 --> 00:17:08,627
of one of the telemetry pages
that we'll be looking at.

404
00:17:08,660 --> 00:17:10,562
You can see, up in
the left hand side,

405
00:17:10,595 --> 00:17:12,664
we get short messages
from the spacecraft

406
00:17:12,697 --> 00:17:16,601
that tell us where in the
sequence we are, of events,

407
00:17:16,634 --> 00:17:18,537

you can also see, over
on the right hand side,

408
00:17:18,570 --> 00:17:19,638
that there's a lot of data

409
00:17:19,671 --> 00:17:20,906
that just isn't
even filled in yet,

410
00:17:20,939 --> 00:17:23,542
and that's because we haven't
started the EDL sequence yet,

411
00:17:23,575 --> 00:17:25,644
so all of that will
start filling in tomorrow

412
00:17:25,677 --> 00:17:27,045
when we start doing
this, and of course,

413
00:17:27,078 --> 00:17:28,914
we'll be looking at
lots of other pages too.

414
00:17:28,947 --> 00:17:30,615
We'll be looking
at accelerations

415
00:17:30,648 --> 00:17:32,818
and velocities and
thruster firings,

416
00:17:32,851 --> 00:17:35,854
and there'll be all sorts
of good information.

417
00:17:35,887 --> 00:17:37,722
- Well, that's cool,

and I know you have

418
00:17:37,755 --> 00:17:40,659
a really really cool
special job on landing day.

419
00:17:40,692 --> 00:17:42,694
Can you describe
that to everybody?

420
00:17:42,727 --> 00:17:45,864
- Sure, I'm extremely
honored to be sitting up

421
00:17:45,897 --> 00:17:48,834
in the front row with Devin
Kipp and Christine Szalai,

422
00:17:48,867 --> 00:17:51,002
and we'll be watching
this telemetry real time,

423
00:17:51,035 --> 00:17:53,572
whatever we have, and
trying to interpret it

424
00:17:53,605 --> 00:17:55,974
in real time, and Christine
will be calling out events

425
00:17:56,007 --> 00:17:57,876
to let everybody know
what's happening,

426
00:17:57,909 --> 00:17:59,978
so it should be fun.
- That's great.

427
00:18:00,011 --> 00:18:02,914
I hope you guys have all

brushed up on spacecraft.

428
00:18:02,947 --> 00:18:05,817
- That's right.
[audience chuckles]

429
00:18:05,850 --> 00:18:07,052
- All right, that's fantastic.

430
00:18:07,085 --> 00:18:09,821
So as Julie mentioned, we
have a lot of different ways

431
00:18:09,854 --> 00:18:11,690
that we're gonna be
getting information back

432
00:18:11,723 --> 00:18:14,960
from InSight during our entry,
descent, and landing phase.

433
00:18:14,993 --> 00:18:16,761
The first and primary source is

434
00:18:16,794 --> 00:18:19,598
Mars Reconnaissance Orbiter,
so it's gonna be gathering

435
00:18:19,631 --> 00:18:21,833
all the data that
we see from InSight

436
00:18:21,866 --> 00:18:24,669
as it goes through the
entry, descent, and landing,

437
00:18:24,702 --> 00:18:26,605
but it's gonna store that data

438

00:18:26,638 --> 00:18:27,806
and it's not gonna
tell us what happened

439
00:18:27,839 --> 00:18:29,641
for about three hours,
which is a little bit

440
00:18:29,674 --> 00:18:31,643
of delayed gratification,
especially for me.

441
00:18:31,676 --> 00:18:33,912
I'm gonna be very nervous,
I wanna know right now.

442
00:18:33,945 --> 00:18:36,815
We have another source,
which is our UHF antenna

443
00:18:36,848 --> 00:18:38,984
that will be listened to
directly on the earth.

444
00:18:39,017 --> 00:18:41,786
We have two observatories,
the Green Bank Observatory

445
00:18:41,819 --> 00:18:44,856
in West Virginia, we also have
the Max Planck Observatory

446
00:18:44,889 --> 00:18:46,091
in Effelsberg, Germany.

447
00:18:46,124 --> 00:18:48,827
They'll be listening
to see Doppler shifts,

448
00:18:48,860 --> 00:18:50,762

so we expect that
we will probably see

449
00:18:50,795 --> 00:18:52,931
the parachute
deployment, we might see

450
00:18:52,964 --> 00:18:55,901
heat shield separation,
and we'll definitely know

451
00:18:55,934 --> 00:18:58,036
that we've landed
on the surface.

452
00:18:58,069 --> 00:19:00,906
Again, that's not a
lot of information.

453
00:19:00,939 --> 00:19:03,842
We also have to wait about
five and a half hours

454
00:19:03,875 --> 00:19:05,977
to see that we finally got
our solar arrays deployed,

455
00:19:06,010 --> 00:19:07,779
which is a key
part of making sure

456
00:19:07,812 --> 00:19:08,914
that we're safely
on the surface,

457
00:19:08,947 --> 00:19:10,815
ready to get our science back.

458
00:19:10,848 --> 00:19:12,817
We're not gonna get that for

about five and a half hours

459
00:19:12,850 --> 00:19:15,687
from Odyssey, so all of
that is lots of hours

460
00:19:15,720 --> 00:19:16,955
of delayed gratification.

461
00:19:16,988 --> 00:19:19,791
We do get an X-band beep
from the spacecraft though,

462
00:19:19,824 --> 00:19:21,826
that tells us that
the spacecraft

463
00:19:21,859 --> 00:19:23,128
is arrived down on the surface,

464
00:19:23,161 --> 00:19:26,131
it says, it's taken me
seven months to get here,

465
00:19:26,164 --> 00:19:28,733
you've put me through
seven minutes of terror,

466
00:19:28,766 --> 00:19:30,769
but nonetheless, I'm
safely on the surface,

467
00:19:30,802 --> 00:19:33,772
it's my safe call
home, everything's
looking good so far,

468
00:19:33,805 --> 00:19:36,708
but that still happens before
the solar arrays deploy.

469
00:19:36,741 --> 00:19:38,843
So, because of all that
delayed gratification,

470
00:19:38,876 --> 00:19:41,179
we decided that we'd bring
a couple of stalkers with us

471
00:19:41,212 --> 00:19:45,050
called the MarCO spacecraft,
and what those spacecraft do

472
00:19:45,083 --> 00:19:47,986
is they'll be listening
to us real time,

473
00:19:48,019 --> 00:19:50,922
as we go through the entry,
descent, and landing,

474
00:19:50,955 --> 00:19:52,824
they'll be looking
at our UHF signal,

475
00:19:52,857 --> 00:19:54,059
and immediately
turning it around

476
00:19:54,092 --> 00:19:56,795
and sending an X-band
signal down to the earth.

477
00:19:56,828 --> 00:19:58,797
So, if we run an animation,

478
00:19:58,830 --> 00:19:59,898
I can show you exactly
how that works.

479
00:19:59,931 --> 00:20:01,733
So you can see, in
the middle is InSight.

480
00:20:01,766 --> 00:20:04,002
On each side are the two
MarCOs, MarCO A and B,

481
00:20:04,035 --> 00:20:07,806
in the horizon, Mars
Reconnaissance Orbiter, or MRO,

482
00:20:07,839 --> 00:20:09,741
is rising, so all of
those are listening

483
00:20:09,774 --> 00:20:12,777
to the spacecraft, getting
exactly the same data,

484
00:20:12,810 --> 00:20:14,913
but again, the MarCOs
should be sending us

485
00:20:14,946 --> 00:20:16,214
direct information back.

486
00:20:16,247 --> 00:20:18,049
They are a technology
demonstration,

487
00:20:18,082 --> 00:20:20,952
so it's no guarantee
that they're gonna
work on landing day.

488
00:20:20,985 --> 00:20:22,120
They've been working
great so far,

489
00:20:22,153 --> 00:20:23,755
so we expect that they will,

490
00:20:23,788 --> 00:20:25,890
but you just never know
what's gonna happen.

491
00:20:25,923 --> 00:20:29,027
As the entry, descent,
and landing goes through,

492
00:20:29,060 --> 00:20:32,030
that information goes to
both MRO and the MarCOs.

493
00:20:32,063 --> 00:20:34,199
Hopefully we get information
from both of those,

494
00:20:34,232 --> 00:20:37,102
and Julie will be interpreting
whatever information we get,

495
00:20:37,135 --> 00:20:38,970
along with Sandy and
the rest of the people

496
00:20:39,003 --> 00:20:41,973
in the mission support
area, making sure

497
00:20:42,006 --> 00:20:43,808
that we get that
information out.

498
00:20:43,841 --> 00:20:46,077
But to tell you a little bit
more about how MarCO works,

499

00:20:46,110 --> 00:20:48,246
it's a really cool
technology demonstration,

500
00:20:48,279 --> 00:20:50,982
I have Brian Clement, who's
one of the systems engineers

501
00:20:51,015 --> 00:20:52,251
that worked on MarCO, so Brian?

502
00:20:53,184 --> 00:20:54,986
[audience applauding]

503
00:20:55,019 --> 00:20:56,054
- Nice set up.
- Thank you.

504
00:20:56,087 --> 00:20:58,890
[audience applauding]

505
00:20:58,923 --> 00:21:00,025
- Yeah, so I'll be
here to tell you

506
00:21:00,058 --> 00:21:01,159
a little bit about MarCO.

507
00:21:01,192 --> 00:21:04,195
MarCO consists of
two spacecraft,

508
00:21:04,228 --> 00:21:06,131
it's a technology
demonstration mission,

509
00:21:06,164 --> 00:21:10,035
as Tom mentioned,
and MarCO consists

510
00:21:10,068 --> 00:21:13,204
of two cubesats, and this
is a scale model of MarCO.

511
00:21:13,237 --> 00:21:15,073
One inch equals one inch here,

512
00:21:15,106 --> 00:21:18,209
so it's a really compact
mission overall, very efficient.

513
00:21:18,242 --> 00:21:22,280
It's got three primary
technology demonstration pieces

514
00:21:22,313 --> 00:21:24,816
that allow us to go
where no small spacecraft

515
00:21:24,849 --> 00:21:27,018
has gone before, that
is into deep space,

516
00:21:27,051 --> 00:21:29,187
inter-planetary space,
and those three pieces

517
00:21:29,220 --> 00:21:32,090
are a miniaturized radio
that sits inside MarCO here,

518
00:21:32,123 --> 00:21:33,858
it's about the
size of a softball,

519
00:21:33,891 --> 00:21:34,959
that allows us to communicate

520
00:21:34,992 --> 00:21:37,062

from almost 100
million miles away.

521
00:21:37,095 --> 00:21:40,098
The second piece is
this beautiful HGA,

522
00:21:40,131 --> 00:21:42,067
or high gain antenna,
that sits up here.

523
00:21:42,100 --> 00:21:44,903
This is called
reflect array antenna,

524
00:21:44,936 --> 00:21:46,838
and it allows us
to focus that beam

525
00:21:46,871 --> 00:21:50,208
back towards Earth, from
this little feed right here.

526
00:21:50,241 --> 00:21:53,278
So this is how we are
going to talk to Earth

527
00:21:53,311 --> 00:21:56,047
on that X-band while we're
listening to InSight's

528
00:21:56,080 --> 00:21:57,916
entry, descent,
and landing data.

529
00:21:57,949 --> 00:22:01,052
Now, as I said,
this is a technology
demonstration mission.

530

00:22:01,085 --> 00:22:03,254
We've proven all of
these pieces up, so far,

531
00:22:03,287 --> 00:22:05,256
during our transit towards Mars.

532
00:22:05,289 --> 00:22:08,093
The last piece is the
cold gas propulsion unit.

533
00:22:08,126 --> 00:22:09,828
Now, you may have
heard about this.

534
00:22:09,861 --> 00:22:13,031
This uses fire extinguisher
propellant as its means

535
00:22:13,064 --> 00:22:15,900
of locomotion, and it allows us

536
00:22:15,933 --> 00:22:17,836
to navigate and
maneuver in deep space.

537
00:22:17,869 --> 00:22:20,004
As Tom was saying, you
have to go through TCMs,

538
00:22:20,037 --> 00:22:21,272
trajectory control maneuvers.

539
00:22:21,305 --> 00:22:23,141
This is how we do it on MarCO,

540
00:22:23,174 --> 00:22:25,110
with fire extinguisher
propellant,

541
00:22:25,143 --> 00:22:27,112
to allow us to move
slowly towards our goal

542
00:22:27,145 --> 00:22:29,047
throughout the mission.

543
00:22:29,080 --> 00:22:30,315
Now, we have an
animation that'll show

544
00:22:30,348 --> 00:22:33,084
a little bit about how
the communication occurs,

545
00:22:33,117 --> 00:22:34,352
but the most
important piece here

546
00:22:34,385 --> 00:22:38,123
for tomorrow's event is
the UHF antenna down here.

547
00:22:38,156 --> 00:22:39,257
So if we could roll
that animation,

548
00:22:39,290 --> 00:22:40,959
we'll talk a little bit
about how that works,

549
00:22:40,992 --> 00:22:45,997
as InSight approaches
Mars, we'll be then

550
00:22:47,198 --> 00:22:49,100
picking up communication
using that antenna

551

00:22:49,133 --> 00:22:50,335
at the bottom of MarCO.

552
00:22:50,368 --> 00:22:52,971
InSight will be
broadcasting a UHF signal,

553
00:22:53,004 --> 00:22:55,073
and then the MarCOs
will repeat that signal,

554
00:22:55,106 --> 00:22:57,942
but in the X-band,
looking at Earth

555
00:22:57,975 --> 00:23:01,045
very closely with that HGA
that we have on top there.

556
00:23:01,078 --> 00:23:04,015
This is is how we are
going to allow MarCO

557
00:23:04,048 --> 00:23:06,918
to relay data back
to Earth rapidly

558
00:23:06,951 --> 00:23:09,187
and understand what's
gone on with EDL,

559
00:23:09,220 --> 00:23:10,288
if everything goes to go plan.

560
00:23:10,321 --> 00:23:11,890
Now, of course, the
two MarCO missions,

561
00:23:11,923 --> 00:23:13,057
being a technology

demonstration mission,

562
00:23:13,090 --> 00:23:15,293
we don't need to
perform that relay

563
00:23:15,326 --> 00:23:17,962
for InSight to be
successful, however,

564
00:23:17,995 --> 00:23:21,166
we believe that this is a
really interesting technology

565
00:23:21,199 --> 00:23:24,202
overall, and we've really
shown something unique

566
00:23:24,235 --> 00:23:27,372
in deep space that will allow
us to further future missions

567
00:23:27,405 --> 00:23:29,941
in a compact and efficient way.

568
00:23:29,974 --> 00:23:31,242
And finally, I wanted
to show you a little bit

569
00:23:31,275 --> 00:23:32,977
about the cameras on MarCO.

570
00:23:33,010 --> 00:23:34,345
So we have a camera, right here,

571
00:23:34,378 --> 00:23:38,016
you may have seen pictures,
and we've been learning

572

00:23:38,049 --> 00:23:40,151
how to take pictures as
we've been going along,

573
00:23:40,184 --> 00:23:42,220
and when we originally
left on May 5th,

574
00:23:42,253 --> 00:23:43,955
a few days later, we
took a picture of Earth,

575
00:23:43,988 --> 00:23:46,090
you saw a pale blue
dot in that picture,

576
00:23:46,123 --> 00:23:47,325
and as we've been
approaching Mars,

577
00:23:47,358 --> 00:23:49,160
we've been taking
pictures as well.

578
00:23:49,193 --> 00:23:50,996
If we could put one of those up.

579
00:23:52,096 --> 00:23:53,932
What we have here is
the high gain antenna,

580
00:23:53,965 --> 00:23:55,266
which you see up here,

581
00:23:55,299 --> 00:23:58,236
and right down here in
this lower left quadrant,

582
00:23:58,269 --> 00:24:00,071
is Mars, on the approach.

583
00:24:00,104 --> 00:24:02,140
So we're really looking
forward to getting in,

584
00:24:02,173 --> 00:24:04,209
closer and closer
and closer to Mars

585
00:24:04,242 --> 00:24:06,211
over the next 24
hours and performing

586
00:24:06,244 --> 00:24:10,148
the entry, descent, and
landing relay for InSight.

587
00:24:11,349 --> 00:24:13,351
And, so that's
MarCO in a nutshell,

588
00:24:13,384 --> 00:24:15,253
a small, compact mission
that's going to allow us

589
00:24:15,286 --> 00:24:16,955
to do some really neat things.

590
00:24:16,988 --> 00:24:18,223
But back to InSight,

591
00:24:18,256 --> 00:24:21,226
we have the principal
investigator here,
Bruce Banerdt,

592
00:24:21,259 --> 00:24:24,162
to describe some of the
science behind InSight.

593
00:24:24,195 --> 00:24:27,299
[audience applauding]

594
00:24:30,201 --> 00:24:31,269
- Okay, so you've
been hearing a lot

595
00:24:31,302 --> 00:24:35,173
about the risks involved
in landing tomorrow,

596
00:24:35,206 --> 00:24:39,143
and all the intricate
dance that the spacecraft

597
00:24:39,176 --> 00:24:41,346
has to go through in order to
to get down to the surface,

598
00:24:41,379 --> 00:24:44,282
and I'm very cognizant
of all that stuff.

599
00:24:44,315 --> 00:24:48,486
I've been living that design
for the last seven years,

600
00:24:48,519 --> 00:24:51,189
but what I'm here to
talk to you today about

601
00:24:51,222 --> 00:24:54,225
is the payoff, okay,
this is the benefit,

602
00:24:54,258 --> 00:24:56,060
this is what we're
going to Mars for.

603

00:24:56,093 --> 00:24:58,263
So we've been doing the design,

604
00:24:58,296 --> 00:25:00,265
the construction of the
spacecraft, the operation,

605
00:25:00,298 --> 00:25:05,036
for about seven years,
we've been in space

606
00:25:05,069 --> 00:25:07,238
about, little less
than seven months.

607
00:25:07,271 --> 00:25:09,340
It's gonna take us a little
less than seven minutes

608
00:25:09,373 --> 00:25:11,409
to get down to the
surface, and then,

609
00:25:11,442 --> 00:25:13,411
we're gonna be down
on the surface,

610
00:25:13,444 --> 00:25:15,246
and that's when the
mission actually starts.

611
00:25:15,279 --> 00:25:16,481
So as I've said,
everything up to now

612
00:25:16,514 --> 00:25:20,051
has just been a prologue,
it actually starts tomorrow.

613
00:25:20,084 --> 00:25:22,487

Feels like it's a climax, but
it's actually the beginning.

614
00:25:22,520 --> 00:25:24,455
And so tomorrow,
we're gonna be down

615
00:25:24,488 --> 00:25:27,091
on the surface, in
Elysium Planitia,

616
00:25:27,124 --> 00:25:30,061
and for those of you who are
up on your Martian geology

617
00:25:30,094 --> 00:25:33,498
and geography, we're gonna
be right about here, okay,

618
00:25:33,531 --> 00:25:35,333
on the surface of Mars.

619
00:25:35,366 --> 00:25:37,268
But, what we're
gonna be looking at

620
00:25:37,301 --> 00:25:40,038
is not the area around here,
what we're gonna be looking at

621
00:25:40,071 --> 00:25:43,241
is this, the deep
interior of Mars,

622
00:25:43,274 --> 00:25:45,209
looking at the
deep core of Mars,

623
00:25:45,242 --> 00:25:48,212
its mantle and its

thin crust up here

624
00:25:48,245 --> 00:25:50,481
that have all the rocks that
we actually have access to.

625
00:25:50,514 --> 00:25:53,418
That is the goal of
the InSight mission

626
00:25:53,451 --> 00:25:56,321
is to actually map
out the inside of Mars

627
00:25:56,354 --> 00:25:58,456
in three dimensions
so that we understand

628
00:25:58,489 --> 00:26:01,125
the inside of Mars
as well as we have

629
00:26:01,158 --> 00:26:03,528
come to understand
the surface of Mars.

630
00:26:03,561 --> 00:26:06,497
And by doing that,
we're not only

631
00:26:06,530 --> 00:26:09,500
just sort of
exploring Mars itself,

632
00:26:09,533 --> 00:26:12,203
but we're actually
going back in time,

633
00:26:12,236 --> 00:26:14,138
back four and a

half billion years,

634
00:26:14,171 --> 00:26:17,308
to the, sort of the origin
of the solar system.

635
00:26:17,341 --> 00:26:20,278
The structure of Mars, its
crust, mantle, and core,

636
00:26:20,311 --> 00:26:23,181
which keep on
swinging out of sight,

637
00:26:23,214 --> 00:26:25,316
this crust, mantle,
and core was set up

638
00:26:25,349 --> 00:26:27,118
in the first few
tens of millions

639
00:26:27,151 --> 00:26:29,554
of years after Mars was formed.

640
00:26:29,587 --> 00:26:32,223
Probably, maybe even
20 million years.

641
00:26:32,256 --> 00:26:34,225
And that's out of four
and a half billion years,

642
00:26:34,258 --> 00:26:37,395
that's just a little
tiny slice of time.

643
00:26:38,596 --> 00:26:41,199
The Earth was also formed
at about the same time,

644
00:26:41,232 --> 00:26:44,435
it formed a crust, mantle
and core, as Mars did,

645
00:26:44,468 --> 00:26:47,138
but after that, Earth
just kept on going.

646
00:26:47,171 --> 00:26:49,507
It says, hey, this
is fun, I'm going on,

647
00:26:49,540 --> 00:26:50,508
I'm gonna do plate tectonics,

648
00:26:50,541 --> 00:26:52,343
I'm gonna do mantle convection,

649
00:26:52,376 --> 00:26:53,611
I'm gonna stir everything up,

650
00:26:53,644 --> 00:26:55,380
and then you get four
and a half billion years

651
00:26:55,413 --> 00:26:56,481
and later go, oh, wait a second,

652
00:26:56,514 --> 00:26:58,282
all of that evidence
has been erased.

653
00:26:58,315 --> 00:27:00,318
And so anybody who comes
along and wants to know

654
00:27:00,351 --> 00:27:03,321
where we came from,

you're in tough luck.

655
00:27:03,354 --> 00:27:05,356
Luckily, we can go to Mars

656
00:27:05,389 --> 00:27:07,592
and Mars decided to
rest on its laurels

657
00:27:07,625 --> 00:27:09,594
after it formed,
and so when we look

658
00:27:09,627 --> 00:27:14,165
at the crust of Mars,
that's a snapshot

659
00:27:14,198 --> 00:27:15,333
into the past of what the crust

660
00:27:15,366 --> 00:27:17,135
of the Earth might
have looked like

661
00:27:17,168 --> 00:27:18,369
four and a half
billion years ago,

662
00:27:18,402 --> 00:27:20,238
before it got all busy.

663
00:27:20,271 --> 00:27:23,207
So, in order to
understand the formation

664
00:27:23,240 --> 00:27:25,343
of the Earth, the way
that the Earth evolved

665

00:27:25,376 --> 00:27:27,245
into a planet
which is habitable,

666
00:27:27,278 --> 00:27:29,414
which has oceans, which
has an atmosphere,

667
00:27:29,447 --> 00:27:32,250
which has a nice temperature,

668
00:27:32,283 --> 00:27:34,419
if you're not in New
York right now at least,

669
00:27:34,452 --> 00:27:35,587
it's a nice temperature,

670
00:27:37,655 --> 00:27:39,557
whereas other planets
did not go that way,

671
00:27:39,590 --> 00:27:42,493
and they're the very details,
the small little details

672
00:27:42,526 --> 00:27:44,562
of that evolution,
is what we think

673
00:27:44,595 --> 00:27:48,332
makes a difference between
having a nice planet

674
00:27:48,365 --> 00:27:51,302
like the Earth, a place
where you can take a vacation

675
00:27:51,335 --> 00:27:54,338
and get a tan, or

a place like Venus,

676
00:27:54,371 --> 00:27:56,641
where you're gonna burn
up in a matter of seconds,

677
00:27:56,674 --> 00:27:59,210
or Mars, where you'd
probably freeze to death

678
00:27:59,243 --> 00:28:01,479
and wouldn't be able
to breathe very well.

679
00:28:01,512 --> 00:28:04,415
Those details are
pretty important,

680
00:28:04,448 --> 00:28:06,684
in terms of living, but
they're very small details

681
00:28:06,717 --> 00:28:08,453
in terms of the way
the planet evolved.

682
00:28:08,486 --> 00:28:11,355
And we're trying to
get a good enough,

683
00:28:11,388 --> 00:28:14,459
precise enough measurement
of the conditions

684
00:28:14,492 --> 00:28:17,328
of early Mars that we
can refine our models

685
00:28:17,361 --> 00:28:18,596
and understand how those details

686
00:28:18,629 --> 00:28:20,465
send us down different paths.

687
00:28:21,532 --> 00:28:24,335
Okay, so how are
we gonna do that?

688
00:28:24,368 --> 00:28:26,704
We're gonna do that
with a couple of
geophysical techniques,

689
00:28:26,737 --> 00:28:30,641
that's using physics to
study geological processes,

690
00:28:30,674 --> 00:28:33,711
and the first one, and
the most important one,

691
00:28:33,744 --> 00:28:35,480
is the seismology.

692
00:28:35,513 --> 00:28:38,249
Seismology is the
study of earthquakes,

693
00:28:38,282 --> 00:28:39,717
or in our case, Marsquakes,
and it's not just studying

694
00:28:39,750 --> 00:28:42,520
the quakes themselves,
but we're using

695
00:28:42,553 --> 00:28:45,356
the waves generated
by those quakes,

696
00:28:45,389 --> 00:28:47,692
the vibrational waves, which
pass through the planet,

697
00:28:47,725 --> 00:28:50,595
in order to probe deep
down into the planet.

698
00:28:50,628 --> 00:28:54,532
When we look at things
with our eyeballs,

699
00:28:54,565 --> 00:28:57,602
we're using light waves,
which bounce off of things,

700
00:28:57,635 --> 00:28:59,303
they travel through
the atmosphere,

701
00:28:59,336 --> 00:29:01,205
they travel through
glass, they get bent,

702
00:29:01,238 --> 00:29:02,707
they get reflected, and our eyes

703
00:29:02,740 --> 00:29:04,642
kinda puts together
all that information

704
00:29:04,675 --> 00:29:07,712
to just give us a three
dimensional knowledge

705
00:29:07,745 --> 00:29:09,447
of the world around us.

706
00:29:09,480 --> 00:29:11,449

Okay, so when we turn
our eyes downwards

707
00:29:11,482 --> 00:29:13,384
to look at the
core of the planet,

708
00:29:13,417 --> 00:29:14,719
doesn't work so well,
'cause light waves

709
00:29:14,752 --> 00:29:16,654
don't go through
rocks, but the waves

710
00:29:16,687 --> 00:29:19,257
that do go through
rocks are seismic waves,

711
00:29:19,290 --> 00:29:22,493
and so, on Mars, when
there's a Marsquake,

712
00:29:22,526 --> 00:29:25,396
where the crust moves suddenly,

713
00:29:25,429 --> 00:29:28,466
starts vibrations moving
through the planet,

714
00:29:28,499 --> 00:29:31,569
it's like a flash bulb going
off in the seismic world,

715
00:29:31,602 --> 00:29:35,306
and our seismometer
is our eyes on Mars,

716
00:29:35,339 --> 00:29:38,442
which take those waves and

let us turn those waves

717
00:29:38,475 --> 00:29:41,479
into a 3-D picture of
the inside of Mars.

718
00:29:41,512 --> 00:29:45,316
And so, let's run the
first animation here.

719
00:29:45,349 --> 00:29:47,652
This is where a Marsquake
has occurred on Mars.

720
00:29:47,685 --> 00:29:50,354
These are surface waves,
traveling across the surface

721
00:29:50,387 --> 00:29:52,557
as they go past the seismometer,

722
00:29:52,590 --> 00:29:56,494
here's the seismic, the
seismogram that's generated.

723
00:29:56,527 --> 00:29:58,696
The nice thing about
Mars is it's small enough

724
00:29:58,729 --> 00:30:00,531
that those surface waves
keep going around the Mars,

725
00:30:00,564 --> 00:30:03,367
as they go to the other
side, they pass each other

726
00:30:03,400 --> 00:30:04,602
at what we call the antipode,

727
00:30:04,635 --> 00:30:06,437
the opposite side of the planet,

728
00:30:06,470 --> 00:30:08,573
and they keep on
coming back around.

729
00:30:08,606 --> 00:30:12,743
As they come back around, they
pass the spacecraft again.

730
00:30:12,776 --> 00:30:14,712
The seismometer picks
up the seismic waves

731
00:30:14,745 --> 00:30:17,381
that have gone around,
and, they pick up

732
00:30:17,414 --> 00:30:18,749
the ones going around
the other way as well.

733
00:30:18,782 --> 00:30:21,652
And so, you may have
heard that it takes

734
00:30:21,685 --> 00:30:25,590
three seismometers to
locate an earthquake

735
00:30:25,623 --> 00:30:28,526
and do seismology, well, we
only have one seismometer,

736
00:30:28,559 --> 00:30:31,362
but we're using
extra information.

737

00:30:31,395 --> 00:30:33,664
Here, we have the P wave, the
S wave and the surface wave,

738
00:30:33,697 --> 00:30:36,667
but we have these extra
two surface wave events

739
00:30:36,700 --> 00:30:37,768
that go around the planet

740
00:30:37,801 --> 00:30:39,837
because Mars is small,
it doesn't absorb

741
00:30:39,870 --> 00:30:41,806
the waves as quickly
as the Earth does,

742
00:30:41,839 --> 00:30:43,641
and we can use this
extra information

743
00:30:43,674 --> 00:30:47,545
to actually locate how far
away that Marsquake was

744
00:30:47,578 --> 00:30:49,814
from our spacecraft, we
can do some other analysis

745
00:30:49,847 --> 00:30:52,416
to figure out which way
those waves are coming from,

746
00:30:52,449 --> 00:30:53,718
figure out where
that Marsquake is,

747
00:30:53,751 --> 00:30:56,787

and with that information,
we can use the information

748
00:30:56,820 --> 00:30:59,657
from the velocities of the waves

749
00:30:59,690 --> 00:31:01,626
to probe inside the
planet and figure out

750
00:31:01,659 --> 00:31:05,363
what it's made out of, and
where the boundaries are.

751
00:31:05,396 --> 00:31:07,465
So, in order to do that,
we use an instrument

752
00:31:07,498 --> 00:31:08,699
called a seismometer,
and I have a couple

753
00:31:08,732 --> 00:31:10,735
of seismometers here, well,
I have one seismometer

754
00:31:10,768 --> 00:31:12,436
and one fake seismometer.

755
00:31:12,469 --> 00:31:15,673
This is a Streckeisen STS-2,

756
00:31:15,706 --> 00:31:18,776
it's a so-called
portable seismometer,

757
00:31:18,809 --> 00:31:23,547
it's used quite
a bit in geology.

758
00:31:23,580 --> 00:31:26,784
It's very similar
in size to this,

759
00:31:26,817 --> 00:31:31,823
which is a 3-D printed model
of our InSight seismometer.

760
00:31:33,757 --> 00:31:37,561
On the Earth, this is
a portable seismometer,

761
00:31:37,594 --> 00:31:39,397
which means we
ship it in a crate

762
00:31:39,430 --> 00:31:41,766
that's about this
big, full of foam

763
00:31:41,799 --> 00:31:44,635
so that it doesn't get broken.

764
00:31:44,668 --> 00:31:45,870
When we take it
out in the field,

765
00:31:45,903 --> 00:31:47,605
we don't just set it
down on the ground,

766
00:31:47,638 --> 00:31:50,608
we usually dig a hole,
put down a concrete slab,

767
00:31:50,641 --> 00:31:51,909
put insulation around
it, and everything

768

00:31:51,942 --> 00:31:55,746
so that the temperature's
nice and uniform,

769
00:31:55,779 --> 00:31:57,848
and so then, we can
use this seismometer

770
00:31:57,881 --> 00:32:01,786
to do the kind of seismology
that I'm talking about on Mars.

771
00:32:01,819 --> 00:32:04,689
On Mars, we have this guy.

772
00:32:04,722 --> 00:32:07,758
This is the heart of
our whole mission.

773
00:32:07,791 --> 00:32:09,794
Inside this are three
seismic sensors,

774
00:32:09,827 --> 00:32:12,463
and it has to do the same
kinds of things this does,

775
00:32:12,496 --> 00:32:15,633
but we don't have someone
there to dig a deep hole,

776
00:32:15,666 --> 00:32:17,668
put insulation
around and so forth.

777
00:32:17,701 --> 00:32:20,838
And these seismometers
are so sensitive,

778
00:32:20,871 --> 00:32:23,541

that they're picking up
vibrations from these quakes.

779
00:32:23,574 --> 00:32:24,942
These are not the
kinds of vibrations

780
00:32:24,975 --> 00:32:28,479
that knock your house down,
these are very tiny vibrations

781
00:32:28,512 --> 00:32:29,714
that have traveled
through the entire planet,

782
00:32:29,747 --> 00:32:31,916
and the sensitivity
in these seismometers

783
00:32:31,949 --> 00:32:33,651
is such that they
can see vibrations

784
00:32:33,684 --> 00:32:36,787
with an amplitude of
about the size of an atom,

785
00:32:36,820 --> 00:32:38,756
maybe a fraction
of an atom, and so,

786
00:32:38,789 --> 00:32:40,725
you can imagine that,
if there's a little bit

787
00:32:40,758 --> 00:32:42,727
of wind blowing, if there's,

788
00:32:42,760 --> 00:32:44,929
that the temperature goes

up and down a little bit,

789
00:32:44,962 --> 00:32:47,498
things expand and contract,
all of those things

790
00:32:47,531 --> 00:32:50,601
are gonna go and show
up in our signal,

791
00:32:50,634 --> 00:32:53,871
and so, if I can have
the next picture,

792
00:32:53,904 --> 00:32:56,640
this is what we do in
order to make that work.

793
00:32:56,673 --> 00:32:59,443
Okay, so right here,
this yellow part

794
00:32:59,476 --> 00:33:02,880
in the very center, is that,
what we called our sphere.

795
00:33:02,913 --> 00:33:04,915
It's not really a sphere,
but it's close enough.

796
00:33:04,948 --> 00:33:06,951
And you can see some
of the stuff inside it.

797
00:33:06,984 --> 00:33:08,753
What we've done
is, first of all,

798
00:33:08,786 --> 00:33:09,920
we've evacuated that sphere.

799
00:33:09,953 --> 00:33:11,956
It's a vacuum, a
hard vacuum inside,

800
00:33:11,989 --> 00:33:13,657
that helps to insulate it.

801
00:33:13,690 --> 00:33:16,861
Then, we put, sort of, another
vacuum bottle around it.

802
00:33:16,894 --> 00:33:21,899
This is our thermal enclosure,
it has a hollow inside.

803
00:33:23,634 --> 00:33:25,836
This protects it from the
temperature variations

804
00:33:25,869 --> 00:33:28,739
on Mars, which can be
as much as 100 degrees

805
00:33:28,772 --> 00:33:29,974
as we go from day to night,

806
00:33:30,007 --> 00:33:32,710
and finally, we put
this dome over the top,

807
00:33:32,743 --> 00:33:34,678
we call it our wind
and thermal shield.

808
00:33:34,711 --> 00:33:35,913
That protects it from the wind,

809
00:33:35,946 --> 00:33:37,848

and protects it a little bit
more from the temperature.

810
00:33:37,881 --> 00:33:40,618
It's actually kind of
cool, it has a hard dome,

811
00:33:40,651 --> 00:33:42,586
and then it has
kind of an accordion

812
00:33:42,619 --> 00:33:44,922
thermal blanket
down here, and then,

813
00:33:44,955 --> 00:33:46,690
we actually have chain
mail at the bottom,

814
00:33:46,723 --> 00:33:48,726
that actually can conform itself

815
00:33:48,759 --> 00:33:51,595
to the irregular
ground, keep the wind

816
00:33:51,628 --> 00:33:53,631
from going underneath it.

817
00:33:53,664 --> 00:33:55,833
And so, by putting all
of these different layers

818
00:33:55,866 --> 00:33:58,669
of insulation between
our seismic sensors

819
00:33:58,702 --> 00:34:00,771
and the environment,
we actually have

820
00:34:00,804 --> 00:34:02,840
what we call a
thermal time constant

821
00:34:02,873 --> 00:34:05,709
of about seven and a
half or eight hours

822
00:34:05,742 --> 00:34:07,778
it takes for a thermal
variation to go

823
00:34:07,811 --> 00:34:09,046
from the outside to the inside,

824
00:34:09,079 --> 00:34:11,048
and that keeps it going.

825
00:34:11,081 --> 00:34:15,586
Okay, so this is what
we're gonna do on Mars.

826
00:34:15,619 --> 00:34:17,988
I think that's about
all I have to say,

827
00:34:18,021 --> 00:34:21,025
I think we can wrap it up
and go back to Veronica.

828
00:34:21,058 --> 00:34:22,693
- All right, thank you.

829
00:34:22,726 --> 00:34:25,029
[audience applauding]

830
00:34:25,062 --> 00:34:26,764
We're going to invite,

stay where you are.

831
00:34:27,965 --> 00:34:29,834
We're gonna invite all
the speakers to come back

832
00:34:29,867 --> 00:34:33,871
on stage and we're going
to open it up to questions.

833
00:34:33,904 --> 00:34:35,906
We're gonna take questions
from here in the auditorium,

834
00:34:35,939 --> 00:34:37,775
we'll also be going to
questions on the phone line.

835
00:34:37,808 --> 00:34:39,844
If you're on the phone
line, please hit star, one,

836
00:34:39,877 --> 00:34:41,645
to get into the queue,
so we know you're there,

837
00:34:41,678 --> 00:34:42,913
waiting with a question.

838
00:34:42,946 --> 00:34:45,649
We're also gonna take
questions from social media,

839
00:34:45,682 --> 00:34:48,753
online, using the
hashtag askNASA.

840
00:34:50,754 --> 00:34:52,923
All right, let's start
here in the auditorium.

841
00:34:52,956 --> 00:34:56,794
I'm gonna start on this
side, with Emily Lakdawalla.

842
00:35:00,030 --> 00:35:02,766
- Emily Lakdawalla, with
The Planetary Society.

843
00:35:02,799 --> 00:35:04,768
I have a couple of
MarCO questions.

844
00:35:04,801 --> 00:35:06,871
I'm wondering if you
can give some details

845
00:35:06,904 --> 00:35:09,073
on flyby distances for Mars,

846
00:35:09,106 --> 00:35:10,875
are they basically on the course

847
00:35:10,908 --> 00:35:13,777
that you planned for them,
what will the range be

848
00:35:13,810 --> 00:35:15,913
to InSight during landing?

849
00:35:15,946 --> 00:35:17,648
And you showed us
a cool picture,

850
00:35:17,681 --> 00:35:21,018
are you planning to take any
more as you approach Mars?

851
00:35:21,051 --> 00:35:22,720

- You may have to remind me

852
00:35:22,753 --> 00:35:23,921
of some of those questions
as we go through.

853
00:35:23,954 --> 00:35:26,991
So, first of all, the flyby
will be about 2,500 miles

854
00:35:27,024 --> 00:35:28,792
above the surface of Mars.

855
00:35:28,825 --> 00:35:33,097
The distance to InSight,
directly, as it lands,

856
00:35:33,130 --> 00:35:37,735
will be approximately
3,000 to 3,500,

857
00:35:37,768 --> 00:35:42,773
and then, I think your other
question was, pictures, yes.

858
00:35:43,840 --> 00:35:44,775
Yes, we are taking
more pictures,

859
00:35:44,808 --> 00:35:46,744
we'll see how we do with those,

860
00:35:46,777 --> 00:35:51,148
and the MarCO used a very
off the shelf camera,

861
00:35:51,181 --> 00:35:54,952
if you will, and so
we're learning as we go

862
00:35:54,985 --> 00:35:56,787
with those pictures, so
every time we take one

863
00:35:56,820 --> 00:35:57,855
is a little bit
more information.

864
00:35:57,888 --> 00:35:59,723
We've been happy so
far, but we'll see

865
00:35:59,756 --> 00:36:00,925
how we do as we get closer.

866
00:36:03,794 --> 00:36:05,062
- All right, we're gonna
go one in front here,

867
00:36:05,095 --> 00:36:07,131
to Steve Futterman, go ahead.

868
00:36:07,164 --> 00:36:08,966
- Steve Futterman,
from CBS News.

869
00:36:08,999 --> 00:36:10,167
For Tom, I want to sort of

870
00:36:10,200 --> 00:36:13,737
get to your psychological
makeup right now.

871
00:36:13,770 --> 00:36:15,139
What is your mood right now?

872
00:36:15,172 --> 00:36:17,775
Are you nervous,
excited, a bit of both,

873
00:36:17,808 --> 00:36:19,910
and what is it going to be like

874
00:36:19,943 --> 00:36:22,013
during these seven
minutes of terror?

875
00:36:22,980 --> 00:36:24,114
- That's a great question.

876
00:36:24,147 --> 00:36:26,951
I am completely excited
and completely nervous,

877
00:36:26,984 --> 00:36:29,920
all at the same time,
because everything

878
00:36:29,953 --> 00:36:32,122
that we've done today
makes us feel comfortable

879
00:36:32,155 --> 00:36:35,759
and confident we're
gonna land on Mars, but,

880
00:36:35,792 --> 00:36:37,161
everything has to go perfectly,

881
00:36:37,194 --> 00:36:39,063
and Mars could always
throw us a curve ball,

882
00:36:39,096 --> 00:36:40,898
to use the baseball analogy

883
00:36:40,931 --> 00:36:43,000
that may decrease

our batting average.

884
00:36:43,033 --> 00:36:45,202
But, I think, we've been
practicing very well,

885
00:36:45,235 --> 00:36:48,839
I'm confident, but
very trepidatious.

886
00:36:48,872 --> 00:36:50,774
I have not been
sleeping that great.

887
00:36:50,807 --> 00:36:52,977
Might be because I have
two and four year old kids

888
00:36:53,010 --> 00:36:54,979
running around the
house all the time,

889
00:36:55,012 --> 00:36:57,214
but nonetheless, I'm
gonna be very excited

890
00:36:57,247 --> 00:36:58,882
once we get that
first signal back

891
00:36:58,915 --> 00:37:01,085
that shows that we
successfully landed on Mars.

892
00:37:01,118 --> 00:37:03,087
I am totally gonna unleash

893
00:37:03,120 --> 00:37:05,122
my inner four year
old at that point.

894
00:37:05,155 --> 00:37:07,758
[audience laughing]

895
00:37:07,791 --> 00:37:09,893
- Okay, I'm gonna go to
the phone lines next.

896
00:37:09,926 --> 00:37:13,030
We have AP on the phone, please
go ahead with your question.

897
00:37:18,935 --> 00:37:20,905
- [Operator] Marcia,
your line is open.

898
00:37:22,139 --> 00:37:25,075
- [Marcia] Yes, hi, we've
heard that Dr. Zurbuchen's

899
00:37:25,108 --> 00:37:27,778
got some stomach stuff
going on from nerves,

900
00:37:27,811 --> 00:37:29,947
and we've got the
inner four year old

901
00:37:29,980 --> 00:37:32,216
going to be unleashed
by Tom Hoffman.

902
00:37:32,249 --> 00:37:36,053
Dr. Banerdt, I'd like to
get a look into your mind

903
00:37:36,086 --> 00:37:37,187
and stomach right now, I mean,

904

00:37:37,220 --> 00:37:40,157
how are you feeling and
how do you anticipate

905
00:37:40,190 --> 00:37:44,161
you're gonna be dealing
with the critical times

906
00:37:44,194 --> 00:37:45,863
tomorrow before touchdown?

907
00:37:47,064 --> 00:37:50,200
- Well, I have to admit, I'm
getting a little nervous.

908
00:37:50,233 --> 00:37:52,169
I wasn't sure whether, actually,

909
00:37:52,202 --> 00:37:54,838
I'm probably more nervous
about this press briefing

910
00:37:54,871 --> 00:37:56,106
than I am about the landing.

911
00:37:56,139 --> 00:37:57,207
[audience laughing]

912
00:37:57,240 --> 00:37:59,110
But it'll get there,
it'll get there.

913
00:38:01,178 --> 00:38:05,082
I've been really, along with Tom

914
00:38:05,115 --> 00:38:07,217
and a lot of other people,
been living this mission

915

00:38:07,250 --> 00:38:12,156
for about six years,
and we've been thinking

916
00:38:12,189 --> 00:38:14,124
of everything that
could possibly go wrong,

917
00:38:14,157 --> 00:38:17,061
which is something that
gives you pause, sometimes,

918
00:38:17,094 --> 00:38:19,063
'cause there's a lot of
things that could go wrong,

919
00:38:19,096 --> 00:38:21,131
but every time you think of
something that could go wrong,

920
00:38:21,164 --> 00:38:23,100
you figure out how
to mitigate it,

921
00:38:23,133 --> 00:38:26,136
how to either make it less
likely or how to fix it,

922
00:38:26,169 --> 00:38:29,840
and so, we've fixed an
incredible number of things

923
00:38:29,873 --> 00:38:33,010
over the last six
years, and I'm actually

924
00:38:33,043 --> 00:38:35,112
really confident personally

925
00:38:35,145 --> 00:38:37,214

that we're gonna
land safely tomorrow.

926
00:38:37,247 --> 00:38:40,918
Doesn't mean I'm not
nervous, but we'll see

927
00:38:40,951 --> 00:38:44,188
when they call safe touchdown,
we'll see just how nervous

928
00:38:44,221 --> 00:38:47,925
I actually was, I'll find out
with the rest of you, I think.

929
00:38:47,958 --> 00:38:49,193
[audience chuckling]

930
00:38:49,226 --> 00:38:50,928
- [Veronica] Hey Bruce, I
know you've been working

931
00:38:50,961 --> 00:38:52,162
for the last six years,
really hard on this mission,

932
00:38:52,195 --> 00:38:53,130
but you should tell them how
long you've been dreaming

933
00:38:53,163 --> 00:38:55,199
of this mission.
- Oh, well.

934
00:38:55,232 --> 00:38:58,235
I was actually
here at JPL in 1976

935
00:38:58,268 --> 00:39:01,205
when Viking landed on Mars,

936
00:39:01,238 --> 00:39:03,874
I was a geophysical
graduate student,

937
00:39:03,907 --> 00:39:06,310
and was really disappointed
when the seismometers

938
00:39:06,343 --> 00:39:09,980
on Viking didn't work out,
and I thought back then

939
00:39:10,013 --> 00:39:12,216
that boy, we really need
to send a seismometer

940
00:39:12,249 --> 00:39:14,151
back to Mars, and then
I went back to my,

941
00:39:14,184 --> 00:39:16,086
whatever it was
I was working on,

942
00:39:16,119 --> 00:39:18,922
and then about 10 years
later, in the late 80s,

943
00:39:18,955 --> 00:39:20,924
I started working with
some engineers at JPL

944
00:39:20,957 --> 00:39:25,129
on seismometers and kinda
got the mission bug,

945
00:39:25,162 --> 00:39:26,263
I kinda caught the mission bug,

946
00:39:26,296 --> 00:39:30,000
and got more or less,
some people say obsessed

947
00:39:30,033 --> 00:39:31,235
about sending a mission to Mars.

948
00:39:31,268 --> 00:39:33,303
So I've really been
working pretty steadily

949
00:39:33,336 --> 00:39:38,342
for 25 to 30 years on this,
and had about six or eight

950
00:39:41,144 --> 00:39:43,080
unsuccessful proposals
before this one,

951
00:39:43,113 --> 00:39:46,049
but, which, each one is
a learning experience,

952
00:39:46,082 --> 00:39:50,120
and so, I'd say I'm
a patient person.

953
00:39:50,153 --> 00:39:52,222
[all laughing]

954
00:39:52,255 --> 00:39:55,893
As well as persistent, but
yeah, it's been a long time.

955
00:39:55,926 --> 00:39:59,096
This is really a long time
dream come true for me.

956
00:39:59,129 --> 00:40:01,165

- Okay, we're gonna go
to one more question

957
00:40:01,198 --> 00:40:04,034
on the phone line,
Irish TV, Leo Enright,

958
00:40:04,067 --> 00:40:05,302
go ahead please.

959
00:40:05,335 --> 00:40:07,271
- [Leo] Thanks very
much, Veronica,

960
00:40:07,304 --> 00:40:10,207
and there are a lots
of four year olds

961
00:40:10,240 --> 00:40:14,344
with good Celtic names
watching this as well.

962
00:40:14,377 --> 00:40:16,246
And my question
has to do, really,

963
00:40:16,279 --> 00:40:18,182
with the European involvement.

964
00:40:18,215 --> 00:40:21,151
And I just wondered,
I cannot remember,

965
00:40:21,184 --> 00:40:23,320
and I, as Veronica
knows, I've covered this

966
00:40:23,353 --> 00:40:26,123
for a long time,
I cannot remember

967
00:40:26,156 --> 00:40:29,126
any interplanetary mission
that has this level

968
00:40:29,159 --> 00:40:32,095
of international cooperation.

969
00:40:32,128 --> 00:40:34,264
I just wondered, am
I right about that,

970
00:40:34,297 --> 00:40:37,401
is this unique in
modern history,

971
00:40:37,434 --> 00:40:39,102
or have I missed something?

972
00:40:39,135 --> 00:40:41,238
- So, why don't I
talk about this?

973
00:40:41,271 --> 00:40:43,106
It's Thomas Zurbuchen.

974
00:40:43,139 --> 00:40:45,442
So, close to 2/3 of our missions

975
00:40:45,475 --> 00:40:49,279
do have international
involvement.

976
00:40:49,312 --> 00:40:52,115
What's unique about
this one, if you take

977
00:40:52,148 --> 00:40:54,451
at the whole payload,

which of course,

978
00:40:54,484 --> 00:40:56,186
is the why of a mission, right,

979
00:40:56,219 --> 00:40:59,022
it's there, of course,
the piece in front of you,

980
00:40:59,055 --> 00:41:02,259
I met the guy in
France, I remember,

981
00:41:02,292 --> 00:41:05,295
I was introduced
to him by the CEO

982
00:41:05,328 --> 00:41:07,397
of the company, and
says, this is the guy.

983
00:41:07,430 --> 00:41:10,400
I still remember him,
tattoos down his arm,

984
00:41:10,433 --> 00:41:12,469
he said, "He has the magic
touch, he's the only one

985
00:41:12,502 --> 00:41:15,472
"who really knows
how to put these

986
00:41:15,505 --> 00:41:20,110
"super sensitive sensors
into the sphere."

987
00:41:20,143 --> 00:41:22,179
And so I met him, right,
I'm grateful to him,

988
00:41:22,212 --> 00:41:23,447
right, that together
with his colleagues there

989
00:41:23,480 --> 00:41:26,183
at Sodern and
elsewhere, and CNES,

990
00:41:26,216 --> 00:41:27,451
of course, the other instrument

991
00:41:27,484 --> 00:41:30,354
that you didn't talk much about,

992
00:41:30,387 --> 00:41:33,991
but you can, of course,
is from Germany.

993
00:41:34,024 --> 00:41:36,093
Of course, the electronics
is from Switzerland,

994
00:41:36,126 --> 00:41:38,262
over here, it's
here from Germany,

995
00:41:38,295 --> 00:41:40,264
there's also Polish
contributions

996
00:41:40,297 --> 00:41:42,266
as well as others,
and so, kind of,

997
00:41:42,299 --> 00:41:45,202
just as a fraction of
payload, it is unique.

998

00:41:45,235 --> 00:41:50,040
It is unique, in
terms of just how much

999
00:41:50,073 --> 00:41:51,441
is being done
elsewhere, of course,

1000
00:41:51,474 --> 00:41:55,145
we believe in United
States that leadership

1001
00:41:55,178 --> 00:41:57,147
and collaboration are
not contradicting values.

1002
00:41:57,180 --> 00:42:01,151
We believe that the best
is served for humanity

1003
00:42:01,184 --> 00:42:04,021
if we actually have the
best seismology instrument,

1004
00:42:04,054 --> 00:42:06,356
the best thermal probe,
and in this case,

1005
00:42:06,389 --> 00:42:09,126
they're built elsewhere, and
so that's why we're doing that.

1006
00:42:09,159 --> 00:42:11,228
Bruce worked in on this.

1007
00:42:11,261 --> 00:42:13,297
- That's pretty much, that
pretty much covers it.

1008
00:42:13,330 --> 00:42:15,198

I mean, all these instruments,

1009
00:42:15,231 --> 00:42:16,500
for example, the seismometers,

1010
00:42:16,533 --> 00:42:19,503
being supplied by the
French space agency,

1011
00:42:19,536 --> 00:42:22,439
but there have been
substantial contributions

1012
00:42:22,472 --> 00:42:24,441
from the United
Kingdom, from Germany,

1013
00:42:24,474 --> 00:42:26,410
from Switzerland, and
from the United States.

1014
00:42:26,443 --> 00:42:28,512
We had, actually, a
pretty big part of that,

1015
00:42:28,545 --> 00:42:31,481
and so, it's really
a collaboration,

1016
00:42:31,514 --> 00:42:36,286
and the collaboration really
doesn't have any respect

1017
00:42:36,319 --> 00:42:39,089
for boundaries, we just
get the best people,

1018
00:42:39,122 --> 00:42:41,225
the best technology,
wherever we can find it.

1019
00:42:42,525 --> 00:42:44,227
- Okay, we're gonna take
it back here in the room,

1020
00:42:44,260 --> 00:42:47,297
with a question here
on the end, go ahead.

1021
00:42:47,330 --> 00:42:49,333
- [Jeff] Jeff Foust,
Space News, for Tom.

1022
00:42:49,366 --> 00:42:51,101
Can you give us a
little more details

1023
00:42:51,134 --> 00:42:53,437
on this final TCM in terms
of the timing and duration,

1024
00:42:53,470 --> 00:42:55,205
and are you aiming
to get right back

1025
00:42:55,238 --> 00:42:58,208
onto that X in the center,
or some offset from it?

1026
00:42:58,241 --> 00:43:01,078
- Yeah, so we're hoping
that this afternoon

1027
00:43:01,111 --> 00:43:04,214
we do just a very small burn,
it's only a few centimeters

1028
00:43:04,247 --> 00:43:06,283
per second, which
is a relatively,

1029
00:43:06,316 --> 00:43:08,418
it's almost a breath of
air out of your mouth.

1030
00:43:08,451 --> 00:43:11,388
We hope that we're gonna
move about 11 miles

1031
00:43:11,421 --> 00:43:14,124
from where we are
today to that red X.

1032
00:43:14,157 --> 00:43:15,525
We're a little bit
to the northwest.

1033
00:43:15,558 --> 00:43:18,261
If we go further
northwest than that,

1034
00:43:18,294 --> 00:43:20,430
than where we're
currently showing,

1035
00:43:20,463 --> 00:43:22,532
we get into a region that
we're not as comfortable

1036
00:43:22,565 --> 00:43:24,434
landing in, which
is the reason we had

1037
00:43:24,467 --> 00:43:26,536
a very exciting
and it wasn't clear

1038
00:43:26,569 --> 00:43:29,373
what the answer was gonna
be in our 6:00 a.m. meeting

1039
00:43:29,406 --> 00:43:32,175
this morning, we listened
to all the different inputs,

1040
00:43:32,208 --> 00:43:34,378
and the final decision
was to go ahead

1041
00:43:34,411 --> 00:43:36,279
and do the TCM,
let's move ourselves

1042
00:43:36,312 --> 00:43:38,148
back to that red
X and be exactly

1043
00:43:38,181 --> 00:43:41,151
where we really wanna land,
for both safety standpoint,

1044
00:43:41,184 --> 00:43:43,553
as well as making sure that
we have the right location

1045
00:43:43,586 --> 00:43:45,289
for our science instruments.

1046
00:43:47,290 --> 00:43:50,460
- Okay, we have a question in
the back row, there you go.

1047
00:43:50,493 --> 00:43:52,496
- Hi, Fred Bastien, Fred
Bastien YouTube channel.

1048
00:43:52,529 --> 00:43:54,331
I have a question
about the insights

1049
00:43:54,364 --> 00:43:57,200
we can get from InSight
about the science over there.

1050
00:43:57,233 --> 00:43:59,569
What's the main
hypothesis, but mostly,

1051
00:43:59,602 --> 00:44:01,471
what's the craziest
thing we could learn,

1052
00:44:01,504 --> 00:44:03,240
what is the most
mind blowing thing

1053
00:44:03,273 --> 00:44:05,309
we could learn about
Mars, true insight?

1054
00:44:06,376 --> 00:44:11,248
- Wow, I mean, I
think my imagination's

1055
00:44:12,315 --> 00:44:13,417
really always been
challenged by Mars,

1056
00:44:13,450 --> 00:44:15,652
because we keep on
running into things

1057
00:44:15,685 --> 00:44:18,488
that are crazier
than I ever imagined.

1058
00:44:18,521 --> 00:44:22,159
I think, you know,
we've thought a lot

1059
00:44:22,192 --> 00:44:24,428
about how many quakes
there might be on Mars,

1060
00:44:24,461 --> 00:44:25,662
or how active Mars could be.

1061
00:44:25,695 --> 00:44:27,531
I think probably
what's gonna happen

1062
00:44:27,564 --> 00:44:31,301
is we're gonna find out
that the whole question

1063
00:44:31,334 --> 00:44:33,570
of sort of seismicity,
which is the distribution

1064
00:44:33,603 --> 00:44:36,506
and rate of seismicity on Mars

1065
00:44:36,539 --> 00:44:38,275
is gonna tell us some things

1066
00:44:38,308 --> 00:44:40,610
that we had absolutely no
idea were going on in Mars.

1067
00:44:40,643 --> 00:44:42,546
I mean, seismology
is one of the ways

1068
00:44:42,579 --> 00:44:45,382
that we really confirmed
plate tectonics on the Earth,

1069
00:44:45,415 --> 00:44:49,619
looking at where all

the earthquakes bunch,

1070
00:44:49,652 --> 00:44:52,355
along plate boundaries,
and allowed us to see

1071
00:44:52,388 --> 00:44:53,590
where the plate boundaries were.

1072
00:44:53,623 --> 00:44:56,326
On Mars, when we start
getting these Mars plates,

1073
00:44:56,359 --> 00:44:59,196
they're gonna be telling
us where there's stuff

1074
00:44:59,229 --> 00:45:02,566
going on on Mars, where the
forces are concentrating,

1075
00:45:02,599 --> 00:45:04,501
and I think that's
gonna tell us something

1076
00:45:04,534 --> 00:45:09,540
that was probably completely
absent from our models,

1077
00:45:10,607 --> 00:45:11,541
but, then again, now
that I've thought of it,

1078
00:45:11,574 --> 00:45:13,310
it's probably not true, so.

1079
00:45:13,343 --> 00:45:15,445
[audience laughing]

1080

00:45:15,478 --> 00:45:17,481
- All right, again in
the back row there.

1081
00:45:19,382 --> 00:45:21,284
- [Ivan] Hi there,
it's Ivan Semeniuk

1082
00:45:21,317 --> 00:45:23,286
with the Globe and
Mail, just a short one,

1083
00:45:23,319 --> 00:45:25,288
about that safe call home.

1084
00:45:25,321 --> 00:45:28,291
Can you just remind us
precisely when you're expecting

1085
00:45:28,324 --> 00:45:30,327
that to arrive, how you'll know,

1086
00:45:30,360 --> 00:45:32,262
how we'll know
that you've got it,

1087
00:45:32,295 --> 00:45:35,432
and what, how you would
spring into action,

1088
00:45:35,465 --> 00:45:37,634
or what scenarios
you might pursue

1089
00:45:37,667 --> 00:45:39,469
if you don't get it right away.

1090
00:45:39,502 --> 00:45:42,339
- Yeah, so about seven
minutes after we land,

1091
00:45:42,372 --> 00:45:44,407
we're expecting to
get an X-band beep.

1092
00:45:44,440 --> 00:45:46,510
If we don't get
that X-band beep,

1093
00:45:46,543 --> 00:45:49,312
all is not lost, that just means

1094
00:45:49,345 --> 00:45:50,614
that we're in a
slightly different mode.

1095
00:45:50,647 --> 00:45:53,350
We would be in something
called safe mode,

1096
00:45:53,383 --> 00:45:56,353
which by its name, you
can figure out it's safe.

1097
00:45:56,386 --> 00:45:59,256
In that mode, the only thing
that we would really lose

1098
00:45:59,289 --> 00:46:01,258
is that first image,
everything else

1099
00:46:01,291 --> 00:46:02,626
is autonomously done
by the spacecraft,

1100
00:46:02,659 --> 00:46:05,395
so we'll get the
solar arrays deployed,

1101
00:46:05,428 --> 00:46:09,366
making sure that we're
thermally and energy safe,

1102
00:46:09,399 --> 00:46:12,636
and then we will start talking
with the orbiting assets,

1103
00:46:12,669 --> 00:46:15,505
Odyssey, Mars
Reconnaissance Orbital,

1104
00:46:15,538 --> 00:46:17,507
we'll start getting
that data up to them.

1105
00:46:17,540 --> 00:46:20,477
So it really, seven minutes
means everything's great,

1106
00:46:20,510 --> 00:46:21,745
if we get it a
little bit earlier

1107
00:46:21,778 --> 00:46:24,314
or a little bit after that,
it still means everything's

1108
00:46:24,347 --> 00:46:25,749
in pretty good shape,
we just not gonna

1109
00:46:25,782 --> 00:46:27,584
get a picture back for awhile.

1110
00:46:27,617 --> 00:46:28,552
- [Ivan] Thanks.

1111
00:46:30,453 --> 00:46:33,457

- Okay, I'm gonna
go here to Ian.

1112
00:46:35,625 --> 00:46:36,627
There we go.

1113
00:46:37,760 --> 00:46:40,463
- Hi, Ian O'Neill with
Scientific American

1114
00:46:40,496 --> 00:46:42,566
and HowStuffWorks.com.

1115
00:46:42,599 --> 00:46:45,769
I had a question, in
Mars' ancient past,

1116
00:46:45,802 --> 00:46:48,705
it was hit by a massive impact.

1117
00:46:48,738 --> 00:46:53,543
How will InSight
expose the interior

1118
00:46:53,576 --> 00:46:56,780
of Mars to explain what
actually may have hit it,

1119
00:46:56,813 --> 00:47:00,617
and if it did happen, or
perhaps some other explanation?

1120
00:47:01,751 --> 00:47:03,420
- Okay, I assume you're talking

1121
00:47:03,453 --> 00:47:06,790
about the origin of
the dichotomy boundary

1122

00:47:06,823 --> 00:47:10,360
in the northern plains,
which are a different level

1123
00:47:10,393 --> 00:47:11,761
and different character
than the southern plains,

1124
00:47:11,794 --> 00:47:14,598
and one thing InSight
will be able to do

1125
00:47:14,631 --> 00:47:18,635
is, we think, if we
have a reasonable number

1126
00:47:18,668 --> 00:47:20,770
of Marsquakes that are
distributed around the planet,

1127
00:47:20,803 --> 00:47:23,406
we'll be able to look at
waves that are coming at us

1128
00:47:23,439 --> 00:47:26,576
from the north, through
the northern plains,

1129
00:47:26,609 --> 00:47:30,447
which are the putative
location of this giant impact,

1130
00:47:30,480 --> 00:47:32,382
and waves that are
coming from the south,

1131
00:47:32,415 --> 00:47:35,685
and use the crustal thickness
that we can determine

1132

00:47:35,718 --> 00:47:37,487
from both of those
in order to see

1133
00:47:37,520 --> 00:47:39,556
what the difference
in the thickness

1134
00:47:39,589 --> 00:47:40,657
of the crust is between
the north and the south,

1135
00:47:40,690 --> 00:47:43,760
and that will feed
into evaluation

1136
00:47:43,793 --> 00:47:46,630
of various different models
of how the northern plains

1137
00:47:46,663 --> 00:47:48,632
formed, and so I
think that's probably

1138
00:47:48,665 --> 00:47:51,701
our best bet for
helping to constrain

1139
00:47:51,734 --> 00:47:53,804
that particular problem.
- Thank you.

1140
00:47:55,505 --> 00:47:57,541
- Okay, next question, go ahead.

1141
00:48:04,747 --> 00:48:06,549
- [Fig] Fig O'Reilly
with Girls Who Code.

1142
00:48:06,582 --> 00:48:08,551

My question is, how
long do you expect

1143
00:48:08,584 --> 00:48:10,553
it will take to generate
enough usable data

1144
00:48:10,586 --> 00:48:14,691
to produce insights
about Mars's interior?

1145
00:48:14,724 --> 00:48:18,695
- Okay, so this is, InSight is,

1146
00:48:18,728 --> 00:48:19,863
once we get to the surface,

1147
00:48:19,896 --> 00:48:23,500
InSight is a slow
motion mission, okay?

1148
00:48:23,533 --> 00:48:25,435
We take our time getting
our instruments down,

1149
00:48:25,468 --> 00:48:27,437
it'll probably
take at least two,

1150
00:48:27,470 --> 00:48:28,838
probably more like three months,

1151
00:48:28,871 --> 00:48:31,641
maybe even longer to get
our instruments down.

1152
00:48:31,674 --> 00:48:34,577
It's gonna take us a month or
so to get 'em all calibrated,

1153
00:48:34,610 --> 00:48:37,781
and in tune to
Mars's conditions,

1154
00:48:38,881 --> 00:48:40,583
and then we'll start
collecting our data.

1155
00:48:40,616 --> 00:48:41,818
We'll start collecting
the data at the beginning,

1156
00:48:41,851 --> 00:48:45,589
but then we'll start collecting
the best, the cleanest data.

1157
00:48:47,490 --> 00:48:50,593
I would say, probably it's
gonna be at least six months

1158
00:48:50,626 --> 00:48:54,631
before we even get a glimmer
of what we're looking for,

1159
00:48:54,664 --> 00:48:57,734
and a lot of the
really basic questions,

1160
00:48:57,767 --> 00:49:01,638
I think, it's gonna take close
to the full two year mission.

1161
00:49:01,671 --> 00:49:03,640
We might be getting
stuff out before that,

1162
00:49:03,673 --> 00:49:06,710
but it really depends on how
benevolent Mars is feeling.

1163
00:49:06,743 --> 00:49:08,912
How many Marsquakes
it throws at us.

1164
00:49:08,945 --> 00:49:10,680
The more Marsquakes the better,

1165
00:49:10,713 --> 00:49:14,684
we just love that shakin',
[audience laughing]

1166
00:49:14,717 --> 00:49:18,822
the more shaking it does, the
better we can see the inside.

1167
00:49:18,855 --> 00:49:21,491
Let those flash bulbs
keep on going off.

1168
00:49:21,958 --> 00:49:24,728
If it's nice and a good clip,

1169
00:49:24,761 --> 00:49:26,930
we'll, maybe even
earlier than that,

1170
00:49:26,963 --> 00:49:31,601
but with the rate
that we're expecting,

1171
00:49:31,634 --> 00:49:34,637
we'll probably be getting some
of those really basic results

1172
00:49:34,670 --> 00:49:38,775
out, probably not much
earlier than two years in.

1173
00:49:39,909 --> 00:49:41,511

A lot of other cool
stuff'll happen,

1174
00:49:41,544 --> 00:49:42,946
we'll get weather
reports every day,

1175
00:49:42,979 --> 00:49:45,548
we'll be measuring
the heat flow,

1176
00:49:45,581 --> 00:49:46,816
we'll be measuring the wobble,

1177
00:49:46,849 --> 00:49:51,621
so there will certainly be a
stream of results coming out,

1178
00:49:52,688 --> 00:49:54,624
but in terms of the
really deep questions,

1179
00:49:54,657 --> 00:49:57,728
I think, you know, hold
on to your hat for awhile.

1180
00:49:58,928 --> 00:50:00,964
- Okay, we only have time
for a couple more questions.

1181
00:50:00,997 --> 00:50:02,899
I'm gonna go to social
media, see if we've got

1182
00:50:02,932 --> 00:50:04,968
any burning questions
coming in from online.

1183
00:50:05,001 --> 00:50:06,703
- [Stephanie] So many questions,

1184
00:50:06,736 --> 00:50:08,538
a very lively YouTube chat,

1185
00:50:08,571 --> 00:50:09,973
and everybody out there
on Twitter using askNASA,

1186
00:50:10,006 --> 00:50:12,609
thank you so much, we will
be answering more online

1187
00:50:12,642 --> 00:50:13,943
after the broadcast is over.

1188
00:50:13,976 --> 00:50:16,679
So, we talked about
inner four year olds,

1189
00:50:16,712 --> 00:50:17,947
we have a real four year old,

1190
00:50:17,980 --> 00:50:21,684
Ellie, four, and Jackson, eight,

1191
00:50:21,717 --> 00:50:23,787
together wanna know how
the information we learn

1192
00:50:23,820 --> 00:50:27,690
from NASA InSight will shape
future missions to Mars.

1193
00:50:27,723 --> 00:50:28,925
- [Woman] Nice question.

1194
00:50:28,958 --> 00:50:31,995
- Yeah, I think there's a
couple parts of that question,

1195
00:50:32,028 --> 00:50:33,997
that there's certainly
the science aspect,

1196
00:50:34,030 --> 00:50:36,833
I can talk to the
engineering aspect.

1197
00:50:36,866 --> 00:50:39,702
One of the things that we
do with every EDL mission,

1198
00:50:39,735 --> 00:50:41,704
entry, descent, and landing,

1199
00:50:41,737 --> 00:50:43,039
is we gather a
lot of information

1200
00:50:43,072 --> 00:50:44,908
that we're getting
from the spacecraft

1201
00:50:44,941 --> 00:50:46,776
as it goes through that process.

1202
00:50:46,809 --> 00:50:47,911
Every single time we do that,

1203
00:50:47,944 --> 00:50:49,646
we learn something a
little bit different,

1204
00:50:49,679 --> 00:50:50,713
we change what we're doing,

1205
00:50:50,746 --> 00:50:52,749
we change the parameters

the next time,

1206
00:50:52,782 --> 00:50:54,684
maybe change a little bit
of the design of that,

1207
00:50:54,717 --> 00:50:58,955
so certainly, we're gonna
learn a lot from that activity,

1208
00:50:58,988 --> 00:51:01,758
and we'll feed that forward
to the future missions.

1209
00:51:03,626 --> 00:51:05,895
- Yeah, and of course, the
way we think about the future

1210
00:51:05,928 --> 00:51:10,700
mission is March
2020, is, even though

1211
00:51:10,733 --> 00:51:13,703
everything this
weekend, tomorrow,

1212
00:51:13,736 --> 00:51:15,805
is focused on InSight,
there's other people

1213
00:51:15,838 --> 00:51:17,874
here on this campus
that are worrying about

1214
00:51:17,907 --> 00:51:21,010
what's going to happen in 2020

1215
00:51:21,043 --> 00:51:24,047
when we're going
back with a rover

1216
00:51:24,080 --> 00:51:27,684
just as big as Curiosity,
and doing, really,

1217
00:51:27,717 --> 00:51:29,052
the first leg of
a sample return,

1218
00:51:29,085 --> 00:51:31,654
and it's that very information

1219
00:51:31,687 --> 00:51:34,624
that you just talked about,
information that teaches us

1220
00:51:34,657 --> 00:51:36,926
how to do safely these
entry, descent and landing,

1221
00:51:36,959 --> 00:51:39,662
as well as other things
about the atmosphere

1222
00:51:39,695 --> 00:51:41,097
and the environment
that will help us

1223
00:51:41,130 --> 00:51:43,833
with that mission
and many to come.

1224
00:51:43,866 --> 00:51:46,102
- All right, and
Bruce, couple questions

1225
00:51:46,135 --> 00:51:47,937
from Bill Tandy over on Twitter.

1226

00:51:47,970 --> 00:51:50,874
So, will the seismometer
collect science

1227
00:51:50,907 --> 00:51:54,010
as the heat flow probe
is hammering into Mars,

1228
00:51:54,043 --> 00:51:55,979
and what happens if
that probe encounters

1229
00:51:56,012 --> 00:51:58,815
a rock or ice as it descends?

1230
00:51:58,848 --> 00:52:01,584
- We're definitely gonna be
listening to the vibrations

1231
00:52:01,617 --> 00:52:02,685
that are gonna be put out

1232
00:52:02,718 --> 00:52:05,655
by that hammer of
our heat flow probe.

1233
00:52:05,688 --> 00:52:07,724
It's kind of a bonus
experiment for us.

1234
00:52:07,757 --> 00:52:10,126
It really is not
connected to our main goal

1235
00:52:10,159 --> 00:52:11,928
of looking at the deep interior.

1236
00:52:11,961 --> 00:52:15,698
The waves from that hammer
will probably penetrate

1237
00:52:15,731 --> 00:52:19,068
maybe 40 or 50 or possibly
100 feet down into the soil,

1238
00:52:19,101 --> 00:52:20,837
so it will give us information,

1239
00:52:20,870 --> 00:52:23,940
possibly about
layering in the soil

1240
00:52:23,973 --> 00:52:27,010
and the rocks right
underneath our lander,

1241
00:52:27,043 --> 00:52:30,880
and again, this is not something
that we planned originally,

1242
00:52:30,913 --> 00:52:34,751
but it's really kind of
taken the imagination

1243
00:52:34,784 --> 00:52:36,819
of the team, and a lot of
people have been working on that

1244
00:52:36,852 --> 00:52:37,954
and trying to figure out

1245
00:52:37,987 --> 00:52:39,122
how to make that
particular experiment work,

1246
00:52:39,155 --> 00:52:42,859
because it's just so
cool, it's just so fun.

1247

00:52:42,892 --> 00:52:46,696
So, as far as whether
it encounters a rock,

1248
00:52:46,729 --> 00:52:51,034
our mole is a pretty
muscular mole.

1249
00:52:51,067 --> 00:52:53,102
It can get around,
actually, smaller rocks.

1250
00:52:53,135 --> 00:52:56,739
Anything smaller than
about two inches or so,

1251
00:52:56,772 --> 00:52:58,741
it'll just push it aside.

1252
00:52:58,774 --> 00:53:00,877
If it gets to a larger
rock, it depends

1253
00:53:00,910 --> 00:53:03,079
on the slope of the face.

1254
00:53:03,112 --> 00:53:06,015
If it's a slanted face,
the mole will actually

1255
00:53:06,048 --> 00:53:08,818
work itself sideways
and go around the rock,

1256
00:53:08,851 --> 00:53:10,954
but if it hits a
flat, large rock,

1257
00:53:10,987 --> 00:53:13,089
that's just as far as it can go.

1258
00:53:13,122 --> 00:53:15,124
And we've looked
at the statistics

1259
00:53:15,157 --> 00:53:18,728
of how many rocks we
expect under the surface.

1260
00:53:18,761 --> 00:53:22,065
That's gone into, actually,
our choice of landing area,

1261
00:53:22,098 --> 00:53:25,034
of looking for a place with
few rocks on the surface

1262
00:53:25,067 --> 00:53:27,770
that we could extrapolate to
few rocks under the surface,

1263
00:53:27,803 --> 00:53:30,773
and so we feel like we
have, from our calculations,

1264
00:53:30,806 --> 00:53:33,943
a high probability of
success, of getting down

1265
00:53:33,976 --> 00:53:36,179
at least 10 feet,
which is deep enough

1266
00:53:36,212 --> 00:53:39,215
to do our measurements
easily, and probably

1267
00:53:39,248 --> 00:53:42,885
to the full 16 feet
that we're shooting for.

1268
00:53:42,918 --> 00:53:43,820
- [Stephanie] Veronica,
do we have time

1269
00:53:43,853 --> 00:53:45,021
for one more question?

1270
00:53:45,054 --> 00:53:46,155
- No.
- Agh.

1271
00:53:46,188 --> 00:53:47,223
- [Veronica] We're using
up time quickly here.

1272
00:53:47,256 --> 00:53:48,958
- Find us online.
- Exactly.

1273
00:53:48,991 --> 00:53:50,193
Not only will social
media, we'll continue

1274
00:53:50,226 --> 00:53:52,829
to answer your questions online,

1275
00:53:52,862 --> 00:53:54,063
but there's also
another show coming up

1276
00:53:54,096 --> 00:53:57,100
later on today at 1:00 p.m.
Pacific, 4:00 p.m. Eastern Time.

1277
00:53:57,133 --> 00:53:59,002
It is for all of our social
media attendees today,

1278

00:53:59,035 --> 00:54:01,137
it's another opportunity
for a lot of great Q and A

1279
00:54:01,170 --> 00:54:02,772
with the mission team members,

1280
00:54:02,805 --> 00:54:04,907
so if you don't hear
your question now,

1281
00:54:04,940 --> 00:54:07,010
you might hear it in that show.

1282
00:54:07,043 --> 00:54:09,779
I've got one more,
Leo Enright, Irish TV,

1283
00:54:09,812 --> 00:54:11,247
you've got a followup
question on the phone line,

1284
00:54:11,280 --> 00:54:13,182
and go ahead.

1285
00:54:13,215 --> 00:54:16,119
- [Leo] Oh, thank you very
much indeed, Veronica.

1286
00:54:16,152 --> 00:54:18,054
Appreciate it, I
was just wondering

1287
00:54:18,087 --> 00:54:21,891
about this TCM tonight,
it's I think about midnight

1288
00:54:21,924 --> 00:54:25,061
our time here in
Europe, how important

1289
00:54:25,094 --> 00:54:29,232
will the New Norcia
ESA tracking station

1290
00:54:29,265 --> 00:54:31,167
in Western Australia be?

1291
00:54:31,200 --> 00:54:34,037
I know it's scheduled
to be watching out,

1292
00:54:34,070 --> 00:54:35,972
but has it suddenly
gained an importance

1293
00:54:36,005 --> 00:54:39,309
that it didn't have, now
that you have this burn?

1294
00:54:40,876 --> 00:54:41,811
- Well, we always
appreciate the support

1295
00:54:41,844 --> 00:54:43,079
that we've been getting from it,

1296
00:54:43,112 --> 00:54:46,082
but we're actually not going
to be using that for anything

1297
00:54:46,115 --> 00:54:48,985
related to the trajectory
correction maneuver coming up.

1298
00:54:49,018 --> 00:54:51,921
We don't have really
time to do much tracking

1299

00:54:51,954 --> 00:54:55,058
after that trajectory correction
maneuver this afternoon,

1300
00:54:55,091 --> 00:54:57,260
and so, we're gonna do it,
and we're gonna be targeted

1301
00:54:57,293 --> 00:55:00,063
where we wanna go, and
that's gonna be kinda it.

1302
00:55:03,232 --> 00:55:05,034
- Okay, for those
of you in the room,

1303
00:55:05,067 --> 00:55:06,269
you'll have an
opportunity to come up

1304
00:55:06,302 --> 00:55:09,005
and ask them some questions
when we're off the air.

1305
00:55:09,038 --> 00:55:11,140
I do wanna wrap the
broadcast at this time,

1306
00:55:11,173 --> 00:55:13,309
so I wanna thank all the
speakers for being here today.

1307
00:55:13,342 --> 00:55:18,348
Great information.
[audience applauding]

1308
00:55:22,952 --> 00:55:24,253
Okay, and for all
of you watching,

1309

00:55:24,286 --> 00:55:28,091
a reminder that
we land tomorrow.

1310
00:55:28,124 --> 00:55:31,961
Our commentary begins at
2:00 a.m. Pacific Time,

1311
00:55:31,994 --> 00:55:34,097
I'm sorry, let me
correct that, 11:00 a.m.

1312
00:55:34,130 --> 00:55:35,331
[audience laughing]

1313
00:55:35,364 --> 00:55:38,301
Commentary begins at
11:00 a.m. Pacific Time,

1314
00:55:38,334 --> 00:55:41,003
2:00 p.m. Eastern Time,
landing takes place

1315
00:55:41,036 --> 00:55:43,339
about an hour into
the show there,

1316
00:55:43,372 --> 00:55:45,975
maybe 50 minutes, so tune in.

1317
00:55:46,008 --> 00:55:47,944
There's multiple ways to watch.

1318
00:55:47,977 --> 00:55:51,180
You can go to nasa.gov/live,

1319
00:55:51,213 --> 00:55:53,116
you can see the broadcast there.

1320

00:55:53,149 --> 00:55:55,218
You can also check out
our InSight Toolkit,

1321
00:55:55,251 --> 00:55:57,286
because it gives
you multiple options

1322
00:55:57,319 --> 00:55:59,188
for watching the live stream.

1323
00:55:59,221 --> 00:56:03,226
That is at
go.nasa.gov/InSightToolkit.

1324
00:56:05,928 --> 00:56:08,164
You'll learn where we will
be feeding to YouTube,

1325
00:56:08,197 --> 00:56:12,135
to Facebook, also, our
live 360 degree feed

1326
00:56:12,168 --> 00:56:14,137
from inside mission control.

1327
00:56:14,170 --> 00:56:15,371
There's also a tab on that site

1328
00:56:15,404 --> 00:56:17,306
that says Watch In Person.

1329
00:56:17,339 --> 00:56:19,041
Click there if
you wanna find out

1330
00:56:19,074 --> 00:56:21,010
where there is an in
person viewing event

1331
00:56:21,043 --> 00:56:22,145
that you can attend.

1332
00:56:22,178 --> 00:56:24,313
There are events taking
place from Los Angeles

1333
00:56:24,346 --> 00:56:26,249
to New York, even in
Times Square tomorrow,

1334
00:56:26,282 --> 00:56:28,184
if you happen to
be out in the cold,

1335
00:56:28,217 --> 00:56:30,353
you can watch from
multiple locations.

1336
00:56:31,420 --> 00:56:34,190
We will be back, as I
mentioned, at 1:00 p.m.

1337
00:56:34,223 --> 00:56:37,994
Pacific Time today, with
the NASA Social Show,

1338
00:56:38,027 --> 00:56:41,998
and again, commentary
tomorrow, 11:00 a.m. Pacific,

1339
00:56:42,031 --> 00:56:44,200
2:00 p.m. Eastern
Time, thank you all