
Jet Propulsion Labor

1
00:01:25,084 --> 00:01:27,687
[upbeat music]

2
00:02:09,461 --> 00:02:12,932
- After traveling through
space for more than six months

3
00:02:12,965 --> 00:02:15,902
and crossing 300 million miles

4
00:02:15,935 --> 00:02:18,704
InSight has reached
its destination,

5
00:02:18,737 --> 00:02:20,740
the red planet Mars,

6
00:02:20,773 --> 00:02:22,241
welcome to Mission Control

7
00:02:22,274 --> 00:02:25,845
at NASA's Jet Propulsion
Laboratory, I'm Gay Yee Hill.

8
00:02:25,878 --> 00:02:27,747
Less than an hour
from now InSight

9
00:02:27,780 --> 00:02:29,215
will begin the most harrowing

10
00:02:29,248 --> 00:02:32,285
six and a half minutes
of the entire mission,

11
00:02:32,318 --> 00:02:33,219
EDL,

12

00:02:33,252 --> 00:02:35,555
entry, descent and landing,

13
00:02:35,588 --> 00:02:38,057
the team is as
prepared as it can be,

14
00:02:38,090 --> 00:02:41,260
but who knows what Mars
has in store today.

15
00:02:41,293 --> 00:02:42,895
The cruise mission support area

16
00:02:42,928 --> 00:02:46,232
is filled with engineers
monitoring the situation,

17
00:02:46,265 --> 00:02:48,968
and for the first time
during a Mars landing

18
00:02:49,001 --> 00:02:51,003
you can be in the room too,

19
00:02:51,036 --> 00:02:54,707
we have a 360 degree camera
in this control room,

20
00:02:54,740 --> 00:02:56,442
allowing you to experience

21
00:02:56,475 --> 00:02:59,045
the landing right
along with the team.

22
00:02:59,078 --> 00:03:00,213
There you see it,

23

00:03:00,246 --> 00:03:01,581
and to look up the link,

24
00:03:01,614 --> 00:03:04,584
just go to the
InSight watch page

25
00:03:04,617 --> 00:03:06,419
you see there on the screen.

26
00:03:07,753 --> 00:03:10,623
And this mission has
actually two control rooms,

27
00:03:10,656 --> 00:03:12,692
the second is that
Lockheed Martin Space

28
00:03:12,725 --> 00:03:15,127
outside of Denver Colorado,

29
00:03:15,160 --> 00:03:18,664
engineers there
are on console two.

30
00:03:18,697 --> 00:03:21,934
Plus people all over
the world are tuning in

31
00:03:21,967 --> 00:03:25,004
at museums and libraries
and other locations,

32
00:03:25,037 --> 00:03:29,041
including this one at the
Pasadena Convention Center,

33
00:03:29,074 --> 00:03:32,111
and that's where friends
and family are watching now,

34
00:03:33,679 --> 00:03:36,215
there will also be an
opportunity to watch
in New York City,

35
00:03:36,248 --> 00:03:37,850
there they are cheering,

36
00:03:37,883 --> 00:03:40,686
there will also be
an opportunity to
watch in New York City

37
00:03:40,719 --> 00:03:43,990
when landing coverage gets
displayed on the NASDAQ Tower,

38
00:03:44,023 --> 00:03:45,891
you see there in Times Square.

39
00:03:45,924 --> 00:03:47,893
And of course if
you are watching

40
00:03:47,926 --> 00:03:50,429
please snap a picture
and share it with us,

41
00:03:50,462 --> 00:03:53,132
using the hashtag Mars landing,

42
00:03:53,165 --> 00:03:54,500
we'd love to see it.

43
00:03:54,533 --> 00:03:55,835
Now I'd like to introduce you

44
00:03:55,868 --> 00:03:58,638

to NASA administrator
Jim Bridenstine,

45
00:03:58,671 --> 00:03:59,905
thank you for coming.

46
00:03:59,938 --> 00:04:01,707
- Oh it's my honor,
thank you for having me.

47
00:04:01,740 --> 00:04:02,541
- We are so excited
to have you here.

48
00:04:02,574 --> 00:04:03,776
- Great to be here.

49
00:04:03,809 --> 00:04:04,644
- So this is your
first Mars landing?

50
00:04:04,677 --> 00:04:06,446
- It is in this job,

51
00:04:07,446 --> 00:04:10,016
I have witnessed these I should

52
00:04:10,049 --> 00:04:12,485
say from the sidelines
for many years,

53
00:04:12,518 --> 00:04:13,853
this is gonna be the eighth

54
00:04:13,886 --> 00:04:16,122
time we have a successful
landing on Mars,

55
00:04:16,155 --> 00:04:17,356

everybody knock on wood.

56
00:04:17,389 --> 00:04:18,291
- That's right.

57
00:04:18,324 --> 00:04:19,592
- But this is the first time

58
00:04:19,625 --> 00:04:22,028
for me to participate
as the administrator,

59
00:04:22,061 --> 00:04:22,862
so it's very exciting.

60
00:04:22,895 --> 00:04:24,397
- Excited, nervous?

61
00:04:24,430 --> 00:04:25,998
- Not nervous, excited.
- Not nervous?

62
00:04:26,031 --> 00:04:27,500
- Look at the
amazing people here,

63
00:04:27,533 --> 00:04:29,635
no way I could be nervous.

64
00:04:29,668 --> 00:04:33,339
- Alright, so we hope to have
you back on set after landing

65
00:04:33,372 --> 00:04:36,142
and maybe take a couple
of social media questions.

66
00:04:36,175 --> 00:04:37,610
- Absolutely.

67
00:04:37,643 --> 00:04:40,012
- If you would like to ask
the administrator a question,

68
00:04:40,045 --> 00:04:42,415
use the hashtag askNASA.

69
00:04:42,448 --> 00:04:46,118
And before you go you did
ask about the lucky peanuts,

70
00:04:46,151 --> 00:04:50,256
so this is your bottle
to take in there.

71
00:04:50,289 --> 00:04:51,490
- I will be happily
munching on these.

72
00:04:51,523 --> 00:04:52,958
- Alright thanks for joining us.

73
00:04:52,991 --> 00:04:54,193
- Thank you.

74
00:04:54,226 --> 00:04:55,461
- Now let's give
you some background,

75
00:04:55,494 --> 00:04:58,698
InSight is short for
Interior Exploration

76
00:04:58,731 --> 00:05:03,536
using Seismic Investigations
Geodesy and Heat Transport,

77
00:05:03,569 --> 00:05:05,705

it's different from
other Mars missions

78
00:05:05,738 --> 00:05:07,773
which all studied the surface,

79
00:05:07,806 --> 00:05:09,308
InSight is the first mission

80
00:05:09,341 --> 00:05:12,578
to study the interior
of the red planet.

81
00:05:14,246 --> 00:05:15,614
The basic idea of InSight

82
00:05:15,647 --> 00:05:19,618
is to map out the deep
structure of March,

83
00:05:19,651 --> 00:05:21,354
we know a lot about
the surface of Mars,

84
00:05:21,387 --> 00:05:23,356
we know a lot about
its atmosphere,

85
00:05:23,389 --> 00:05:25,124
even about its ionosphere,

86
00:05:25,157 --> 00:05:26,392
but we don't know very much

87
00:05:26,425 --> 00:05:29,362
about what goes on a
mile below the surface,

88
00:05:29,395 --> 00:05:31,564

much less 2000 miles below the
surface down to the center,

89
00:05:31,597 --> 00:05:32,865
and this will be
the first mission

90
00:05:32,898 --> 00:05:34,200
that is going to
Mars specifically

91
00:05:34,233 --> 00:05:37,903
to investigate the
deep inside of Mars.

92
00:05:37,936 --> 00:05:39,905
- We know that the
Earth is habitable,

93
00:05:39,938 --> 00:05:41,774
we know that Mars is not,

94
00:05:41,807 --> 00:05:43,642
there might be something
that we find out

95
00:05:43,675 --> 00:05:46,178
in terms of the
structure of Mars

96
00:05:46,211 --> 00:05:47,947
versus the structure of Earth,

97
00:05:47,980 --> 00:05:51,050
that maybe can help us
understand why that is.

98
00:05:51,083 --> 00:05:53,185
- InSight carries a
seismometer which measures

99
00:05:53,218 --> 00:05:54,954
the seismic waves
that have travel

100
00:05:54,987 --> 00:05:56,655
through Mars from Marsquakes,

101
00:05:56,688 --> 00:05:59,925
and maps out the deep
interior structure of Mars,

102
00:05:59,958 --> 00:06:02,695
we're gonna also
have a heat flow

103
00:06:02,728 --> 00:06:04,230
and physical properties probe,

104
00:06:04,263 --> 00:06:06,899
which will penetrate into the
Mars surface about five meters

105
00:06:06,932 --> 00:06:10,403
or 16 feet to take the
temperature on Mars.

106
00:06:10,436 --> 00:06:12,405
And it has a radio
science experiment

107
00:06:12,438 --> 00:06:14,473
which uses the radio
on the spacecraft

108
00:06:14,506 --> 00:06:18,978
to measure small variations
in the wobble of Mars' poles

109

00:06:19,011 --> 00:06:20,813
to understand more
about the structure

110
00:06:20,846 --> 00:06:22,782
and composition of the core.

111
00:06:26,151 --> 00:06:28,220
- InSight will be
the first mission

112
00:06:28,253 --> 00:06:30,489
to pick instruments off the deck

113
00:06:30,522 --> 00:06:33,125
of the Lander and place
them on the surface of Mars.

114
00:06:33,158 --> 00:06:34,326
I like to say that
we are playing

115
00:06:34,359 --> 00:06:36,863
the claw game on Mars
with no joystick.

116
00:06:38,297 --> 00:06:40,232
The seismometer needs to
be installed in one place

117
00:06:40,265 --> 00:06:44,437
and not move in order to
get the best seismic data.

118
00:06:44,470 --> 00:06:47,339
- [Bruce] We also have a
wind and thermal shield

119
00:06:47,372 --> 00:06:49,074
that we place on top

of that seismometer

120
00:06:49,107 --> 00:06:51,444
to protect it further
from the environment.

121
00:06:52,578 --> 00:06:55,414
- [Jaime] For the
heat flow probe, HPQ,

122
00:06:55,447 --> 00:06:57,316
it also needs to
sit in one place,

123
00:06:57,349 --> 00:07:00,653
take a while to hammer
itself down into the ground

124
00:07:00,686 --> 00:07:02,188
and acquire the
demo measurements

125
00:07:02,221 --> 00:07:03,723
over a long period of time.

126
00:07:07,559 --> 00:07:08,928
- InSight is a mission to Mars,

127
00:07:08,961 --> 00:07:10,796
but it's much, much more
than a Mars mission,

128
00:07:10,829 --> 00:07:12,798
in some sense it's
like a time machine,

129
00:07:12,831 --> 00:07:15,000
it's measuring the
structure of Mars

130
00:07:15,033 --> 00:07:17,837
that was put in place four
and a half billion years ago,

131
00:07:17,870 --> 00:07:20,940
so we can go back and
understand the processes

132
00:07:20,973 --> 00:07:22,675
that formed Mars just shortly

133
00:07:22,708 --> 00:07:25,611
after it was accreted
from the solar nebula.

134
00:07:25,644 --> 00:07:28,147
By studying Mars we'll
be able to learn more

135
00:07:28,180 --> 00:07:31,317
about Earth, Venus,
Mercury, even the moon,

136
00:07:31,350 --> 00:07:33,786
even exoplanets
around other stars.

137
00:07:36,021 --> 00:07:39,692
- Landing on Mars
is always difficult,

138
00:07:39,725 --> 00:07:42,127
more than half the
missions have failed,

139
00:07:42,160 --> 00:07:43,996
our experts in this field

140
00:07:44,029 --> 00:07:47,733

our systems engineers for
entry, descent and landing,

141
00:07:47,766 --> 00:07:49,268
they speak EDL.

142
00:07:49,301 --> 00:07:51,937
Let me introduce you to
two in our control room,

143
00:07:51,970 --> 00:07:54,006
Christine Szalai,
who will be making

144
00:07:54,039 --> 00:07:55,674
the mission callouts
during landing,

145
00:07:55,707 --> 00:07:57,176
and Julie Wertz Chen,

146
00:07:57,209 --> 00:07:59,144
She is our color commentator

147
00:07:59,177 --> 00:08:01,981
who will help explain
mission operations.

148
00:08:02,014 --> 00:08:03,716
Christine let's start with you,

149
00:08:03,749 --> 00:08:06,852
I understand that
there was a funnel

150
00:08:06,885 --> 00:08:08,787
software update and adjustment,

151
00:08:08,820 --> 00:08:10,122

what does that mean?

152
00:08:10,155 --> 00:08:11,590
- That's right,

153
00:08:11,623 --> 00:08:14,059
yesterday we sent the last
EDL software parameter

154
00:08:14,092 --> 00:08:16,629
update to the
spacecraft's computer,

155
00:08:16,662 --> 00:08:18,831
this update told the
spacecraft exactly

156
00:08:18,864 --> 00:08:21,567
when it will hit the
top of the atmosphere,

157
00:08:21,600 --> 00:08:25,771
and also fine tune things like
when to deploy the parachute,

158
00:08:25,804 --> 00:08:27,806
this ADL software
is very important,

159
00:08:27,839 --> 00:08:29,808
because InSight
uses this software

160
00:08:29,841 --> 00:08:34,079
to perform entry, descent and
landing completely on its own,

161
00:08:34,112 --> 00:08:35,981
Mars is so far away from Earth

162
00:08:36,014 --> 00:08:37,583
that when a command
is sent from Earth

163
00:08:37,616 --> 00:08:41,120
it takes about eight minutes
for it to reach the spacecraft,

164
00:08:41,153 --> 00:08:42,655
entry, descent and
landing from start

165
00:08:42,688 --> 00:08:45,357
to finish is less than
eight minutes long,

166
00:08:45,390 --> 00:08:48,027
so InSight has to do
this all by itself.

167
00:08:48,060 --> 00:08:50,763
- Alright, it's fate is sealed.

168
00:08:50,796 --> 00:08:52,765
Now I understand
that the team is

169
00:08:52,798 --> 00:08:54,800
about to do a readiness poll,

170
00:08:54,833 --> 00:08:57,002
Julie can you fill
us in on that?

171
00:08:57,035 --> 00:08:59,271
- Sure, so that's
gonna be a poll,

172
00:08:59,304 --> 00:09:01,373

between our EDL
communications engineer

173
00:09:01,406 --> 00:09:04,176
and several of the
different orbiters

174
00:09:04,209 --> 00:09:05,844
and antennas we
have here on Earth,

175
00:09:05,877 --> 00:09:08,247
so we have MarCO
listening in on us,

176
00:09:08,280 --> 00:09:10,816
and MRO, which is Mars
Reconnaissance Orbiter,

177
00:09:10,849 --> 00:09:13,852
will be listening to our
data and recording it for us,

178
00:09:13,885 --> 00:09:15,955
and then the radio
science engineers

179
00:09:15,988 --> 00:09:18,023
will be eavesdropping
in on our signal

180
00:09:18,056 --> 00:09:19,725
from all the way
back here on Earth,

181
00:09:19,758 --> 00:09:22,061
and Sandy, our EDL
communications engineer

182
00:09:22,094 --> 00:09:23,295

we'll be checking in with them,

183
00:09:23,328 --> 00:09:24,964
making sure that they
are all ready to go,

184
00:09:24,997 --> 00:09:28,100
ready to support us
in just a little under

185
00:09:28,133 --> 00:09:29,769
an hour to land on Mars.

186
00:09:31,737 --> 00:09:33,772
- Alright so we're
standing by for that,

187
00:09:33,805 --> 00:09:35,574
for that readiness poll.

188
00:09:35,607 --> 00:09:38,143
And I understand
that the peanuts

189
00:09:38,176 --> 00:09:40,412
are going to be passed
in there pretty soon?

190
00:09:40,445 --> 00:09:42,147
- I believe that's
the idea yeah,

191
00:09:42,180 --> 00:09:44,717
we'll be passing around the
peanuts very soon after that,

192
00:09:44,750 --> 00:09:46,118
for those of you who don't know,

193

00:09:46,151 --> 00:09:49,221
the JPL peanuts are a tradition,

194
00:09:49,254 --> 00:09:50,623
it gives us a
little bit of extra

195
00:09:50,656 --> 00:09:52,992
luck on our critical events,

196
00:09:53,025 --> 00:09:55,060
so if anybody out there
wants to join in on peanuts

197
00:09:55,093 --> 00:09:57,997
and give us some extra
good luck peanuts vibe,

198
00:09:58,030 --> 00:09:59,231
we'd love to have it.

199
00:09:59,264 --> 00:10:01,700
- Well there's a
story behind that,

200
00:10:01,733 --> 00:10:04,970
that way back when in
the early days of JPL

201
00:10:05,003 --> 00:10:06,572
there were several missions,

202
00:10:06,605 --> 00:10:11,310
and there were six
Ranger missions to
the moon that failed,

203
00:10:12,177 --> 00:10:13,412
but then with Ranger seven--

204
00:10:13,445 --> 00:10:14,680
- Ranger seven somebody--

205
00:10:14,713 --> 00:10:16,782
- [Gay] Somebody
passed around peanuts.

206
00:10:16,815 --> 00:10:18,017
- Yeah, and it worked,

207
00:10:18,050 --> 00:10:19,184
and you don't mess
with what works,

208
00:10:19,217 --> 00:10:21,954
it's not a superstition,
it's a tradition,

209
00:10:21,987 --> 00:10:25,491
and we just give yourselves
that little bit of extra luck.

210
00:10:25,524 --> 00:10:27,393
- So if you have
peanuts at home,

211
00:10:27,426 --> 00:10:28,293
please have some.

212
00:10:28,326 --> 00:10:29,094
- [Julie] That's right.

213
00:10:29,127 --> 00:10:30,996
- Alright, thanks Julie.

214
00:10:31,029 --> 00:10:34,066
NASA has had seven
successful Mars landings,

215
00:10:34,099 --> 00:10:38,570
but the EDL team never
ever becomes overconfident,

216
00:10:38,603 --> 00:10:40,773
JPL chief engineer Rob Manning

217
00:10:40,806 --> 00:10:43,375
says things have
to work just right

218
00:10:43,408 --> 00:10:46,646
during six and a half
critical minutes.

219
00:10:48,280 --> 00:10:51,183
[dramatic music]

220
00:10:51,216 --> 00:10:52,951
- Although we've done it before,

221
00:10:52,984 --> 00:10:54,720
landing on Mars is hard,

222
00:10:54,753 --> 00:10:56,722
and this mission
is no different.

223
00:10:58,156 --> 00:10:59,625
The process to get from the top

224
00:10:59,658 --> 00:11:01,727
of the atmosphere of
Mars to this surface,

225
00:11:01,760 --> 00:11:03,729
we call entry,
descent and landing,

226
00:11:03,762 --> 00:11:05,264
or EDL,

227
00:11:05,297 --> 00:11:07,733
it takes thousands
of steps to go

228
00:11:07,766 --> 00:11:09,935
from the top of the
atmosphere to the surface,

229
00:11:09,968 --> 00:11:11,403
and each one of them has

230
00:11:11,436 --> 00:11:14,473
to work perfectly to be
a successful mission.

231
00:11:15,373 --> 00:11:17,710
The process starts well above

232
00:11:17,743 --> 00:11:19,812
the top of the
atmosphere of Mars,

233
00:11:19,845 --> 00:11:22,681
the cruise stage faces the sun,

234
00:11:22,714 --> 00:11:27,252
it also has its radio
antenna which faces Earth,

235
00:11:27,285 --> 00:11:29,488
but now we don't need
the cruise stage,

236
00:11:29,521 --> 00:11:31,390
its job is done.

237
00:11:31,423 --> 00:11:33,025
The next step just seven minutes

238
00:11:33,058 --> 00:11:35,594
before arriving to the
top of the Mars atmosphere

239
00:11:35,627 --> 00:11:37,796
is to separate the cruise stage,

240
00:11:37,829 --> 00:11:40,866
before you hit the top
of the atmosphere though,

241
00:11:40,899 --> 00:11:43,268
the space capsule
has to orient itself

242
00:11:43,301 --> 00:11:47,573
so that the heat shield is
precisely facing the atmosphere.

243
00:11:48,607 --> 00:11:50,209
Now the fun begins,

244
00:11:50,242 --> 00:11:54,546
the vehicle is moving at
nearly 13,000 miles an hour,

245
00:11:54,579 --> 00:11:56,081
but it's hitting the
top of the atmosphere

246
00:11:56,114 --> 00:11:57,783
at a very shallow angle,

247
00:11:57,816 --> 00:11:59,118
12 degrees,

248
00:11:59,151 --> 00:12:00,552
any steeper,

249
00:12:00,585 --> 00:12:02,354
the vehicle will hit the
thicker part of the atmosphere

250
00:12:02,387 --> 00:12:04,256
and will melt and burn out,

251
00:12:04,289 --> 00:12:05,724
any shallower,

252
00:12:05,757 --> 00:12:08,393
the vehicle will bounce
off the atmosphere of Mars,

253
00:12:08,426 --> 00:12:10,028
at the very top the atmosphere

254
00:12:10,061 --> 00:12:13,298
it's about 70 miles above
the surface of Mars,

255
00:12:13,331 --> 00:12:15,834
and the air is starting to
get thicker and thicker,

256
00:12:15,867 --> 00:12:17,069
as it does that,

257
00:12:17,102 --> 00:12:18,337
the temperature
in the heat shield

258
00:12:18,370 --> 00:12:20,639
gets well over 1000
degrees centigrade,

259
00:12:20,672 --> 00:12:22,441
enough to melt steel,

260
00:12:22,474 --> 00:12:23,776
over the next two minutes,

261
00:12:23,809 --> 00:12:25,144
the vehicle decelerates

262
00:12:25,177 --> 00:12:27,913
at a backbreaking 12 Earth Gs,

263
00:12:27,946 --> 00:12:31,850
from 13,000 miles an hour
to about 1000 miles an hour,

264
00:12:31,883 --> 00:12:34,853
at about 10 miles above
the surface of Mars,

265
00:12:34,886 --> 00:12:37,523
a supersonic
parachute is launched

266
00:12:37,556 --> 00:12:39,224
out of the back of the vehicle,

267
00:12:39,257 --> 00:12:41,693
15 seconds after the
parachute inflates,

268
00:12:41,726 --> 00:12:43,529
it's time to get rid
of the heat shield,

269
00:12:43,562 --> 00:12:47,132
six pyrotechnic devices
fire simultaneously

270
00:12:47,165 --> 00:12:50,202
allowing the heat shield
to fall and tumble away

271
00:12:50,235 --> 00:12:54,740
from the vehicle exposing the
lander to the surface of Mars.

272
00:12:54,773 --> 00:12:56,241
10 seconds after the
heat shield is dropped,

273
00:12:56,274 --> 00:12:58,944
three pyrotechnically
deployed legs

274
00:12:58,977 --> 00:13:01,747
are released and
locked for landing.

275
00:13:01,780 --> 00:13:05,017
About a minute later, the
landing RADAR is turned on,

276
00:13:05,050 --> 00:13:08,053
sending pulses toward
the surface of Mars,

277
00:13:08,086 --> 00:13:10,222
as the vehicle starts
to try to measure

278
00:13:10,255 --> 00:13:12,224
how high it is
above the surface,

279
00:13:12,257 --> 00:13:14,092
and how fast it's going.

280

00:13:14,125 --> 00:13:16,528
At about a mile above
the surface of Mars,

281
00:13:16,561 --> 00:13:18,931
the lander falls away
from the back shell

282
00:13:18,964 --> 00:13:20,632
and lights its engines.

283
00:13:20,665 --> 00:13:24,436
And very quickly the vehicle
must rotate out of the way,

284
00:13:24,469 --> 00:13:25,838
so that the parachute

285
00:13:25,871 --> 00:13:28,473
and the back shield doesn't
come down to hit it,

286
00:13:28,506 --> 00:13:30,475
the last thing
that has to happen,

287
00:13:30,508 --> 00:13:32,744
is that in the moment of contact

288
00:13:32,777 --> 00:13:36,315
the engines have to
shut down immediately,

289
00:13:36,348 --> 00:13:39,117
if they don't the
vehicle will tip over.

290
00:13:39,150 --> 00:13:42,354
So with all the steps
of entry, descent

291
00:13:42,387 --> 00:13:44,556
and landing happen perfectly

292
00:13:44,589 --> 00:13:47,192
and we are safely on
the surface of Mars,

293
00:13:47,225 --> 00:13:50,496
we'll be ready to do some
exciting new science.

294
00:13:56,935 --> 00:13:58,437
- Person later on
in the program,

295
00:13:58,470 --> 00:14:00,672
meantime let me
introduce you to someone

296
00:14:00,705 --> 00:14:03,709
who has been working on
InSight for seven years,

297
00:14:03,742 --> 00:14:06,511
he's the project
manager Tom Hoffman,

298
00:14:06,544 --> 00:14:09,314
seven years and
today is the day.

299
00:14:09,347 --> 00:14:10,515
- That's right, seven years,

300
00:14:10,548 --> 00:14:13,018
but we're just a little
over 40 minutes now

301

00:14:13,051 --> 00:14:14,887
and we're gonna be on the
surface, it's gonna be awesome.

302
00:14:14,920 --> 00:14:16,288
- Really exciting stuff.

303
00:14:17,289 --> 00:14:19,124
So let's talk about InSight,

304
00:14:19,157 --> 00:14:21,393
it's using tried
and true technology,

305
00:14:21,426 --> 00:14:22,861
based on the Phoenix,

306
00:14:22,894 --> 00:14:27,032
this time there's a bigger
challenge with communication,

307
00:14:27,065 --> 00:14:28,600
normally we have an orbiter

308
00:14:28,633 --> 00:14:31,336
that can give us bent
pipe communications,

309
00:14:31,369 --> 00:14:33,238
but it's different this time.

310
00:14:33,271 --> 00:14:34,406
- That's right, most

311
00:14:34,439 --> 00:14:35,207
of the time when
we've landed recently,

312
00:14:35,240 --> 00:14:36,441

we've had Mars Odyssey

313
00:14:36,474 --> 00:14:37,943
which can do bent
pipe communications,

314
00:14:37,976 --> 00:14:40,779
and so we get real-time
data as we go through EDL,

315
00:14:40,812 --> 00:14:42,014
and we've come to expect that

316
00:14:42,047 --> 00:14:44,750
and actually we really,
really want that.

317
00:14:44,783 --> 00:14:46,685
In this case our
primary technology,

318
00:14:46,718 --> 00:14:49,354
primary orbiter is Mars
Reconnaissance Orbiter,

319
00:14:49,387 --> 00:14:51,356
and so what that's gonna
be doing is actually

320
00:14:51,389 --> 00:14:53,091
will be listening
to us on the UHF,

321
00:14:53,124 --> 00:14:55,494
if you go to the video
you can see this,

322
00:14:55,527 --> 00:14:57,195
MRO will be listening to us

323
00:14:57,228 --> 00:14:59,131
and be getting all
the primary data,

324
00:14:59,164 --> 00:15:00,832
and it will send it back to us,

325
00:15:00,865 --> 00:15:03,468
unfortunately only three
hours after we land.

326
00:15:03,501 --> 00:15:05,203
- So it doesn't give
us the bent pipe

327
00:15:05,236 --> 00:15:08,006
live information as it happens?

328
00:15:08,039 --> 00:15:09,474
- It doesn't,

329
00:15:09,507 --> 00:15:10,842
we have a couple of other
sources that we're looking at,

330
00:15:10,875 --> 00:15:12,945
we have at Green Bay
Observatory in West Virginia,

331
00:15:12,978 --> 00:15:15,347
Max Planck Observatory
in Effelsberg, Germany,

332
00:15:15,380 --> 00:15:17,015
which will be giving us UHF,

333
00:15:17,048 --> 00:15:19,751
but those only give us a couple
of different points in time,

334
00:15:19,784 --> 00:15:21,887
and so we did something
kind of cool this time,

335
00:15:21,920 --> 00:15:25,891
we brought along a couple
of Cubesats called MarCO,

336
00:15:25,924 --> 00:15:28,260
so hopefully they're
both working great today.

337
00:15:28,293 --> 00:15:29,461
- [Gay] Oh, fantastic.

338
00:15:29,494 --> 00:15:30,629
- So we're hoping
they're gonna continue

339
00:15:30,662 --> 00:15:32,030
to work all the way through EDL,

340
00:15:32,063 --> 00:15:34,433
and they will be giving
us real-time feed,

341
00:15:34,466 --> 00:15:38,103
so we can show how that
works on the next video here.

342
00:15:38,136 --> 00:15:39,938
So you can see here's InSight

343
00:15:39,971 --> 00:15:42,874
with its cruise stage
getting close to Mars,

344
00:15:42,907 --> 00:15:44,743

but we have two
stalkers following us,

345
00:15:44,776 --> 00:15:46,244
they've been following
us since we launched,

346
00:15:46,277 --> 00:15:48,480
they launched on the same
launch vehicle as us,

347
00:15:48,513 --> 00:15:49,681
so you can see the green there

348
00:15:49,714 --> 00:15:51,917
is we're sending
UHF signals to them,

349
00:15:51,950 --> 00:15:53,285
and then they turn
that around and send

350
00:15:53,318 --> 00:15:55,120
a much stronger
signal back to Earth,

351
00:15:55,153 --> 00:15:56,788
we can't communicate
on UHF direct

352
00:15:56,821 --> 00:15:58,256
to Earth with this signal,

353
00:15:58,289 --> 00:15:59,891
that tells us what's going
on in the spacecraft,

354
00:15:59,924 --> 00:16:01,393
but MarCO can,

355
00:16:01,426 --> 00:16:03,028
if it works for us all the
way down to the surface

356
00:16:03,061 --> 00:16:05,263
we're gonna have some great
information coming from MarCO.

357
00:16:05,296 --> 00:16:07,432
- So MarCO is basically
trying to fill

358
00:16:07,465 --> 00:16:09,001
that gap that we would have had

359
00:16:09,034 --> 00:16:12,437
if we had live communication
coming down to us.

360
00:16:12,470 --> 00:16:13,372
- Absolutely.

361
00:16:13,405 --> 00:16:14,639
- So if it does not work does

362
00:16:14,672 --> 00:16:17,309
it affect InSight's
mission at all?

363
00:16:17,342 --> 00:16:18,543
- No not at all,

364
00:16:18,576 --> 00:16:20,746
we'll just be doing a
little more nailbiting,

365
00:16:20,779 --> 00:16:23,181
but right now it looks
like it's gonna be working,

366
00:16:23,214 --> 00:16:25,017
but it doesn't impact
InSight at all,

367
00:16:25,050 --> 00:16:26,818
and we have one final
way that we're gonna

368
00:16:26,851 --> 00:16:29,354
know that we've got
successfully to the ground,

369
00:16:29,387 --> 00:16:30,756
which is the spacecraft
will phone home,

370
00:16:30,789 --> 00:16:31,923
once it gets down to the ground,

371
00:16:31,956 --> 00:16:34,026
it's gone seven
months through cruise,

372
00:16:34,059 --> 00:16:35,293
seven and a half
minutes of terror,

373
00:16:35,326 --> 00:16:36,962
and it's gonna call back and say

374
00:16:36,995 --> 00:16:39,164
I'm on the surface I'm
feeling pretty good,

375
00:16:39,197 --> 00:16:40,699
everything looks good so far.

376
00:16:40,732 --> 00:16:43,068

- And also to prep the audience,

377
00:16:43,101 --> 00:16:45,637
even after landing we're not out

378
00:16:45,670 --> 00:16:47,439
of the woods just yet, correct?

379
00:16:47,472 --> 00:16:48,673
- Not just yet,

380
00:16:48,706 --> 00:16:50,008
we have one more step
that we have to do,

381
00:16:50,041 --> 00:16:52,110
we have to let the dust
settle quite literally,

382
00:16:52,143 --> 00:16:54,179
we're gonna kick up a
lot of dust when we land,

383
00:16:54,212 --> 00:16:55,580
we need to let that dust settle,

384
00:16:55,613 --> 00:16:57,816
before we unfurl
our solar arrays,

385
00:16:57,849 --> 00:16:59,551
we're 100% solar powered,

386
00:16:59,584 --> 00:17:01,420
so it's very important
that we get those out,

387
00:17:01,453 --> 00:17:02,854
unfortunately,

388
00:17:02,887 --> 00:17:05,957
both MRO and MarCO
will be out of view,

389
00:17:05,990 --> 00:17:08,727
by the time that we have
those completely unfurled,

390
00:17:08,760 --> 00:17:11,930
and so we're gonna have to
wait five and a half hours

391
00:17:11,963 --> 00:17:13,498
until Odyssey comes by and tells

392
00:17:13,531 --> 00:17:15,901
us that yes indeed our
solar arrays are out.

393
00:17:15,934 --> 00:17:17,736
So we'll definitely
have a celebration

394
00:17:17,769 --> 00:17:19,171
when we get a
successful landing,

395
00:17:19,204 --> 00:17:21,339
but we're gonna have to
temper that just a little bit

396
00:17:21,372 --> 00:17:23,208
and wait about five
and a half hours

397
00:17:23,241 --> 00:17:25,610
to know absolutely for
sure we're in good shape.

398
00:17:25,643 --> 00:17:28,880
- So we have immediate
knowledge if we have MarCOs,

399
00:17:28,913 --> 00:17:32,217
so just to run it
through once again,

400
00:17:32,250 --> 00:17:34,186
what's gonna happen with EDL,

401
00:17:34,219 --> 00:17:36,855
we have the video of the show,

402
00:17:36,888 --> 00:17:39,257
how exactly is this
all gonna play out

403
00:17:39,290 --> 00:17:41,460
in six and a half minutes,
we can roll the video.

404
00:17:41,493 --> 00:17:42,928
- Okay,

405
00:17:42,961 --> 00:17:44,830
you can see here we are
attached to the cruise stage,

406
00:17:44,863 --> 00:17:46,098
we drop that off,

407
00:17:46,131 --> 00:17:47,799
say thank you for
the ride to Mars,

408
00:17:47,832 --> 00:17:49,267
it burns up in the atmosphere,

409
00:17:49,300 --> 00:17:52,304
you can see it gets very
hot on our heat shield,

410
00:17:52,337 --> 00:17:53,705
we're getting up in some places

411
00:17:53,738 --> 00:17:56,975
maybe 3000 degrees Fahrenheit
as we go through this,

412
00:17:57,008 --> 00:17:59,010
we're on the heat shield
for about four minutes,

413
00:17:59,043 --> 00:18:01,213
that dissipates about
90 percent of the energy

414
00:18:01,246 --> 00:18:03,548
that we need to dissipate
before we get to the surface,

415
00:18:03,581 --> 00:18:05,183
then we pop our parachute,

416
00:18:05,216 --> 00:18:06,718
we're going about 850 miles

417
00:18:06,751 --> 00:18:08,620
an hour when we
pop the parachute,

418
00:18:08,653 --> 00:18:10,255
we're on that for
about two minutes,

419
00:18:10,288 --> 00:18:12,290
then we'll drop off

the heat shield,

420
00:18:12,323 --> 00:18:14,392
we'll start acquiring the
ground with our RADAR,

421
00:18:14,425 --> 00:18:16,962
very much like an F-16
fighter jet RADAR,

422
00:18:16,995 --> 00:18:18,830
the legs will pop out,

423
00:18:18,863 --> 00:18:19,798
we'll start descending,

424
00:18:19,831 --> 00:18:21,299
we drop for just a second

425
00:18:21,332 --> 00:18:24,002
which is very terrifying for
me our descent thrusters,

426
00:18:24,035 --> 00:18:25,337
we have 12 of them,

427
00:18:25,370 --> 00:18:26,771
they are 16 pound thrusters,

428
00:18:26,804 --> 00:18:28,907
start thrusting and
dropping us to the ground,

429
00:18:28,940 --> 00:18:31,977
and slowly slowly we drop down,

430
00:18:32,010 --> 00:18:33,411
going only five miles an hour,

431
00:18:33,444 --> 00:18:35,113
so when that six and a
half minutes of terror,

432
00:18:35,146 --> 00:18:36,581
which is a little less
then seven minutes

433
00:18:36,614 --> 00:18:38,316
so that's great for me,

434
00:18:38,349 --> 00:18:40,152
we go from 12,300 miles

435
00:18:40,185 --> 00:18:43,421
an hour 75 miles above
the surface of Mars,

436
00:18:43,454 --> 00:18:44,689
we get to the surface

437
00:18:44,722 --> 00:18:45,957
we're at five and a
half miles an hour.

438
00:18:45,990 --> 00:18:47,159
- That's amazing,

439
00:18:47,192 --> 00:18:48,360
that's absolutely amazing,

440
00:18:48,393 --> 00:18:49,761
well before you go Tom,

441
00:18:49,794 --> 00:18:52,030
there was a couple of pictures
we wanted to show you,

442

00:18:52,063 --> 00:18:55,300
we have watch parties taking
place all over the country,

443
00:18:55,333 --> 00:18:57,035
and let's see if we can put one

444
00:18:57,068 --> 00:18:58,703
of these watch
parties up for you

445
00:18:58,736 --> 00:19:01,640
to see this is from Ohio,

446
00:19:01,673 --> 00:19:04,376
this is a person who
has a watch party,

447
00:19:04,409 --> 00:19:06,378
it looks like in a classroom.

448
00:19:06,411 --> 00:19:07,879
- [Tom] That is so awesome.

449
00:19:07,912 --> 00:19:09,481
- [Gay] Isn't that great that
folks are watching with us?

450
00:19:09,514 --> 00:19:10,715
- Yeah I know,

451
00:19:10,748 --> 00:19:12,250
people all across the
globe are watching this,

452
00:19:12,283 --> 00:19:13,718
and we really want to put a
good show on for them today.

453

00:19:13,751 --> 00:19:16,821
- Alright I'll let
you back in the room,

454
00:19:16,854 --> 00:19:18,156
- I gotta get back in there.
- I know you're excited.

455
00:19:18,189 --> 00:19:20,058
Alright take care,
thanks for joining us.

456
00:19:20,091 --> 00:19:21,626
- Thank you.

457
00:19:21,659 --> 00:19:24,396
[dramatic music]

458
00:19:50,688 --> 00:19:54,626
- Okay let's introduce you to
the people who built InSight,

459
00:19:54,659 --> 00:19:57,195
Lockheed Martin Space
outside of Denver,

460
00:19:57,228 --> 00:20:00,398
these are the folks who
built Viking in 1976,

461
00:20:00,431 --> 00:20:03,068
and Mars Phoenix in 2008,

462
00:20:03,101 --> 00:20:04,836
the operations team is there,

463
00:20:04,869 --> 00:20:09,274
and Lockheed InSight EDL
manager Tim Linn is standing by,

464
00:20:09,307 --> 00:20:10,809
Tim, what's going on in there?

465
00:20:13,211 --> 00:20:14,045
- The team is getting
really excited,

466
00:20:14,078 --> 00:20:15,347
we are just about ready,

467
00:20:15,380 --> 00:20:17,916
we're about half
an hour from entry,

468
00:20:17,949 --> 00:20:19,985
and the start of entry,
descent and landing,

469
00:20:20,018 --> 00:20:22,320
so the team is really
excited and focused,

470
00:20:22,353 --> 00:20:24,823
but also very excited
about the upcoming

471
00:20:24,856 --> 00:20:26,291
successful entry descent

472
00:20:26,324 --> 00:20:27,792
and landing we're
getting close to.

473
00:20:27,825 --> 00:20:29,794
- We talked about
the fact that InSight

474
00:20:29,827 --> 00:20:32,497
is based on tried

and true technology,

475
00:20:32,530 --> 00:20:34,099
it's based on Phoenix,

476
00:20:34,132 --> 00:20:37,802
but you've had to make a
couple of changes for InSight,

477
00:20:37,835 --> 00:20:38,670
what were they?

478
00:20:40,171 --> 00:20:41,906
- Yeah, so obviously
as you said,

479
00:20:41,939 --> 00:20:43,174
we leveraged Phoenix a lot,

480
00:20:43,207 --> 00:20:44,709
there was a lot of great things

481
00:20:44,742 --> 00:20:46,311
that we were able to take
from the Phoenix mission,

482
00:20:46,344 --> 00:20:48,613
but InSight is a unique mission,

483
00:20:48,646 --> 00:20:51,082
it's landing towards
the equator of Mars,

484
00:20:51,115 --> 00:20:53,151
and a number of
things are different,

485
00:20:53,184 --> 00:20:55,453
where we're landing,

486
00:20:55,486 --> 00:20:58,857
we are about one and a half
kilometers higher in altitude,

487
00:20:58,890 --> 00:21:00,959
in addition, so what
that required us to do

488
00:21:00,992 --> 00:21:03,461
it's come in a little
bit more shallow,

489
00:21:03,494 --> 00:21:07,666
in addition we are a little
bit heavier than Phoenix was,

490
00:21:07,699 --> 00:21:09,334
so we've had to increase
some of the strength

491
00:21:09,367 --> 00:21:10,835
of some of the lander itself,

492
00:21:10,868 --> 00:21:12,671
so the parachute, we had
to increase the strength,

493
00:21:12,704 --> 00:21:15,240
we have to deploy the
parachute a little bit higher

494
00:21:15,273 --> 00:21:18,009
because of some of
the differences in
our entry timeline,

495
00:21:18,042 --> 00:21:19,511
and because of
when we're landing,

496
00:21:19,544 --> 00:21:21,780
we're landing towards
the end of dust season,

497
00:21:21,813 --> 00:21:23,014
so we've also actually increased

498
00:21:23,047 --> 00:21:24,549
the thickness of
the heat shield,

499
00:21:24,582 --> 00:21:26,518
so we are about a quarter inch
thicker on our heat shield

500
00:21:26,551 --> 00:21:29,554
to accommodate that potential
sandblasting we could see

501
00:21:29,587 --> 00:21:31,489
when we actually do our
entry, descent and landing.

502
00:21:31,522 --> 00:21:32,724
So a number of
things we've changed,

503
00:21:32,757 --> 00:21:34,192
but we obviously leveraged

504
00:21:34,225 --> 00:21:37,095
a lot from the very successful
Phoenix mission as well.

505
00:21:37,128 --> 00:21:40,398
- That's fantastic so you
are able to customize it,

506

00:21:40,431 --> 00:21:42,567
because there were
some concerns earlier

507
00:21:42,600 --> 00:21:45,103
on that there was a
dust storm taking place,

508
00:21:45,136 --> 00:21:47,139
it was dust storm season.

509
00:21:48,539 --> 00:21:49,841
- That's right,

510
00:21:49,874 --> 00:21:52,010
in fact we've had a
lot of great support

511
00:21:52,043 --> 00:21:53,545
from our orbiting assets,

512
00:21:53,578 --> 00:21:54,913
MRO and Odyssey,

513
00:21:54,946 --> 00:21:57,048
a couple of spacecraft
that we've partnered

514
00:21:57,081 --> 00:21:59,217
with JPL and were built
here at Lockheed Martin,

515
00:21:59,250 --> 00:22:01,252
they have actually provided
a lot of great insight

516
00:22:01,285 --> 00:22:04,155
into the weather on Mars,

517

00:22:04,188 --> 00:22:06,224
the dust storms that are
potentially happening on Mars,

518
00:22:06,257 --> 00:22:07,926
and as of today,

519
00:22:07,959 --> 00:22:09,194
and actually the last couple

520
00:22:09,227 --> 00:22:11,529
of weeks it's been great
on the surface of Mars,

521
00:22:11,562 --> 00:22:13,665
we are anticipating
a very nominal,

522
00:22:13,698 --> 00:22:16,735
very seasonal weather in
terms of both density,

523
00:22:16,768 --> 00:22:18,470
atmosphere as well
as temperature,

524
00:22:18,503 --> 00:22:20,939
and dust storms appear
to be very benign,

525
00:22:20,972 --> 00:22:22,741
so we're very
optimistic it's gonna

526
00:22:22,774 --> 00:22:25,043
be a great day for landing
on the surface of Mars.

527
00:22:25,076 --> 00:22:26,911
- Alright that's great news,

528
00:22:26,944 --> 00:22:28,146
thanks Tim,

529
00:22:28,179 --> 00:22:29,814
and I know your team
is getting excited

530
00:22:29,847 --> 00:22:32,250
over there just
as much as we are.

531
00:22:32,283 --> 00:22:34,819
Take care.
- Absolutely, thanks a lot.

532
00:22:34,852 --> 00:22:37,489
- The time now is 11:21,

533
00:22:37,522 --> 00:22:39,424
it's about 20 minutes,

534
00:22:39,457 --> 00:22:42,394
the tension is building
in both control rooms,

535
00:22:42,427 --> 00:22:45,897
it's about 20 minutes before
cruise stage separation,

536
00:22:45,930 --> 00:22:47,432
it's not too far off,

537
00:22:47,465 --> 00:22:49,734
cruise stage
separation is expected

538
00:22:49,767 --> 00:22:52,036
at about 40 minutes

past the hour,

539
00:22:52,069 --> 00:22:55,006
so we are indeed getting close.

540
00:22:55,039 --> 00:22:57,976
So where is InSight
going to Mars?

541
00:22:58,009 --> 00:23:01,146
It's a place called
Elysium Planitia,

542
00:23:01,179 --> 00:23:02,747
Planitia is Latin for flat,

543
00:23:02,780 --> 00:23:06,851
Elysium is ancient Greek
for afterlife paradise,

544
00:23:06,884 --> 00:23:08,820
it's located near the equator,

545
00:23:08,853 --> 00:23:10,522
north of Gale Crater,

546
00:23:10,555 --> 00:23:13,491
not too far from
Curiosity Rover,

547
00:23:13,524 --> 00:23:17,162
the team calls it the
biggest parking lot on Mars,

548
00:23:17,195 --> 00:23:19,197
it's a place that's safe,

549
00:23:19,230 --> 00:23:22,467
got plenty of sunshine that

will power solar instruments

550
00:23:22,500 --> 00:23:25,704
to study the interior of Mars.

551
00:23:27,405 --> 00:23:29,507
[light music]

552
00:23:29,540 --> 00:23:31,409
- [Narrator] What's inside Mars?

553
00:23:31,442 --> 00:23:33,378
We know a lot about
what's inside the Earth,

554
00:23:33,411 --> 00:23:37,849
but at Mars we've only
just scratched the surface,

555
00:23:37,882 --> 00:23:41,486
to learn how Mars formed we
have to study its deep interior,

556
00:23:41,519 --> 00:23:45,023
NASA's InSight Lander was
designed to do just that,

557
00:23:45,056 --> 00:23:46,991
by taking the
planet's vital signs,

558
00:23:47,024 --> 00:23:50,728
listening to its pulse
for seismic activity,

559
00:23:50,761 --> 00:23:52,630
including any Marsquakes,

560
00:23:52,663 --> 00:23:54,599

taking its temperature

561
00:23:54,632 --> 00:23:57,169
to see how much heat is
flowing out from deep inside,

562
00:23:58,336 --> 00:24:00,472
and checking its
reflexes to see how much

563
00:24:00,505 --> 00:24:02,808
the planet wobbles as
it whips around the sun.

564
00:24:04,141 --> 00:24:05,343
These all provide clues to

565
00:24:05,376 --> 00:24:07,212
what the planet is
really like inside.

566
00:24:08,246 --> 00:24:10,281
So what's inside Mars?

567
00:24:10,314 --> 00:24:12,617
InSight can help us
find out by giving Mars

568
00:24:12,650 --> 00:24:14,319
its first thorough checkup since

569
00:24:14,352 --> 00:24:17,355
it formed four and a
half billion years ago,

570
00:24:17,388 --> 00:24:18,590
the more we learn,

571
00:24:18,623 --> 00:24:20,859

the better we understand
all the rocky planets,

572
00:24:20,892 --> 00:24:22,694
and the history of
our solar system.

573
00:24:26,864 --> 00:24:28,600
- Joining us now
is Bruce Banerdt,

574
00:24:28,633 --> 00:24:31,603
the principal investigator
of Mars InSight,

575
00:24:31,636 --> 00:24:34,138
InSight is a mission to Mars,

576
00:24:34,171 --> 00:24:36,307
but we keep hearing
again and again

577
00:24:36,340 --> 00:24:38,343
it's more than a
mission to Mars.

578
00:24:38,376 --> 00:24:39,844
- That's right Gay,

579
00:24:39,877 --> 00:24:43,114
I mean we are going to Mars
to study the Martian interior

580
00:24:43,147 --> 00:24:45,283
and to map out the
divisions inside Mars,

581
00:24:45,316 --> 00:24:47,352
but we want to use
that information

582
00:24:47,385 --> 00:24:49,954
to understand more
about the solar system

583
00:24:49,987 --> 00:24:53,191
as a whole and how
rocky planets form.

584
00:24:53,224 --> 00:24:54,158
- And rocky planets,

585
00:24:54,191 --> 00:24:55,994
we have an image to show folks,

586
00:24:56,027 --> 00:25:00,164
so we're talking about
Earth, the Moon, Mars.

587
00:25:00,197 --> 00:25:02,500
- Mercury, Venus, the planets

588
00:25:02,533 --> 00:25:04,936
of the inner solar system
that are made mostly of rocks,

589
00:25:04,969 --> 00:25:07,772
and they all share the
same basic structure

590
00:25:07,805 --> 00:25:09,741
with a dense iron core,

591
00:25:09,774 --> 00:25:11,676
a rocky mantle,

592
00:25:11,709 --> 00:25:15,213
and then a crust of
lighter silicate rocks,

593
00:25:15,246 --> 00:25:20,051
but the very details of the
thicknesses of those layers,

594
00:25:20,084 --> 00:25:23,888
the sizes and the compositions,

595
00:25:23,921 --> 00:25:26,691
give us a lot of clues as
to how those planets formed,

596
00:25:26,724 --> 00:25:28,726
and why they went down
very different paths

597
00:25:28,759 --> 00:25:31,596
into the different
planets we see today.

598
00:25:31,629 --> 00:25:32,797
- So explain to me,

599
00:25:32,830 --> 00:25:34,899
we are going to have a lander,

600
00:25:34,932 --> 00:25:36,134
you're gonna be on the surface,

601
00:25:36,167 --> 00:25:40,538
how will you be able
to study the interior?

602
00:25:40,571 --> 00:25:43,441
- We use what are called
geophysical instruments,

603
00:25:43,474 --> 00:25:44,676
they use the

principles of physics

604
00:25:44,709 --> 00:25:46,210
to actually see
through the rocks,

605
00:25:46,243 --> 00:25:47,946
we are using seismic waves,

606
00:25:47,979 --> 00:25:51,282
the same way you
might use a flashbulb

607
00:25:51,315 --> 00:25:53,751
to take pictures of something,

608
00:25:53,784 --> 00:25:55,687
we are using Marsquakes,

609
00:25:55,720 --> 00:25:59,324
which send out vibrational
waves through the planet,

610
00:25:59,357 --> 00:26:00,458
and as they go through

611
00:26:00,491 --> 00:26:02,293
the planet they
reflect off boundaries,

612
00:26:02,326 --> 00:26:03,561
they get bent,

613
00:26:03,594 --> 00:26:05,096
they change their velocity,

614
00:26:05,129 --> 00:26:09,701
and it changes the wiggles
that you see on a seismograph,

615
00:26:09,734 --> 00:26:11,836
when we go through the planet

616
00:26:11,869 --> 00:26:14,539
you can see that here it
hits the various boundaries,

617
00:26:14,572 --> 00:26:16,174
and those waves are reflected,

618
00:26:16,207 --> 00:26:17,442
sometimes they're bent,

619
00:26:17,475 --> 00:26:19,911
it becomes a pretty
complicated pattern,

620
00:26:19,944 --> 00:26:22,180
but scientifically
we have learned over

621
00:26:22,213 --> 00:26:25,984
the last hundred years
how to interpret the code

622
00:26:26,017 --> 00:26:29,187
of the signals that comes
back up to the surface,

623
00:26:29,220 --> 00:26:32,790
in the seismometers
that pick up that signal

624
00:26:32,823 --> 00:26:35,526
and then turn it into data
that we can use on Earth,

625
00:26:35,559 --> 00:26:38,229

to understand what the 3D
structure is of the planet.

626
00:26:38,262 --> 00:26:41,265
- So normally you use
three seismometers,

627
00:26:41,298 --> 00:26:43,334
in this case you're
bringing size,

628
00:26:43,367 --> 00:26:44,268
that's one,

629
00:26:44,301 --> 00:26:46,104
how are you going to be able

630
00:26:48,272 --> 00:26:49,440
to get that
information using one?

631
00:26:49,473 --> 00:26:50,875
- Well we had to
get kind of clever,

632
00:26:50,908 --> 00:26:52,910
because all the Earth usually

633
00:26:52,943 --> 00:26:54,145
you have plenty of seismometers,

634
00:26:54,178 --> 00:26:55,847
you can use multiple
seismometers

635
00:26:55,880 --> 00:26:58,983
to triangulate in on
where the Earthquake is,

636

00:26:59,016 --> 00:27:01,819
on Mars we're gonna do something
a little bit different,

637
00:27:01,852 --> 00:27:04,822
we're gonna use not only
the P and the S waves

638
00:27:04,855 --> 00:27:06,057
that you may have heard about,

639
00:27:06,090 --> 00:27:07,325
but we are using
the surface waves,

640
00:27:07,358 --> 00:27:09,360
and here you can see
the surface waves

641
00:27:09,393 --> 00:27:11,963
moving out from a Marsquake,

642
00:27:11,996 --> 00:27:14,065
and as it passes over
the InSight Lander

643
00:27:14,098 --> 00:27:15,733
you can see the seismograph

644
00:27:15,766 --> 00:27:18,503
up there in the upper
left-hand corner

645
00:27:18,536 --> 00:27:19,837
where you have the wiggles,

646
00:27:19,870 --> 00:27:22,340
now those waves keep on
going around the planet,

647
00:27:22,373 --> 00:27:24,976
and because Mars
is not so large,

648
00:27:25,009 --> 00:27:28,546
they still have a fair
amount of amplitude,

649
00:27:28,579 --> 00:27:31,883
they haven't gotten
completely damped out,

650
00:27:31,916 --> 00:27:34,118
by the time it's gone all
the way around the planet,

651
00:27:34,151 --> 00:27:36,888
passes over the
spacecraft again,

652
00:27:36,921 --> 00:27:39,590
and finally even the way
they went the other way

653
00:27:39,623 --> 00:27:43,227
around the planet comes across
and hits us yet a third time,

654
00:27:43,260 --> 00:27:45,229
and so we have extra information

655
00:27:45,262 --> 00:27:47,965
over the P and the S wave,

656
00:27:47,998 --> 00:27:49,467
we have these
surface wave arrivals

657
00:27:49,500 --> 00:27:53,938

that we can use to pinpoint
the distance from the Marsquake

658
00:27:53,971 --> 00:27:55,406
to our lander,

659
00:27:55,439 --> 00:27:57,475
and then we use something
called polarization analysis,

660
00:27:57,508 --> 00:27:59,677
to figure out which direction
the waves are coming from,

661
00:27:59,710 --> 00:28:01,179
and by doing that,

662
00:28:01,212 --> 00:28:02,647
we can do the same thing

663
00:28:02,680 --> 00:28:04,015
that we can do with three
stations on the Earth,

664
00:28:04,048 --> 00:28:05,583
just using the P
and the S waves.

665
00:28:05,616 --> 00:28:08,319
- And very quickly, there
is still another instrument

666
00:28:08,352 --> 00:28:11,422
built by DLR that's also
being carried up by InSight,

667
00:28:11,455 --> 00:28:13,257
can you talk a little
bit about that?

668
00:28:13,290 --> 00:28:14,492
- Yeah that's our
heat flow probe,

669
00:28:14,525 --> 00:28:16,494
and it's a pretty
cool instrument

670
00:28:16,527 --> 00:28:19,330
that uses a mechanical
mole we call it,

671
00:28:19,363 --> 00:28:21,766
to burrow its way
down into the surface,

672
00:28:21,799 --> 00:28:24,869
it has a motor that
winds up a hammer

673
00:28:24,902 --> 00:28:27,905
and knocks itself down just
a few millimeters at a time,

674
00:28:27,938 --> 00:28:31,943
but we do that 20 or
30,000 hammer strokes

675
00:28:31,976 --> 00:28:33,377
and it gets it down,

676
00:28:33,410 --> 00:28:36,247
we hope to get down to be about
16 feet below the surface,

677
00:28:36,280 --> 00:28:37,749
and once we get down there,

678
00:28:37,782 --> 00:28:40,118

we're actually measuring the
heat coming out of the planet,

679
00:28:40,151 --> 00:28:42,120
by measuring the
temperature along

680
00:28:42,153 --> 00:28:44,589
the cable as it comes
up to the surface,

681
00:28:44,622 --> 00:28:49,127
and looking at how
that temperature
increases as we go down,

682
00:28:49,160 --> 00:28:51,429
and extrapolate that
deep into the planet

683
00:28:51,462 --> 00:28:54,132
to understand how much energy
there is inside the planet

684
00:28:54,165 --> 00:28:58,269
to drive the geology and to
drive volcanism, Marsquakes,

685
00:28:58,302 --> 00:28:59,704
all kinds of activity.

686
00:28:59,737 --> 00:29:01,472
- It's amazing how
much you'll be able

687
00:29:01,505 --> 00:29:03,975
to learn from the surface
about the interior.

688
00:29:04,008 --> 00:29:06,210

- I think it is amazing,

689
00:29:06,243 --> 00:29:07,879
it's been something that I've

690
00:29:07,912 --> 00:29:10,214
been working on for my
whole professional career,

691
00:29:10,247 --> 00:29:13,351
and I find it fascinating.

692
00:29:13,384 --> 00:29:15,319
- Alright we'll talk about that,

693
00:29:15,352 --> 00:29:16,954
thanks Bruce.

694
00:29:16,987 --> 00:29:19,223
Bruce first thought of the
mission like this as he mentions

695
00:29:19,256 --> 00:29:23,094
40 years ago when he
was a graduate student,

696
00:29:23,127 --> 00:29:26,197
the rest of the team hasn't
waited quite that long,

697
00:29:26,230 --> 00:29:28,800
but this is a big
moment for them too,

698
00:29:28,833 --> 00:29:30,735
recently we sat down
with a few of the members

699
00:29:30,768 --> 00:29:33,771

and asked them what
is it going to be like

700
00:29:33,804 --> 00:29:35,473
as we get close to landing.

701
00:29:37,107 --> 00:29:39,143
[dramatic music]

702
00:29:39,176 --> 00:29:40,678
- It's a very
difficult thing to do,

703
00:29:40,711 --> 00:29:42,847
and everything has
to go perfectly,

704
00:29:42,880 --> 00:29:45,183
as humans we've sent
17 different missions

705
00:29:45,216 --> 00:29:48,419
to the surface of Mars and
10 of them have crashed.

706
00:29:48,452 --> 00:29:51,222
Before we can land on Mars
we have to get to Mars.

707
00:29:51,255 --> 00:29:52,690
How do we get to Mars?

708
00:29:52,723 --> 00:29:54,792
- The main responsibility
of the navigation team

709
00:29:54,825 --> 00:29:56,794
is to ensure that the
spacecraft is delivered

710
00:29:56,827 --> 00:29:58,963
to the right point on
the Martian atmosphere.

711
00:29:58,996 --> 00:30:02,099
The target location is
about 12 kilometers in size,

712
00:30:02,132 --> 00:30:04,068
our accuracy is
comparable to shooting

713
00:30:04,101 --> 00:30:06,938
a basketball from Staple
Center in downtown LA,

714
00:30:06,971 --> 00:30:08,172
and hitting nothing but net

715
00:30:08,205 --> 00:30:09,941
in a basketball hoop
in New York City,

716
00:30:09,974 --> 00:30:11,409
that is moving at a speed

717
00:30:11,442 --> 00:30:14,378
of about two feet per second
and is spinning about its axis.

718
00:30:14,411 --> 00:30:16,914
- The landing site we have an
ellipse that is pretty big,

719
00:30:16,947 --> 00:30:18,282
it's about 60 miles long,

720
00:30:18,315 --> 00:30:20,084
We could land anywhere

in that ellipse,

721
00:30:20,117 --> 00:30:22,286
there's a chance that we
could land right on a rock,

722
00:30:22,319 --> 00:30:24,088
and we don't have any
control over that,

723
00:30:24,121 --> 00:30:25,590
so that's what makes me nervous.

724
00:30:25,623 --> 00:30:28,192
- We have tested the RADAR
by flying it on a helicopter,

725
00:30:28,225 --> 00:30:30,027
we've tested pieces
of the heat shield

726
00:30:30,060 --> 00:30:31,996
by putting them in
an arc jet facility,

727
00:30:32,029 --> 00:30:34,632
we have tested the parachute
by testing it in a wind tunnel,

728
00:30:34,665 --> 00:30:36,033
and putting that all together

729
00:30:36,066 --> 00:30:38,169
in a very tightly
controlled sequence

730
00:30:38,202 --> 00:30:39,737
where every single
thing has to go right,

731
00:30:39,770 --> 00:30:41,339
we have never tested that,

732
00:30:41,372 --> 00:30:42,273
and the first time
it's gonna happen

733
00:30:42,306 --> 00:30:44,442
is once you deliver us to Mars.

734
00:30:50,247 --> 00:30:54,352
- It is about 11:29 AM Pacific,

735
00:30:54,385 --> 00:30:57,889
and you're watching live
coverage of the InSight landing

736
00:30:57,922 --> 00:31:00,057
from NASA's Jet
Propulsion Laboratory

737
00:31:00,090 --> 00:31:02,627
in Pasadena, California.

738
00:31:02,660 --> 00:31:05,630
We are about a half
hour away from landing,

739
00:31:05,663 --> 00:31:09,200
and people all over
the world are watching,

740
00:31:09,233 --> 00:31:12,436
take a look at a map
that we have for you,

741
00:31:12,469 --> 00:31:13,838
we can show you right now,

742
00:31:13,871 --> 00:31:16,140
this is a watch in person map

743
00:31:16,173 --> 00:31:19,744
where people have watch
parties all over the world,

744
00:31:19,777 --> 00:31:21,545
all over the United States,

745
00:31:21,578 --> 00:31:23,648
in Paris, in Berlin,

746
00:31:23,681 --> 00:31:26,851
even off the coast
of Madagascar,

747
00:31:26,884 --> 00:31:30,788
and folks in the Big Apple
will also be watching today,

748
00:31:30,821 --> 00:31:35,026
the NASDAQ Tower will switch
over to landing coverage

749
00:31:35,059 --> 00:31:37,161
for about an hour,

750
00:31:37,194 --> 00:31:40,331
that means people in Times
Square can watch too,

751
00:31:40,364 --> 00:31:42,500
and later today, NASA will have

752
00:31:42,533 --> 00:31:45,202
the honor of ringing
the closing bell,

753
00:31:45,235 --> 00:31:48,139
and that will be a little
over an hour from now.

754
00:31:48,172 --> 00:31:49,807
And if you are watching,

755
00:31:49,840 --> 00:31:51,909
take a picture
and send it to us,

756
00:31:51,942 --> 00:31:54,578
using hashtag Marslanding,

757
00:31:54,611 --> 00:31:56,681
here is one I believe it is

758
00:31:56,714 --> 00:32:00,184
from the California Science
Center in Los Angeles,

759
00:32:00,217 --> 00:32:05,223
and I am told Eric Garcetti
will be visiting later today.

760
00:32:06,423 --> 00:32:08,492
Things are getting more
active for the team now,

761
00:32:08,525 --> 00:32:11,095
let's check back in
with Julie Wertz Chen

762
00:32:11,128 --> 00:32:13,631
in the control room,
what's going on Julie?

763
00:32:15,032 --> 00:32:18,369
- Yeah so we have heard

from MRO a couple of times,

764
00:32:18,402 --> 00:32:20,104
that's Mars
Reconnaissance Orbiter,

765
00:32:20,137 --> 00:32:21,138
they are doing their slew,

766
00:32:21,171 --> 00:32:22,173
they are ready to support us,

767
00:32:22,206 --> 00:32:23,107
they are doing great,

768
00:32:23,140 --> 00:32:25,409
and we heard from both MarCO's,

769
00:32:25,442 --> 00:32:26,777
MarCO A and B that
they're out there,

770
00:32:26,810 --> 00:32:28,646
they've got telemetry lock

771
00:32:28,679 --> 00:32:30,715
with them from the
ground stations here,

772
00:32:30,748 --> 00:32:32,316
so they are doing great,

773
00:32:32,349 --> 00:32:35,519
and everybody is ready to
go, so we're pretty excited.

774
00:32:35,552 --> 00:32:36,754
- Fantastic,

775
00:32:36,787 --> 00:32:39,323
we will check back in
with Julie in a moment,

776
00:32:39,356 --> 00:32:42,126
meantime this is a good time
to tell you a little bit more

777
00:32:42,159 --> 00:32:44,895
about that technology experiment
we've been talking about,

778
00:32:44,928 --> 00:32:45,830
MarCO,

779
00:32:45,863 --> 00:32:47,231
as we mentioned earlier,

780
00:32:47,264 --> 00:32:49,600
InSight does not have an orbiter

781
00:32:49,633 --> 00:32:53,170
in position to send
EDL data back live,

782
00:32:53,203 --> 00:32:55,740
so the Cubesats hope
to fill that gap,

783
00:32:55,773 --> 00:32:57,275
here's how they'll work.

784
00:32:58,642 --> 00:33:00,611
- [Narrator] Communicating
between Mars and Earth requires

785
00:33:00,644 --> 00:33:02,580
a complicated choreography,

786
00:33:02,613 --> 00:33:05,916
with everything in the right
place at the right time.

787
00:33:05,949 --> 00:33:08,219
Sometimes hours can
pass before information

788
00:33:08,252 --> 00:33:10,421
is related from one
planet to another,

789
00:33:10,454 --> 00:33:13,024
that's why when NASA's Mars
InSight Lander launches

790
00:33:13,057 --> 00:33:14,692
this year the rocket will carry

791
00:33:14,725 --> 00:33:18,129
two tiny satellites for a
technology test of their own.

792
00:33:18,162 --> 00:33:19,797
Meet Mars Cube One,

793
00:33:19,830 --> 00:33:23,801
MarCO, NASA's first Cubesat
mission to deep space,

794
00:33:23,834 --> 00:33:25,536
these briefcase-sized satellites

795
00:33:25,569 --> 00:33:27,772
will travel separately
from the InSight Lander

796
00:33:27,805 --> 00:33:30,608
while they test out new

miniaturized technologies,

797
00:33:30,641 --> 00:33:31,909
and if they make it to Mars

798
00:33:31,942 --> 00:33:33,344
they could relate
information back

799
00:33:33,377 --> 00:33:36,247
to Earth about InSight's
descent and touchdown,

800
00:33:36,280 --> 00:33:38,716
and do it in mere minutes.

801
00:33:38,749 --> 00:33:40,918
Although this fast
communication isn't crucial

802
00:33:40,951 --> 00:33:42,787
to the success of
the InSight Lander,

803
00:33:42,820 --> 00:33:44,655
this Cubesat test could change

804
00:33:44,688 --> 00:33:47,191
the way future
spacecraft phone home.

805
00:33:50,794 --> 00:33:52,596
- Alright let's
check back with Julie

806
00:33:52,629 --> 00:33:54,865
to see if the MarCOs
are indeed ready

807

00:33:54,898 --> 00:33:57,701
to support and
listen for InSight,

808
00:33:57,734 --> 00:33:58,936
Julie what do you know?

809
00:34:00,204 --> 00:34:02,473
- So they are ready to go,

810
00:34:02,506 --> 00:34:04,742
I haven't heard about
their slew coming up yet,

811
00:34:04,775 --> 00:34:06,677
but they are ready to go,

812
00:34:06,710 --> 00:34:08,112
we have heard from them,
they are both healthy,

813
00:34:08,145 --> 00:34:09,180
and they're both doing great,

814
00:34:09,213 --> 00:34:11,115
which is just wonderful news.

815
00:34:11,148 --> 00:34:13,350
So I think they should
be doing a slew,

816
00:34:13,383 --> 00:34:14,919
actually I think they should

817
00:34:14,952 --> 00:34:16,187
be doing a slew
in just a minute.

818
00:34:16,220 --> 00:34:18,089

- [Gay] We'll stand
by and listen then.

819
00:34:58,795 --> 00:35:02,633
[men mumbling off-microphone]

820
00:35:51,982 --> 00:35:53,217
- [Woman] All
stations and systems,

821
00:35:53,250 --> 00:35:54,919
we can confirm we are
entry -20 minutes,

822
00:35:54,952 --> 00:35:57,588
EDL nav two has been initiated,

823
00:35:57,621 --> 00:35:59,524
the star tracker has
been powered off.

824
00:36:14,605 --> 00:36:17,575
- The nav two software
has been initiated,

825
00:36:17,608 --> 00:36:21,011
so when we're in cruise
we use a star tracker,

826
00:36:21,044 --> 00:36:25,082
in a similar manner to how
sailors navigated years ago,

827
00:36:25,115 --> 00:36:26,350
we look at the stars

828
00:36:26,383 --> 00:36:27,718
and get our relative
position from them,

829
00:36:27,751 --> 00:36:29,587
we use a star tracker for that,

830
00:36:29,620 --> 00:36:31,922
and now that we are
close enough to Mars,

831
00:36:31,955 --> 00:36:32,856
we don't need that anymore,

832
00:36:32,889 --> 00:36:34,725
so we're gonna transition

833
00:36:34,758 --> 00:36:36,961
to what's called
Nav two software,

834
00:36:36,994 --> 00:36:40,231
and that let's us
basically just use velocity

835
00:36:40,264 --> 00:36:41,498
and acceleration
from this point on,

836
00:36:41,531 --> 00:36:43,668
so we don't need the
star tracker any more.

837
00:36:47,471 --> 00:36:50,908
- [Man] MarCO clarify, slew to
inertia or start a bent pipe.

838
00:36:52,342 --> 00:36:54,879
- [Man] Slew to appropriate
altitude for bent pipe,

839
00:36:56,079 --> 00:36:57,248
bent pipe mode will

be entered shortly.

840
00:36:57,281 --> 00:36:58,583
- [Man] Okay thank
you very much.

841
00:37:00,550 --> 00:37:03,053
- And that was obviously
confirmation of
the slew for MarCO,

842
00:37:03,086 --> 00:37:04,488
so that's great news.

843
00:37:04,521 --> 00:37:06,257
- [Gay] Fantastic.

844
00:37:09,926 --> 00:37:11,729
- So as I was saying before,

845
00:37:11,762 --> 00:37:15,399
the Nav two software will
propagate from here on out,

846
00:37:15,432 --> 00:37:16,734
and we'll use velocity
and acceleration,

847
00:37:16,767 --> 00:37:18,335
so we've powered off
our star tracker,

848
00:37:18,368 --> 00:37:19,536
and we are on our
Nav two software

849
00:37:19,569 --> 00:37:21,505
and everything is looking great.

850

00:37:21,538 --> 00:37:23,541
- Okay thanks Julie.

851
00:37:25,475 --> 00:37:27,611
Alright the cruise
stage separation

852
00:37:27,644 --> 00:37:29,913
is just about four minutes away,

853
00:37:29,946 --> 00:37:32,216
and Rob Manning joins us now,

854
00:37:32,249 --> 00:37:35,219
Rob is the chief
engineer here at JPL,

855
00:37:35,252 --> 00:37:38,489
and an absolute veteran
of Mars landings.

856
00:37:38,522 --> 00:37:41,125
We are going to play a little
video for you right now,

857
00:37:41,158 --> 00:37:42,359
you haven't seen it yet,

858
00:37:42,392 --> 00:37:43,394
but we'll roll it.

859
00:37:46,496 --> 00:37:47,631
Let's go ahead.

860
00:37:47,664 --> 00:37:48,832
This is--

861
00:37:48,865 --> 00:37:49,767
- [Man] Lander

acceleration live,

862
00:37:49,800 --> 00:37:51,168
14 reports carrier lock at--

863
00:37:51,201 --> 00:37:54,171
- [Gay] There you are,
you were the phase lead.

864
00:37:55,906 --> 00:37:58,042
You were sitting
up from [laughs].

865
00:37:58,075 --> 00:38:00,678
[crowd cheers]

866
00:38:01,745 --> 00:38:02,580
- [Rob] Yeah,

867
00:38:05,182 --> 00:38:07,151
that's what I look like
when it's successful.

868
00:38:07,184 --> 00:38:09,053
- [Gay] Yes.

869
00:38:11,154 --> 00:38:12,356
- I'd hate to see
what I would have

870
00:38:12,389 --> 00:38:14,658
looked like if I
wasn't successful.

871
00:38:14,691 --> 00:38:16,026
- But talk about that,

872
00:38:16,059 --> 00:38:17,895
what is EDL like,

873
00:38:17,928 --> 00:38:19,697
why is it so hard?

874
00:38:19,730 --> 00:38:23,434
- Well its many years of
work by many many people

875
00:38:23,467 --> 00:38:26,070
who struggle to put all
the pieces together,

876
00:38:26,103 --> 00:38:28,972
and particularly because
we can't really test

877
00:38:29,005 --> 00:38:31,909
entry, descent and
landing on this planet,

878
00:38:31,942 --> 00:38:33,977
it's much more complicated,

879
00:38:34,010 --> 00:38:36,046
Mars has a lower atmosphere,

880
00:38:36,079 --> 00:38:37,047
thinner atmosphere,

881
00:38:37,080 --> 00:38:38,482
less gravity,

882
00:38:38,515 --> 00:38:39,683
you just can't put the pieces,

883
00:38:39,716 --> 00:38:42,653
so imagine you had a
big Broadway production,

884
00:38:42,686 --> 00:38:43,987
but you couldn't really

885
00:38:44,020 --> 00:38:47,291
do the show until all
the audience shows up,

886
00:38:47,324 --> 00:38:49,026
so that's what it feels like,

887
00:38:49,059 --> 00:38:52,429
so you never really know if
you've really done it right.

888
00:38:52,462 --> 00:38:55,599
- Well we've done
it seven times,

889
00:38:55,632 --> 00:39:00,037
can we say piece of cake,
we know what we're doing?

890
00:39:00,070 --> 00:39:01,505
- No I don't think so,

891
00:39:01,538 --> 00:39:03,240
we get better at it,

892
00:39:03,273 --> 00:39:04,641
and there's no doubt
we have learned,

893
00:39:04,674 --> 00:39:07,578
we've learned from both
successes and our own failures,

894
00:39:07,611 --> 00:39:09,380
including failures of other

895
00:39:09,413 --> 00:39:11,115
missions outside
of this country,

896
00:39:11,148 --> 00:39:13,884
so those pieces come
together in our minds eye,

897
00:39:13,917 --> 00:39:16,487
and we try to put what
we learned together,

898
00:39:16,520 --> 00:39:19,323
and just do the best we can,

899
00:39:19,356 --> 00:39:22,025
and if we don't succeed,

900
00:39:22,058 --> 00:39:23,494
we will learn,

901
00:39:23,527 --> 00:39:25,529
because we are collecting
data on the way down,

902
00:39:25,562 --> 00:39:27,998
if something bad happens today,

903
00:39:28,031 --> 00:39:29,500
we'll be able to
take what we learned,

904
00:39:29,533 --> 00:39:31,602
even though we may
fall on the ground

905
00:39:31,635 --> 00:39:33,637
after being kicked off the horse

906
00:39:33,670 --> 00:39:35,439
we'll get back up,
brush ourselves off,

907
00:39:35,472 --> 00:39:36,607
figure out what we did wrong,

908
00:39:36,640 --> 00:39:38,208
and get back on the horse.

909
00:39:38,241 --> 00:39:40,477
- Well there's a
lot of uncertainty,

910
00:39:40,510 --> 00:39:44,014
just very quickly give
some possible scenarios

911
00:39:44,047 --> 00:39:46,717
of what could happen
during EDL today,

912
00:39:46,750 --> 00:39:48,952
especially during
communications?

913
00:39:48,985 --> 00:39:51,922
- Well the great news about
having communications,

914
00:39:51,955 --> 00:39:54,391
almost anything could go wrong,

915
00:39:54,424 --> 00:39:56,460
there's a very good chance
we can figure it out,

916
00:39:56,493 --> 00:39:59,062
but things like the

parachute has to go right,

917
00:39:59,095 --> 00:40:00,364
you don't open parachutes

918
00:40:00,397 --> 00:40:03,434
on Earth going Mach
one and a half,

919
00:40:03,467 --> 00:40:05,169
one and a half times
the speed of sound,

920
00:40:05,202 --> 00:40:06,403
you just don't do that,

921
00:40:06,436 --> 00:40:07,571
you don't need to
on this planet,

922
00:40:07,604 --> 00:40:08,906
but we have to
because if we waited

923
00:40:08,939 --> 00:40:10,574
any longer we'd
be on the ground.

924
00:40:10,607 --> 00:40:13,844
A very complicated
RADAR system has to work

925
00:40:13,877 --> 00:40:15,612
from outer space all the way

926
00:40:15,645 --> 00:40:18,215
to the ground and
look for the ground,

927

00:40:18,248 --> 00:40:20,184
what if it locked up
on the heat shield,

928
00:40:20,217 --> 00:40:22,119
well we've tried to
avoid that problem,

929
00:40:22,152 --> 00:40:24,121
we fixed that problem we think

930
00:40:24,154 --> 00:40:25,889
to prevent that from happening,

931
00:40:25,922 --> 00:40:27,324
but what if we got it wrong,

932
00:40:27,357 --> 00:40:28,959
things like that can happen,

933
00:40:28,992 --> 00:40:32,362
and our vehicle could
have things bad happen,

934
00:40:32,395 --> 00:40:34,932
but we have worked
hard to prevent them.

935
00:40:35,999 --> 00:40:37,468
- So we're getting close,

936
00:40:37,501 --> 00:40:38,635
we're gonna go to the control

937
00:40:38,668 --> 00:40:40,571
room for cruise
stage separation Rob.

938
00:40:40,604 --> 00:40:41,439

- Okay.

939
00:40:48,311 --> 00:40:49,713
I need to take off.

940
00:40:51,781 --> 00:40:53,451
Yes, yes.

941
00:41:27,450 --> 00:41:28,452
- [Man] InSight
systems, EDL COMM.

942
00:41:29,953 --> 00:41:31,455
- [Woman] Go-ahead?

943
00:41:31,488 --> 00:41:32,956
- [Man] At this time MRO

944
00:41:32,989 --> 00:41:35,792
will have loaded their
electro sequences,

945
00:41:35,825 --> 00:41:39,696
and MarCO is expecting
carrier lock any time,

946
00:41:39,729 --> 00:41:41,899
MarCO B has recorded
they're in bent pipe,

947
00:41:43,033 --> 00:41:43,934
still waiting on A.

948
00:41:45,368 --> 00:41:46,904
- [Woman] Copy that, thank you.

949
00:41:57,213 --> 00:41:58,515
- [Man] Radio Science report,

950
00:41:58,548 --> 00:42:00,384
UHF carrier detected.

951
00:42:01,785 --> 00:42:04,922
- [Man] EDL COMM, MarCO
Alpha is an bent pipe mode,

952
00:42:04,955 --> 00:42:07,258
MarCO bravo has
locked on the carrier.

953
00:42:08,425 --> 00:42:10,194
MarCO Alpha has also
locked on carrier.

954
00:42:11,628 --> 00:42:14,398
[people applaud]

955
00:42:17,534 --> 00:42:18,869
- [Man] Systems based
on InSight court,

956
00:42:18,902 --> 00:42:22,006
as expected the DSN
has LS inside x-band.

957
00:42:23,406 --> 00:42:24,575
- Copy that, thank you.

958
00:42:51,901 --> 00:42:53,503
All station InSight
systems on InSight core,

959
00:42:53,536 --> 00:42:55,939
DSN has lost the X-band
signal from InSight,

960
00:42:55,972 --> 00:42:59,310
indicated at expected

cruise stage separation.

961
00:43:01,578 --> 00:43:03,714
Standing by for UHF
signal acquisition

962
00:43:03,747 --> 00:43:05,549
via MarCO radio science.

963
00:43:13,089 --> 00:43:14,891
We are about five
minutes from entry,

964
00:43:14,924 --> 00:43:16,727
and have confirmation
we have lost

965
00:43:16,760 --> 00:43:19,496
the X-band signal from InSight,

966
00:43:19,529 --> 00:43:21,865
this was expected because
we have transitioned

967
00:43:21,898 --> 00:43:23,767
from the antenna
on the cruise stage

968
00:43:23,800 --> 00:43:27,071
to the UHF antenna
aboard the spacecraft.

969
00:43:28,271 --> 00:43:30,507
Ground stations have
detected UHF signal

970
00:43:30,540 --> 00:43:33,043
and MarCO has locked
on the signal,

971
00:43:33,076 --> 00:43:34,544
this confirms that InSight

972
00:43:34,577 --> 00:43:37,581
is transmitting UHF
signals as expected.

973
00:43:38,682 --> 00:43:40,917
InSight telemetry
through the MarCO relay

974
00:43:40,950 --> 00:43:44,221
is not expected till about
two minutes before entry.

975
00:43:51,127 --> 00:43:53,030
- [Gay] So Rob that was exactly
what we were hoping here,

976
00:43:53,063 --> 00:43:54,931
that the MarCOs are--

977
00:43:54,964 --> 00:43:58,168
- The vehicle has also performed
the turn to entry maneuver,

978
00:43:58,201 --> 00:44:01,171
the vehicle is turning away
from the sun pointing altitude,

979
00:44:01,204 --> 00:44:04,508
and oriented itself to enter
the Martian atmosphere.

980
00:44:05,375 --> 00:44:06,977
- This is a big first step,

981
00:44:08,178 --> 00:44:11,248
just getting the

cruise stage separated,

982
00:44:11,281 --> 00:44:15,185
After the vehicle turns itself
to the right orientation,

983
00:44:15,218 --> 00:44:18,121
The cruise stage is now
going to get further

984
00:44:18,154 --> 00:44:19,890
and further away
till it's about three

985
00:44:19,923 --> 00:44:22,559
or four football fields
away and will burn

986
00:44:22,592 --> 00:44:25,395
up in parallel as the
vehicle enters Mars.

987
00:44:25,428 --> 00:44:27,731
- And Christine
mentioned turn to entry,

988
00:44:27,764 --> 00:44:29,266
what does that mean?

989
00:44:29,299 --> 00:44:30,567
- Well it's because
the cruise stage

990
00:44:30,600 --> 00:44:32,569
has to be pushed off
to one side like this,

991
00:44:32,602 --> 00:44:36,239
the rest of the vehicle has to
turn to face the atmosphere,

992
00:44:36,272 --> 00:44:40,010
and to be dead nuts on as it
hits the top of the atmosphere.

993
00:44:40,043 --> 00:44:41,912
- [Gay] So this is
taking all the heat

994
00:44:41,945 --> 00:44:43,213
coming into the atmosphere?

995
00:44:43,246 --> 00:44:44,481
- Exactly,

996
00:44:44,514 --> 00:44:45,549
it'll both provide
a source for drag,

997
00:44:45,582 --> 00:44:46,983
but also thermal protection,

998
00:44:47,016 --> 00:44:50,153
because it gets over
1500 degrees Celsius

999
00:44:50,186 --> 00:44:52,389
on this heat shield,

1000
00:44:52,422 --> 00:44:53,857
very, very hot,

1001
00:44:53,890 --> 00:44:55,459
but on the inside
of the heat shield,

1002
00:44:55,492 --> 00:44:59,963
it's maybe only a few degrees
above room temperature,

1003
00:44:59,996 --> 00:45:01,832
so it's a wonderful
protector device

1004
00:45:01,865 --> 00:45:03,633
to keep our lander safe.

1005
00:45:03,666 --> 00:45:07,270
- Alright so the next thing
were standing by for is,

1006
00:45:07,303 --> 00:45:08,739
- Is entry.
- Entry.

1007
00:45:08,772 --> 00:45:10,340
- Getting to the top
of the atmosphere

1008
00:45:10,373 --> 00:45:11,875
and gradually slowing down,

1009
00:45:11,908 --> 00:45:14,311
Right now the vehicle
is just now beginning,

1010
00:45:14,344 --> 00:45:17,247
very soon will be
beginning to feel

1011
00:45:17,280 --> 00:45:18,915
the atmosphere touching it,

1012
00:45:18,948 --> 00:45:21,118
actually entry is above
the atmosphere slightly,

1013
00:45:21,151 --> 00:45:24,721

so it's really not till
half a minute or so

1014
00:45:24,754 --> 00:45:27,991
after entry before we really
start detecting the fact

1015
00:45:28,024 --> 00:45:30,127
that that atmosphere
is slowing us down.

1016
00:45:30,160 --> 00:45:31,661
- Alright, we'll be standing by.

1017
00:45:31,694 --> 00:45:32,863
- Yes, exciting.

1018
00:46:28,418 --> 00:46:33,089
- [Gay] Rob, now entry
is scheduled for 11:47,

1019
00:46:33,122 --> 00:46:34,491
the cruise stage set

1020
00:46:34,524 --> 00:46:36,960
and the entry times
are locked in correct?

1021
00:46:36,993 --> 00:46:38,195
- [Rob] They are,

1022
00:46:38,228 --> 00:46:40,397
they are locked in when
we selected the target

1023
00:46:40,430 --> 00:46:42,199
and aimed the vehicle
very precisely,

1024

00:46:42,232 --> 00:46:45,035
that allows us to know exactly
when we hit the entry point,

1025
00:46:45,068 --> 00:46:48,972
which is 35 to 55 kilometers
from the center of Mars.

1026
00:46:49,005 --> 00:46:50,907
- [Gay] So we know those
times are locked in,

1027
00:46:50,940 --> 00:46:54,344
but what about all the other
events that take place--

1028
00:46:54,377 --> 00:46:55,946
- [Man] Radio Science
reports dropping

1029
00:46:55,979 --> 00:46:58,248
carrier power as expected.

1030
00:46:58,281 --> 00:47:00,784
- [Man] MarCO A and
MarCO B have telemetry.

1031
00:47:00,817 --> 00:47:03,554
[people applaud]

1032
00:47:07,390 --> 00:47:09,125
- [Gay] Just heard, both
MarCO's have telemetry.

1033
00:47:09,158 --> 00:47:10,794
- [Rob] They are
doing their job,

1034
00:47:10,827 --> 00:47:14,097
these small Cubesats are

relaying ones and zeros

1035
00:47:14,130 --> 00:47:17,000
with a few seconds lag From

1036
00:47:17,033 --> 00:47:20,170
the vehicle up to
these two vehicles,

1037
00:47:20,203 --> 00:47:22,172
and they forward
them back to Earth

1038
00:47:22,205 --> 00:47:25,442
to the deep space network
using X-band antennas,

1039
00:47:25,475 --> 00:47:28,078
- And keep in mind this
was all an experiment,

1040
00:47:28,111 --> 00:47:30,413
we weren't sure that
this was going to work,

1041
00:47:30,446 --> 00:47:33,016
but we had this
need that we didn't

1042
00:47:33,049 --> 00:47:36,152
have live communication in
this particular mission.

1043
00:47:36,185 --> 00:47:38,021
- Well we don't really
need communications,

1044
00:47:38,054 --> 00:47:39,623
we don't need their information,

1045
00:47:39,656 --> 00:47:41,124
except if something went wrong,

1046
00:47:41,157 --> 00:47:43,260
we would very much like
to get the data right now,

1047
00:47:43,293 --> 00:47:44,861
we have other spacecraft.

1048
00:47:44,894 --> 00:47:46,062
- [Christine] We are
now receiving InSight

1049
00:47:46,095 --> 00:47:47,964
telemetry via the MarCO really.

1050
00:47:47,997 --> 00:47:49,666
[people applaud]

1051
00:47:49,699 --> 00:47:53,770
- Ah, it's flowing
into it, fabulous.

1052
00:47:53,803 --> 00:47:55,705
That means the
team now can watch

1053
00:47:55,738 --> 00:47:58,375
the data flowing onto
their screens as if

1054
00:47:58,408 --> 00:48:00,310
they're communicating
directly with the vehicle.

1055
00:48:00,343 --> 00:48:02,178
- This data will provide
detailed information

1056
00:48:02,211 --> 00:48:04,548
about the state of the
spacecraft throughout EDL.

1057
00:48:10,520 --> 00:48:12,422
- [Gay] We were on pins and
needles waiting for that,

1058
00:48:12,455 --> 00:48:15,325
because we weren't really sure.

1059
00:48:15,358 --> 00:48:17,060
- [Rob] This is wonderful news,

1060
00:48:17,093 --> 00:48:20,830
if this continues
working all the way

1061
00:48:20,863 --> 00:48:22,532
to the ground and beyond,

1062
00:48:22,565 --> 00:48:26,036
we might even see a
first picture from
the surface of Mars.

1063
00:48:26,069 --> 00:48:27,270
- [Gay] Wouldn't that be great?

1064
00:48:27,303 --> 00:48:28,672
- [Rob] Very soon.

1065
00:48:28,705 --> 00:48:30,374
- [Christine] Atmospheric
entry on my mark,

1066
00:48:32,575 --> 00:48:35,112
three, two, one, mark.

1067
00:48:37,146 --> 00:48:38,481
- [Gay] Here we go.

1068
00:48:38,514 --> 00:48:40,150
- [Rob] So in a few seconds

1069
00:48:40,183 --> 00:48:42,652
the vehicle will start
sensing the atmosphere,

1070
00:48:42,685 --> 00:48:45,855
22 kilometers from
the center of Mars,

1071
00:48:45,888 --> 00:48:48,024
and it's gonna start
to slow down very

1072
00:48:48,057 --> 00:48:49,426
very slowly at first,

1073
00:48:49,459 --> 00:48:51,761
but then faster and
faster and faster,

1074
00:48:51,794 --> 00:48:54,831
till it reaches about seven Gs,

1075
00:48:54,864 --> 00:48:56,166
I made that mistake
on the video,

1076
00:48:56,199 --> 00:48:57,867
it's actually seven Gs not 12,

1077
00:48:57,900 --> 00:49:02,539
but it will still very,
very quickly slow down,

1078
00:49:04,907 --> 00:49:05,809
from 15--

1079
00:49:05,842 --> 00:49:07,310
- In approximately one minute,

1080
00:49:07,343 --> 00:49:10,613
InSight is expected to reach
its maximum heating rate,

1081
00:49:10,646 --> 00:49:14,217
plasma blackout is possible
during peak heating,

1082
00:49:14,250 --> 00:49:17,821
and could cause a temporary
drop out of telemetry,

1083
00:49:17,854 --> 00:49:20,791
this could last for as
long as two minutes.

1084
00:49:22,759 --> 00:49:23,960
- [Rob] The gas that comes

1085
00:49:23,993 --> 00:49:26,596
off the heat shield
as it's slowing down,

1086
00:49:26,629 --> 00:49:28,498
it looks like a meteor
if you're on Mars

1087
00:49:28,531 --> 00:49:30,133
watching the streak go by,

1088
00:49:30,166 --> 00:49:32,569
that brightness of

gas does interfere

1089
00:49:32,602 --> 00:49:33,904
with the radio reception,

1090
00:49:35,038 --> 00:49:36,473
so it's possible
that MarCO will lose

1091
00:49:36,506 --> 00:49:40,010
that signal while going
through this very hot entry.

1092
00:49:40,043 --> 00:49:41,811
- [Gay] But not to be alarmed.

1093
00:49:41,844 --> 00:49:42,812
- [Rob] Not to be alarmed,

1094
00:49:42,845 --> 00:49:44,014
it's part of the design,

1095
00:49:44,047 --> 00:49:45,648
we completely expect it.

1096
00:49:45,681 --> 00:49:47,717
- [Man] Radio science reports

1097
00:49:47,750 --> 00:49:49,886
plasma blackouts as expected.

1098
00:49:49,919 --> 00:49:51,855
- [Rob] Okay, oh wow.

1099
00:49:57,794 --> 00:49:59,462
- Ground stations have
reported plasma blackout,

1100

00:49:59,495 --> 00:50:02,165
still receiving InSight
telemetry via MarCO.

1101
00:50:03,800 --> 00:50:06,069
- [Man] MarCO Alpha has
carrier interruption.

1102
00:50:09,138 --> 00:50:12,109
- InSight should now
be experiencing the
peak heating rate,

1103
00:50:13,342 --> 00:50:15,111
portions of the heat
shield may reach

1104
00:50:15,144 --> 00:50:17,981
nearly 3000 degrees
Fahrenheit as it protects

1105
00:50:18,014 --> 00:50:20,283
the lander from the
heating environment.

1106
00:50:25,054 --> 00:50:25,989
- [Rob] That's hot.

1107
00:50:27,857 --> 00:50:29,359
- [Man] MarCO Bravo has
carrier interruption,

1108
00:50:29,392 --> 00:50:30,293
but still in lock.

1109
00:50:55,685 --> 00:50:58,822
- InSight has passed
through peak deceleration,

1110
00:50:58,855 --> 00:51:01,858

telemetry shows the
spacecraft at about 8 Gs.

1111
00:51:01,891 --> 00:51:04,127
- [Man] MarCO Alpha and
MarCO Bravo maintain lock.

1112
00:51:04,160 --> 00:51:06,863
- [Man] Radio science
reports carrier detected.

1113
00:51:11,567 --> 00:51:14,104
- [Gay] Several different
communications coming in.

1114
00:51:15,171 --> 00:51:16,639
- InSight is now
traveling at a velocity

1115
00:51:16,672 --> 00:51:18,708
of 2000 meters per second.

1116
00:51:22,478 --> 00:51:23,746
- [Rob] It seems to have
passed this very critical

1117
00:51:23,779 --> 00:51:26,316
point of peak heating
and peak deceleration.

1118
00:51:30,820 --> 00:51:32,989
The next big step is
parachute inflation.

1119
00:51:34,223 --> 00:51:36,226
- [Gay] You can see
that on our timeline

1120
00:51:36,259 --> 00:51:37,627
on the bottom of the screen,

1121
00:51:39,128 --> 00:51:41,865
the next event is
parachute deploy.

1122
00:51:41,898 --> 00:51:42,899
- InSight is now traveling

1123
00:51:42,932 --> 00:51:44,935
at 1000 meters per second.

1124
00:51:46,335 --> 00:51:48,872
Once InSight slows to
about 400 meters per second

1125
00:51:48,905 --> 00:51:53,510
it will deploy its 12 meter
diameter supersonic parachute,

1126
00:51:53,543 --> 00:51:56,446
the parachute will deploy
nominally at about Mach 1.7.

1127
00:52:02,218 --> 00:52:05,021
Standing by for
parachute deploy.

1128
00:52:23,806 --> 00:52:26,776
- [Man] Radio science reports
sudden change in Doppler.

1129
00:52:28,544 --> 00:52:30,079
- [Christine] Ground stations
are observing signals

1130
00:52:30,112 --> 00:52:31,881
consistent with
parachute deploy.

1131

00:52:31,914 --> 00:52:33,816
[people applaud]

1132
00:52:33,849 --> 00:52:34,951
- [Man] MarCO Alpha
and MarCO Bravo

1133
00:52:34,984 --> 00:52:36,219
maintain locked status.

1134
00:52:39,589 --> 00:52:41,457
- [Christine] Telemetry
shows parachute deployment,

1135
00:52:41,490 --> 00:52:43,093
RADAR powered on.

1136
00:52:44,260 --> 00:52:46,963
[people applaud]

1137
00:52:49,031 --> 00:52:50,667
Heat shield
separation commanded.

1138
00:53:01,477 --> 00:53:03,480
- [Rob] This is really
good news so far.

1139
00:53:04,380 --> 00:53:05,215
- [Gay] It's fantastic.

1140
00:53:07,149 --> 00:53:08,752
- [Rob] I'm on pins and needles.

1141
00:53:12,755 --> 00:53:14,224
- We have RADAR activation

1142
00:53:14,257 --> 00:53:17,026
where the RADAR is beginning

to search for the ground,

1143
00:53:17,059 --> 00:53:19,462
once the RADAR
locks on the ground,

1144
00:53:19,495 --> 00:53:21,431
and InSight is about one
kilometer above the surface,

1145
00:53:21,464 --> 00:53:23,833
the lander will separate
from the back shell

1146
00:53:23,866 --> 00:53:27,771
and begin terminal descent
using its 12 descent engines.

1147
00:53:55,431 --> 00:53:58,001
Altitude convergence, the
RADAR has locked on the ground.

1148
00:53:58,034 --> 00:54:00,770
[people applaud]

1149
00:54:02,938 --> 00:54:05,008
Standing by for the
lander separation.

1150
00:54:05,041 --> 00:54:06,542
- [Man] Carrier interruption

1151
00:54:06,575 --> 00:54:07,744
on MarCO Alpha and MarCO Bravo.

1152
00:54:11,847 --> 00:54:13,816
- [Christine] Lander
separation commanded,

1153

00:54:13,849 --> 00:54:15,485
altitude 600 meters.

1154
00:54:16,686 --> 00:54:20,189
Gravity turn,
altitude 400 meters.

1155
00:54:20,222 --> 00:54:21,591
- [Rob] We're getting there.

1156
00:54:21,624 --> 00:54:22,892
- 300 meters.

1157
00:54:26,662 --> 00:54:27,797
200 meters.

1158
00:54:29,865 --> 00:54:31,534
80 meters.

1159
00:54:31,567 --> 00:54:33,236
60 meters.

1160
00:54:34,970 --> 00:54:37,707
50 meters, constant velocity,

1161
00:54:37,740 --> 00:54:39,042
37 meters,

1162
00:54:40,009 --> 00:54:41,744
30 meters,

1163
00:54:41,777 --> 00:54:42,812
20 meters,

1164
00:54:43,813 --> 00:54:44,714
17 meters,

1165
00:54:44,747 --> 00:54:46,116

standing by for touchdown.

1166
00:55:00,229 --> 00:55:01,964
Touchdown confirmed.

1167
00:55:01,997 --> 00:55:05,568
[people cheer and applaud]

1168
00:55:24,253 --> 00:55:26,356
- [Gay] That's fantastic.

1169
00:55:28,991 --> 00:55:29,926
- [Rob] This never gets old.

1170
00:55:29,959 --> 00:55:32,095
- [Gay] No it doesn't Rob,

1171
00:55:34,864 --> 00:55:36,933
the control room just erupted.

1172
00:55:40,169 --> 00:55:41,337
- [Rob] Fabulous, fabulous.

1173
00:55:41,370 --> 00:55:43,206
- [Gay] Command of
the MarCO team there.

1174
00:55:44,373 --> 00:55:46,376
- [Rob] The MarCO
team did great,

1175
00:55:46,409 --> 00:55:48,645
Ted Reising, one of the
key designers of Lockheed.

1176
00:55:50,980 --> 00:55:52,315
Sandy Krasner,

1177

00:55:52,348 --> 00:55:53,416
they are a great team.

1178
00:55:58,921 --> 00:56:00,656
This is really fabulous.

1179
00:56:00,689 --> 00:56:01,825
- [Gay] Fantastic news.

1180
00:56:07,930 --> 00:56:11,801
- [Rob] [laughs] Thank you.

1181
00:56:11,834 --> 00:56:14,204
- [Gay] Lots of fist
pumping going on in there.

1182
00:56:15,905 --> 00:56:17,340
What a relief,

1183
00:56:17,373 --> 00:56:21,411
we have cut over to the
camera over in Times Square,

1184
00:56:22,611 --> 00:56:24,748
people are weathering
the rain to see this.

1185
00:56:42,231 --> 00:56:43,533
[people cheering]

1186
00:56:43,566 --> 00:56:45,802
- [Rob] They can't help it.

1187
00:57:06,388 --> 00:57:07,523
This is the hardest part,

1188
00:57:07,556 --> 00:57:08,758
getting to the
surface and landing,

1189
00:57:08,791 --> 00:57:11,327
this thing has a lot
more to do though,

1190
00:57:13,062 --> 00:57:15,565
there's a lot more
to go on both today

1191
00:57:15,598 --> 00:57:19,502
and the days that follow
before the science can begin,

1192
00:57:19,535 --> 00:57:22,839
but just getting a
vehicle from Earth

1193
00:57:22,872 --> 00:57:25,475
to the surface of
Mars is no mean feat.

1194
00:57:26,642 --> 00:57:28,077
- [Gay] And Rob, could
you talk about that,

1195
00:57:28,110 --> 00:57:31,647
just the mere accomplishment
here that we're seeing.

1196
00:57:31,680 --> 00:57:34,250
- You have to understand,

1197
00:57:34,283 --> 00:57:37,854
this vehicle is
very complicated,

1198
00:57:37,887 --> 00:57:39,789
it uses 12 engines,

1199

00:57:39,822 --> 00:57:42,825
each of those engines are
pulsed 10 times a second,

1200
00:57:42,858 --> 00:57:45,862
producing these
little tiny impulses,

1201
00:57:45,895 --> 00:57:47,930
almost like little
bullets that keep

1202
00:57:47,963 --> 00:57:50,566
the vehicle going at
a constant velocity

1203
00:57:50,599 --> 00:57:52,468
as it approaches the ground,

1204
00:57:52,501 --> 00:57:55,137
and still going over
five miles an hour,

1205
00:57:55,170 --> 00:57:57,373
so those legs feel a
fair amount of crush,

1206
00:57:57,406 --> 00:57:59,141
we still don't know the state
of the vehicle right now,

1207
00:57:59,174 --> 00:58:01,210
we need to look to make sure
there are no rocks nearby,

1208
00:58:01,243 --> 00:58:05,047
the solar panels in about five

1209
00:58:05,080 --> 00:58:08,484
to 10 minutes will

begin to open up,

1210
00:58:08,517 --> 00:58:10,019
they're waiting for
the dust to settle,

1211
00:58:10,052 --> 00:58:13,356
because there is certainly
a lot of dust being lifted

1212
00:58:13,389 --> 00:58:15,157
in the air around the
vehicle right now,

1213
00:58:15,190 --> 00:58:17,293
which is now just settling.

1214
00:58:17,326 --> 00:58:18,795
- [Gay] So we're standing by,

1215
00:58:19,962 --> 00:58:22,598
after touchdown
it waits a couple

1216
00:58:22,631 --> 00:58:25,134
of minutes to give
us an X-band beep,

1217
00:58:26,535 --> 00:58:28,571
so we are standing by for that,

1218
00:58:28,604 --> 00:58:30,640
it's a communication
that comes directly

1219
00:58:30,673 --> 00:58:32,208
to Earth from InSight.

1220
00:58:32,241 --> 00:58:33,509

- [Rob] Yes,

1221
00:58:33,542 --> 00:58:36,913
and it goes to the
Deep Space Network,

1222
00:58:36,946 --> 00:58:38,881
there's also something that
might be happening now,

1223
00:58:38,914 --> 00:58:40,283
if we are very lucky,

1224
00:58:40,316 --> 00:58:42,752
InSight might be able
to relay an image

1225
00:58:42,785 --> 00:58:45,121
or a partial image taken just

1226
00:58:45,154 --> 00:58:48,057
a couple of minutes
after landing,

1227
00:58:48,090 --> 00:58:51,160
so I'm standing by
hoping to see that,

1228
00:58:51,193 --> 00:58:52,595
but if that doesn't happen,

1229
00:58:52,628 --> 00:58:56,065
we'll certainly get more images
later in our Odyssey pass

1230
00:58:56,098 --> 00:58:57,300
in about five hours.

1231
00:58:57,333 --> 00:58:59,936

- [Gay] We see Bruce
Banerdt waiting for it,

1232
00:58:59,969 --> 00:59:02,138
I don't know if they see it yet.

1233
00:59:02,171 --> 00:59:03,372
- [Rob] They are waiting,

1234
00:59:03,405 --> 00:59:05,808
that's Justin Mackie
and Bruce Banerdt

1235
00:59:05,841 --> 00:59:09,378
looking carefully at the cameras
to see what they might see.

1236
00:59:09,411 --> 00:59:12,114
They're waiting for
the image to come back.

1237
00:59:12,147 --> 00:59:15,751
- [Gay] So this is the first
image from InSight itself,

1238
00:59:15,784 --> 00:59:19,755
InSight is taking a picture
with one of its two cameras,

1239
00:59:19,788 --> 00:59:23,526
it's probably a view
of what is directly

1240
00:59:23,559 --> 00:59:26,696
in front of the spacecraft,

1241
00:59:26,729 --> 00:59:28,164
right in front of the lander,

1242

00:59:28,197 --> 00:59:31,867
this is a camera that it
will be using to figure out

1243
00:59:31,900 --> 00:59:33,569
is this a good space,

1244
00:59:33,602 --> 00:59:36,305
is it a good place to
put down our instruments,

1245
00:59:36,338 --> 00:59:39,041
so it is going to take an image

1246
00:59:39,074 --> 00:59:41,877
and then send that
image to the MarCOs,

1247
00:59:41,910 --> 00:59:45,247
the MarCOs in turn will
relay it back to Earth.

1248
00:59:45,280 --> 00:59:46,782
- [Rob] That's
great, they got it.

1249
00:59:46,815 --> 00:59:48,985
[people cheer and applaud]

1250
00:59:49,018 --> 00:59:51,687
This is great, let's
see what they've got.

1251
00:59:51,720 --> 00:59:53,489
There it is.

1252
00:59:53,522 --> 00:59:55,792
- [Gay] There's the picture.

1253

01:00:02,965 --> 01:00:05,635
- [Rob] That's a good site,

1254
01:00:05,668 --> 01:00:06,802
that's not far from where

1255
01:00:06,835 --> 01:00:07,903
they'll be able to
deploy the instruments,

1256
01:00:07,936 --> 01:00:08,938
so it's great,

1257
01:00:08,971 --> 01:00:10,706
I don't see a lot of--

1258
01:00:10,739 --> 01:00:12,642
- [Gay] Let's
explain that image,

1259
01:00:12,675 --> 01:00:16,312
now this image has a
dust cover on top of it.

1260
01:00:16,345 --> 01:00:17,947
- [Man] EDL COMM, we have
lost the signal from MarCO.

1261
01:00:17,980 --> 01:00:20,716
- [Rob] You can see
potentially a lot of--

1262
01:00:20,749 --> 01:00:24,187
- [Man] Radio signs
reports loss for UHF.

1263
01:00:27,156 --> 01:00:28,858
- [Rob] So we don't know
what I'm looking at.

1264
01:00:28,891 --> 01:00:30,560
- Thank you everybody
on EDL COMM.

1265
01:00:33,228 --> 01:00:34,163
- [Man] Trusty job MarCO.

1266
01:00:34,196 --> 01:00:35,431
- [Rob] Yay, MarCO.

1267
01:00:35,464 --> 01:00:38,201
[people applaud]

1268
01:00:43,205 --> 01:00:44,540
Congratulations.

1269
01:00:47,509 --> 01:00:49,045
But there it is,

1270
01:00:49,078 --> 01:00:50,279
you can see a better view,

1271
01:00:50,312 --> 01:00:51,213
you can see that
really is debris,

1272
01:00:51,246 --> 01:00:52,348
there is the horizon back there,

1273
01:00:52,381 --> 01:00:54,050
the bluish sky,

1274
01:00:55,517 --> 01:00:57,820
that's part of the lander
deck on the front left,

1275
01:00:57,853 --> 01:00:59,088
I can't make out,

1276
01:00:59,121 --> 01:01:00,022
but it looks like
there's not a lot

1277
01:01:00,055 --> 01:01:01,290
of rocks in the field of view,

1278
01:01:01,323 --> 01:01:03,225
but those dots you see
there are very likely

1279
01:01:03,258 --> 01:01:07,596
to be dust particles
on the dust cover,

1280
01:01:07,629 --> 01:01:09,365
which will be removed.

1281
01:01:09,398 --> 01:01:12,134
- [Gay] And will get
another shot later on.

1282
01:01:12,167 --> 01:01:13,602
- [Rob] Yes.

1283
01:01:13,635 --> 01:01:16,539
And a better clearer view after
the dust cover is removed,

1284
01:01:20,175 --> 01:01:24,547
Cubesats relay
communications job is done,

1285
01:01:24,580 --> 01:01:25,948
they're now flying on,

1286
01:01:25,981 --> 01:01:28,517
they're now taking

pictures back toward Mars,

1287
01:01:28,550 --> 01:01:31,687
hopefully MRO
which flew overhead

1288
01:01:31,720 --> 01:01:34,957
might have been lucky enough
to capture the descent

1289
01:01:34,990 --> 01:01:38,094
of this InSight Lander
under its parachute,

1290
01:01:38,127 --> 01:01:41,130
while this was going on,

1291
01:01:41,163 --> 01:01:43,299
MRO was flying overhead
recording the data,

1292
01:01:43,332 --> 01:01:47,002
and also monitoring
the transactions,

1293
01:01:47,035 --> 01:01:49,338
and recording every
bit of signal it could,

1294
01:01:49,371 --> 01:01:51,273
but it also had the
ability to take a picture,

1295
01:01:51,306 --> 01:01:53,809
maybe like we did with Phoenix

1296
01:01:53,842 --> 01:01:56,545
and later for Curiosity Rover,

1297

01:01:56,578 --> 01:01:58,848
we might be able to see
the parachute inflated.

1298
01:01:58,881 --> 01:02:00,116
- [Gay] That would be fantastic,

1299
01:02:00,149 --> 01:02:03,319
we are standing by now
for that X-band beep,

1300
01:02:04,720 --> 01:02:08,691
InSight phoning home saying
I'm here, and I'm okay.

1301
01:02:11,160 --> 01:02:13,996
[crowd murmuring]

1302
01:02:47,663 --> 01:02:48,464
- [Man] Systems on InSight core,

1303
01:02:48,497 --> 01:02:49,899
the DSM and X-band.

1304
01:02:53,869 --> 01:02:56,639
- [Man] Radio science reports
X-band carrier detected.

1305
01:02:57,739 --> 01:03:00,576
[people cheer and applaud]

1306
01:03:00,609 --> 01:03:04,680
[man mumbles off microphone]

1307
01:03:04,713 --> 01:03:06,282
- [Man] Four and a half minutes

1308
01:03:06,315 --> 01:03:07,917
with InSight in nominal mode.

1309
01:03:07,950 --> 01:03:09,685
- [Woman] Copy that, thank you.

1310
01:03:11,687 --> 01:03:13,055
- [Rob] Flawless,

1311
01:03:13,088 --> 01:03:13,889
- [Gay] Perfect,

1312
01:03:13,922 --> 01:03:14,824
- [Rob] Flawless,

1313
01:03:14,857 --> 01:03:16,592
- [Gay] We've got the beep,

1314
01:03:16,625 --> 01:03:20,930
this was a perfect case
scenario in my book.

1315
01:03:20,963 --> 01:03:22,832
- [Rob] This is
what we really hoped

1316
01:03:22,865 --> 01:03:24,834
and imagined in our minds eye,

1317
01:03:24,867 --> 01:03:27,536
we spent a lot of
time visualizing

1318
01:03:27,569 --> 01:03:29,238
all these bad things can happen,

1319
01:03:29,271 --> 01:03:31,407
but sometimes things
work out in your favor.

1320

01:03:31,440 --> 01:03:32,575
And we'll look very
carefully at the data

1321
01:03:32,608 --> 01:03:35,945
and see how well it went,

1322
01:03:35,978 --> 01:03:37,680
but it certainly
looked like it was

1323
01:03:37,713 --> 01:03:39,748
a very successful
and perfect landing,

1324
01:03:39,781 --> 01:03:43,119
we'll have to see as we get
more data how well things go,

1325
01:03:44,586 --> 01:03:48,824
as the vehicle proceeds the
solar panels will be deployed,

1326
01:03:48,857 --> 01:03:50,392
hopefully were not on a tilt,

1327
01:03:50,425 --> 01:03:52,862
it doesn't look like
we are from the image,

1328
01:03:52,895 --> 01:03:56,198
but the solar panels will
be deployed safely we hope,

1329
01:03:56,231 --> 01:03:58,500
and we'll get
confirmation of that

1330
01:03:58,533 --> 01:04:01,203
around five o'clock local time

1331
01:04:01,236 --> 01:04:04,640
here in about four and a
half to five hours from now.

1332
01:04:04,673 --> 01:04:07,309
- [Gay] And this is
such a difficult feat,

1333
01:04:07,342 --> 01:04:10,112
in that because of
the one-way lag time,

1334
01:04:10,145 --> 01:04:12,882
there is no way that
any of these engineers

1335
01:04:12,915 --> 01:04:16,118
could possibly
control the vehicle,

1336
01:04:16,151 --> 01:04:20,055
it all has to be done in
commands and software.

1337
01:04:20,088 --> 01:04:21,290
- [Rob] Yes,

1338
01:04:21,323 --> 01:04:23,425
we have to train it to
do this work on its own.

1339
01:04:23,458 --> 01:04:28,097
- [Man] Radio science
reports nominal carrier

1340
01:04:28,130 --> 01:04:31,667
30 seconds past the
first acquisition,

1341
01:04:32,834 --> 01:04:34,637
so we are nominal
on the surface.

1342
01:04:36,505 --> 01:04:38,173
- [Rob] So the vehicle
is completely nominal,

1343
01:04:38,206 --> 01:04:39,541
reported nominal,

1344
01:04:39,574 --> 01:04:40,843
it's happy,

1345
01:04:40,876 --> 01:04:42,611
the lander is not complaining,

1346
01:04:42,644 --> 01:04:46,815
we had a way to tell
us if it was unhappy,

1347
01:04:46,848 --> 01:04:47,783
and it wasn't,

1348
01:04:47,816 --> 01:04:49,251
it's not unhappy,

1349
01:04:49,284 --> 01:04:51,553
it's in normal mode,

1350
01:04:51,586 --> 01:04:54,189
and so it's gonna chug
along for the rest

1351
01:04:54,222 --> 01:04:57,560
of the afternoon on Mars
and finish the activities.

1352

01:04:58,727 --> 01:05:00,129
- [Gay] Alright well Rob
I know you're anxious

1353
01:05:00,162 --> 01:05:03,098
to get in and
congratulate the crew,

1354
01:05:03,131 --> 01:05:06,235
thank you so much for sitting
here and helping us out.

1355
01:05:06,268 --> 01:05:08,137
- It was my pleasure.
- And explaining EDL.

1356
01:05:08,170 --> 01:05:09,071
- Thank you.

1357
01:05:09,104 --> 01:05:10,239
- Alright, well I'll let you go,

1358
01:05:10,272 --> 01:05:12,107
and go congratulate
your friend's.

1359
01:05:12,140 --> 01:05:14,410
- Thank you.
- Alright, take care.

1360
01:05:45,841 --> 01:05:49,178
- [Man] EDL COMM on
InSight ops recording

1361
01:05:49,211 --> 01:05:51,814
completed at 20:04:34.

1362
01:07:08,957 --> 01:07:10,426
- Alright,

1363
01:07:10,459 --> 01:07:12,861
as we had promised we said we
bring back the administrator

1364
01:07:12,894 --> 01:07:15,631
to get your take
on what was it like

1365
01:07:15,664 --> 01:07:16,865
to be in that control room,

1366
01:07:16,898 --> 01:07:17,833
Jim, what was it like?

1367
01:07:17,866 --> 01:07:19,034
- Well I'll tell you,

1368
01:07:19,067 --> 01:07:20,536
it was intense,

1369
01:07:20,569 --> 01:07:22,805
and you could feel the emotion,

1370
01:07:22,838 --> 01:07:25,808
it was very, very quiet when
it was time to be quiet,

1371
01:07:25,841 --> 01:07:29,311
and of course very
celebratory with every little

1372
01:07:29,344 --> 01:07:31,513
new piece of information
that was received,

1373
01:07:31,546 --> 01:07:33,816
it's very different being here

1374

01:07:33,849 --> 01:07:35,751
than watching it on TV by far,

1375
01:07:35,784 --> 01:07:39,421
I can tell you that for sure
now that I've experienced both,

1376
01:07:39,454 --> 01:07:40,489
and then of course,

1377
01:07:41,957 --> 01:07:43,826
what's amazing is as
soon as it was over,

1378
01:07:43,859 --> 01:07:45,427
I got a call on my cell phone,

1379
01:07:45,460 --> 01:07:48,230
and the phone number
with all zeros,

1380
01:07:48,263 --> 01:07:50,232
and whenever I get a phone
call that's all zeros

1381
01:07:50,265 --> 01:07:51,867
it's got to be
somebody important,

1382
01:07:51,900 --> 01:07:52,801
I answered it,

1383
01:07:52,834 --> 01:07:54,536
and it was the vice president,

1384
01:07:54,569 --> 01:07:56,038
he watched the whole thing,

1385
01:07:56,071 --> 01:07:58,540

he is absolutely ecstatic
about our program,

1386
01:07:58,573 --> 01:08:00,509
as you are aware,
he's the chairman

1387
01:08:00,542 --> 01:08:02,444
of the National Space Council,

1388
01:08:02,477 --> 01:08:06,915
and he's been of course a
keen advocate for what we do,

1389
01:08:06,948 --> 01:08:10,886
and to have him call within
seconds of mission success,

1390
01:08:10,919 --> 01:08:11,820
is tremendous,

1391
01:08:11,853 --> 01:08:13,489
and just so everybody knows,

1392
01:08:13,522 --> 01:08:15,491
he wants me to say
congratulations

1393
01:08:15,524 --> 01:08:16,725
to everybody here at NASA,

1394
01:08:16,758 --> 01:08:18,193
and all of our
international partners,

1395
01:08:18,226 --> 01:08:22,131
and everybody who has
contributed to this mission,

1396

01:08:22,164 --> 01:08:23,966
what an amazing day for NASA.

1397
01:08:23,999 --> 01:08:26,468
- It is an amazing
accomplishment,

1398
01:08:26,501 --> 01:08:30,205
in that this is something
that is happening millions

1399
01:08:30,238 --> 01:08:32,741
and millions and
millions of miles away,

1400
01:08:32,774 --> 01:08:34,676
and these people
are able to do it.

1401
01:08:34,709 --> 01:08:35,544
- Incredible,

1402
01:08:36,545 --> 01:08:37,913
and what's fascinating is,

1403
01:08:37,946 --> 01:08:39,381
the whole time I'm
watching it I'm thinking,

1404
01:08:39,414 --> 01:08:41,316
every milestone is something

1405
01:08:41,349 --> 01:08:42,918
that happened eight minutes ago,

1406
01:08:42,951 --> 01:08:44,620
because that's
the timelag to get

1407

01:08:44,653 --> 01:08:46,255
a signal from Mars to Earth,

1408
01:08:49,524 --> 01:08:51,160
so it's exciting,

1409
01:08:51,193 --> 01:08:52,895
but then you have to
step back and realize

1410
01:08:52,928 --> 01:08:55,397
that this has already
occurred in history,

1411
01:08:55,430 --> 01:08:57,766
so it's an unique experience,

1412
01:08:57,799 --> 01:09:02,538
incredible, just the
enthusiasm here is incredible.

1413
01:09:02,571 --> 01:09:04,640
- So what's for the future,

1414
01:09:04,673 --> 01:09:06,241
looking ahead, 2020?

1415
01:09:06,274 --> 01:09:08,210
- Well let's get
through December,

1416
01:09:08,243 --> 01:09:10,379
so for the rest,

1417
01:09:10,412 --> 01:09:12,481
we think about happening next,

1418
01:09:12,514 --> 01:09:15,284
December 3rd, we're lunching

another American astronaut

1419
01:09:16,618 --> 01:09:17,853
to the International
Space Station,

1420
01:09:17,886 --> 01:09:19,121
so that's gonna be
a big achievement,

1421
01:09:19,154 --> 01:09:20,856
and it's gonna be on a
Russian Soyuz rocket,

1422
01:09:20,889 --> 01:09:23,525
the last time we launched
a human was not successful.

1423
01:09:23,558 --> 01:09:24,359
- [Gay] That was scary.

1424
01:09:24,392 --> 01:09:25,594
- It was scary,

1425
01:09:25,627 --> 01:09:27,296
but we figured out
what the problem is,

1426
01:09:27,329 --> 01:09:29,097
we're moving forward,

1427
01:09:29,130 --> 01:09:30,699
and now we've got that
underway on December 3rd.

1428
01:09:30,732 --> 01:09:31,900
Going forward from there,

1429
01:09:31,933 --> 01:09:33,502

we're gonna get the
first science data back

1430
01:09:33,535 --> 01:09:36,438
from the Parker Solar
Probe on December 7th,

1431
01:09:36,471 --> 01:09:37,973
so that's not too
far away either,

1432
01:09:38,006 --> 01:09:41,243
and then we've got Osiris Rex,

1433
01:09:41,276 --> 01:09:42,811
that will be in orbit around

1434
01:09:42,844 --> 01:09:44,980
Benu shortly after Christmas,

1435
01:09:45,013 --> 01:09:47,416
so no shortage of
exciting things.

1436
01:09:47,449 --> 01:09:50,085
And then on January 1st,

1437
01:09:50,118 --> 01:09:52,254
we're gonna to fly the
New Horizons mission,

1438
01:09:52,287 --> 01:09:53,822
which for people
who are not aware,

1439
01:09:53,855 --> 01:09:56,758
that's the mission that
went to Pluto back in 2014,

1440

01:09:56,791 --> 01:10:01,797
give us stunning images and
data and science on Pluto,

1441
01:10:02,964 --> 01:10:05,167
and now that mission
is still going strong,

1442
01:10:05,200 --> 01:10:08,136
it's in what we call
the Kuiper Belt now,

1443
01:10:08,169 --> 01:10:11,039
which is an asteroid
belt well beyond Pluto,

1444
01:10:11,072 --> 01:10:13,175
and it's gonna be taking
images of Ultima Thule,

1445
01:10:13,208 --> 01:10:17,779
which is an object
in the Khyber belt

1446
01:10:17,812 --> 01:10:21,016
which we have never been
able to go out there

1447
01:10:21,049 --> 01:10:23,452
and take images of anything
at close range before,

1448
01:10:23,485 --> 01:10:24,686
and now we're doing it,

1449
01:10:24,719 --> 01:10:26,188
so you ask what's
happening next.

1450
01:10:26,221 --> 01:10:27,623

- I'm sorry I asked.

1451
01:10:28,890 --> 01:10:31,460
- We have right now at NASA,

1452
01:10:31,493 --> 01:10:33,562
there is more underway,

1453
01:10:33,595 --> 01:10:37,499
probably than I don't
know how many years past,

1454
01:10:37,532 --> 01:10:38,433
but it's like there's a drought,

1455
01:10:38,466 --> 01:10:39,501
and then all of a sudden there's

1456
01:10:39,534 --> 01:10:40,769
all of these
activities all at once,

1457
01:10:40,802 --> 01:10:42,004
so we're busy,

1458
01:10:42,037 --> 01:10:43,872
we're gonna be working
through the holiday,

1459
01:10:43,905 --> 01:10:46,341
but a lot of amazing
discoveries to be made,

1460
01:10:46,374 --> 01:10:47,342
and we're looking forward to it.

1461
01:10:47,375 --> 01:10:48,777
- It's so funny,

1462
01:10:48,810 --> 01:10:51,814
because our ask NASA question
you basically answered,

1463
01:10:53,014 --> 01:10:54,683
is does the success of
NASA InSight influence

1464
01:10:54,716 --> 01:10:59,455
the timeline for future
manned lunar or Mars missions?

1465
01:11:00,789 --> 01:11:02,724
- Well certainly everything
we learn about Mars

1466
01:11:02,757 --> 01:11:04,926
at this point is gonna
help us understand

1467
01:11:04,959 --> 01:11:07,296
how to do in situ
resource utilization,

1468
01:11:07,329 --> 01:11:09,831
so InSight could
actually provide

1469
01:11:09,864 --> 01:11:11,333
some really good
information about whether

1470
01:11:11,366 --> 01:11:13,402
or not there is
liquid water on Mars,

1471
01:11:13,435 --> 01:11:16,438
and maybe even where it
is and how to get to it,

1472
01:11:16,471 --> 01:11:19,141
we strongly believe that
there's liquid water

1473
01:11:19,174 --> 01:11:21,076
10 kilometers under
the surface of Mars,

1474
01:11:21,109 --> 01:11:24,279
so the key is,

1475
01:11:24,312 --> 01:11:25,747
the answer is yes,

1476
01:11:25,780 --> 01:11:27,416
the more we learn the more
we're able to achieve,

1477
01:11:27,449 --> 01:11:29,484
so to get to Mars yes.

1478
01:11:29,517 --> 01:11:31,353
But the lunar missions,

1479
01:11:31,386 --> 01:11:33,422
the president's space
first policy directive,

1480
01:11:33,455 --> 01:11:34,490
is to go to the moon,

1481
01:11:35,724 --> 01:11:36,525
to go sustainably
with international

1482
01:11:36,558 --> 01:11:37,726
and commercial partners,

1483

01:11:37,759 --> 01:11:39,027
so when we say sustainably,

1484
01:11:39,060 --> 01:11:40,962
that means we're
gonna have reusability

1485
01:11:40,995 --> 01:11:42,464
built into the system,

1486
01:11:42,497 --> 01:11:45,701
and we're gonna test and prove
technologies at the moon,

1487
01:11:45,734 --> 01:11:48,637
which ultimately we
can replicate at Mars,

1488
01:11:48,670 --> 01:11:50,238
so we're gonna retire at risk,

1489
01:11:50,271 --> 01:11:52,174
prove human physiology
at the moon,

1490
01:11:52,207 --> 01:11:53,942
which is only a
three day journey,

1491
01:11:53,975 --> 01:11:55,944
which means if
something goes wrong,

1492
01:11:55,977 --> 01:11:56,945
you can get home safely,

1493
01:11:56,978 --> 01:11:59,214
we saw that with Apollo 13,

1494

01:11:59,247 --> 01:12:02,017
but we need to use the
moon as a proving ground

1495
01:12:02,050 --> 01:12:03,618
to accelerate our path to Mars,

1496
01:12:03,651 --> 01:12:04,753
in the meantime,

1497
01:12:04,786 --> 01:12:06,054
we're doing missions
like InSight

1498
01:12:06,087 --> 01:12:08,056
to learn as much about
Mars as possible,

1499
01:12:08,089 --> 01:12:09,257
InSight is gonna help us

1500
01:12:09,290 --> 01:12:11,793
understand asteroid
impacts as well,

1501
01:12:11,826 --> 01:12:13,829
because it's got a seismometer,

1502
01:12:13,862 --> 01:12:15,430
which is gonna help us know

1503
01:12:15,463 --> 01:12:17,632
how often is Mars getting
impacted with asteroids,

1504
01:12:17,665 --> 01:12:19,434
and if we're gonna
send humans there,

1505

01:12:19,467 --> 01:12:20,936
it would be important to know,

1506
01:12:20,969 --> 01:12:24,539
if those humans are gonna
experience asteroid impacts.

1507
01:12:24,572 --> 01:12:25,807
- And that's pretty
much our goal,

1508
01:12:25,840 --> 01:12:27,376
is always learned
from our missions

1509
01:12:27,409 --> 01:12:29,144
and build upon those missions.

1510
01:12:29,177 --> 01:12:30,345
- One after another,

1511
01:12:30,378 --> 01:12:32,547
and NASA has a long
history of doing amazing

1512
01:12:32,580 --> 01:12:35,150
work in building on
its past successes,

1513
01:12:35,183 --> 01:12:36,685
and in fact its past failures.

1514
01:12:36,718 --> 01:12:37,886
- That's true.

1515
01:12:38,753 --> 01:12:39,988
- I'll tell you,

1516
01:12:40,021 --> 01:12:41,623

what an amazing time
to be at the helm

1517
01:12:41,656 --> 01:12:44,359
of this extraordinary agency.

1518
01:12:44,392 --> 01:12:46,261
- Well we are so glad that you

1519
01:12:46,294 --> 01:12:48,130
are here to share it with us,

1520
01:12:48,163 --> 01:12:49,364
thanks for joining us.

1521
01:12:49,397 --> 01:12:50,632
- Well Gay, it's
been a true pleasure.

1522
01:12:50,665 --> 01:12:52,267
- And I'm sure you
need to go in there

1523
01:12:52,300 --> 01:12:53,802
and celebrate with those folks,

1524
01:12:53,835 --> 01:12:55,303
but thank you for
stepping out for us.

1525
01:12:55,336 --> 01:12:56,738
- Absolutely, thank you so much.

1526
01:12:56,771 --> 01:12:57,906
- Alright, take care.

1527
01:12:57,939 --> 01:13:00,308
Now Mars exploration
is cool stuff,

1528
01:13:00,341 --> 01:13:03,245
but if you're not
convinced just yet,

1529
01:13:03,278 --> 01:13:06,681
just talk to the InSight
scientists and engineers,

1530
01:13:06,714 --> 01:13:09,050
no one conveys the
excitement more

1531
01:13:09,083 --> 01:13:11,887
than the people who actually
work on the mission,

1532
01:13:11,920 --> 01:13:15,257
so earlier this year the
outreach team filled up a van

1533
01:13:15,290 --> 01:13:18,193
and went to 15
Californian cities,

1534
01:13:18,226 --> 01:13:20,796
they called it the
InSight Roadshow.

1535
01:13:21,963 --> 01:13:25,033
[upbeat music]

1536
01:13:25,066 --> 01:13:28,069
- So we are here in San
Francisco at the Exploratorium,

1537
01:13:28,102 --> 01:13:31,206
and this is part of
InSight's roadshow,

1538
01:13:31,239 --> 01:13:33,508
since it's the first
inter-planetary mission

1539
01:13:33,541 --> 01:13:35,811
we've ever launched
from California,

1540
01:13:35,844 --> 01:13:38,914
we're actually doing a lot of
public engagement activities

1541
01:13:38,947 --> 01:13:40,515
along California.

1542
01:13:40,548 --> 01:13:42,150
- We're just talking
to the public,

1543
01:13:42,183 --> 01:13:44,352
and talking to them
about InSight and
getting them excited,

1544
01:13:44,385 --> 01:13:46,688
and sharing information
that they probably

1545
01:13:46,721 --> 01:13:49,257
wouldn't get just
from the website.

1546
01:13:49,290 --> 01:13:51,626
- We have Mars globes
and technical kits,

1547
01:13:51,659 --> 01:13:54,396
we have replicas of the
actual launch vehicle

1548
01:13:54,429 --> 01:13:56,765
that's gonna be taking
InSight to Mars,

1549
01:13:56,798 --> 01:13:59,401
we have a selfie
station with fun props,

1550
01:13:59,434 --> 01:14:00,902
people can take pictures.

1551
01:14:00,935 --> 01:14:04,172
Children really,
really like Mars.

1552
01:14:04,205 --> 01:14:05,507
- We have a jump station,

1553
01:14:05,540 --> 01:14:08,109
where we invite kids
to come in and jump,

1554
01:14:08,142 --> 01:14:10,111
we have a little
seismometer on the floor,

1555
01:14:10,144 --> 01:14:11,880
which measures ground motion,

1556
01:14:11,913 --> 01:14:14,483
so if students can come
and jump next to it,

1557
01:14:14,516 --> 01:14:17,018
they can actually see their
own recording on the screen,

1558
01:14:17,051 --> 01:14:19,221
and they can make

their own quake.

1559
01:14:19,254 --> 01:14:20,956
- I've had people come
to me and say this

1560
01:14:20,989 --> 01:14:23,758
is the most I've ever understood
about a space mission,

1561
01:14:23,791 --> 01:14:25,760
I'm so happy I came,

1562
01:14:25,793 --> 01:14:28,029
because now I understand
what you're doing,

1563
01:14:28,062 --> 01:14:29,397
I understand why it's important,

1564
01:14:29,430 --> 01:14:30,599
and I'm really excited.

1565
01:14:30,632 --> 01:14:32,467
- You kind of
imagine how it looks,

1566
01:14:32,500 --> 01:14:35,103
but seeing it in person
actually puts it in perspective.

1567
01:14:35,136 --> 01:14:38,139
She was able to explain
a lot of what happens,

1568
01:14:38,172 --> 01:14:40,475
the cameras, what
goes into the ground,

1569

01:14:40,508 --> 01:14:42,143
it's a great exhibit you know,

1570
01:14:42,176 --> 01:14:44,346
both for myself,
and also for kids

1571
01:14:44,379 --> 01:14:46,815
that want to learn about Mars.

1572
01:14:50,852 --> 01:14:52,487
- Okay, we want you to meet

1573
01:14:52,520 --> 01:14:55,223
another Mars
veteran here at JPL,

1574
01:14:55,256 --> 01:14:57,359
hardware director Mike Hawkins.

1575
01:14:57,392 --> 01:15:00,228
You are a mission
manager for curiosity.

1576
01:15:00,261 --> 01:15:01,730
- Absolutely,

1577
01:15:01,763 --> 01:15:02,998
I think this is the fifth
Mars mission I've worked on,

1578
01:15:03,031 --> 01:15:04,132
the fifth Mars lander,

1579
01:15:05,533 --> 01:15:07,402
so maybe we are getting
the hang of it finally.

1580
01:15:07,435 --> 01:15:09,571

- Does it ever get better,

1581
01:15:09,604 --> 01:15:10,972
does it get old,

1582
01:15:11,005 --> 01:15:12,807
is it always the same?

1583
01:15:12,840 --> 01:15:14,042
- No it doesn't,

1584
01:15:14,075 --> 01:15:15,110
I think we are just
as nervous every time,

1585
01:15:15,143 --> 01:15:16,344
the whole landing sequence,

1586
01:15:16,377 --> 01:15:18,380
it's just such a crazy time,

1587
01:15:18,413 --> 01:15:19,614
and we can't do anything,

1588
01:15:19,647 --> 01:15:20,749
it's this feeling
of helplessness

1589
01:15:20,782 --> 01:15:22,117
because the spacecraft
is on its own,

1590
01:15:22,150 --> 01:15:25,020
and everything we could
do we did a day ago,

1591
01:15:25,053 --> 01:15:28,323
and so I think you always
have that nervousness,

1592
01:15:28,356 --> 01:15:29,824
but we have confidence
in the team,

1593
01:15:29,857 --> 01:15:31,626
we have confidence in the
engineers and scientists

1594
01:15:31,659 --> 01:15:33,662
that they did everything
that they could do,

1595
01:15:33,695 --> 01:15:36,665
and you have to put
it in their hands.

1596
01:15:36,698 --> 01:15:38,567
- And it's our eighth
successful landing,

1597
01:15:38,600 --> 01:15:40,302
so we learn from this,

1598
01:15:40,335 --> 01:15:42,270
we learn a little more and we do

1599
01:15:42,303 --> 01:15:44,773
it better the next
time pretty much.

1600
01:15:44,806 --> 01:15:45,607
- Absolutely,

1601
01:15:45,640 --> 01:15:46,541
we have had one failure,

1602
01:15:46,574 --> 01:15:48,176
we learn from the failures too,

1603
01:15:48,209 --> 01:15:51,546
we learned from all the
failures from all the missions,

1604
01:15:51,579 --> 01:15:54,049
even if they are not JPL
missions or NASA missions,

1605
01:15:54,082 --> 01:15:55,350
each one of them tells
you a little something,

1606
01:15:55,383 --> 01:15:56,885
an extra test you should do,

1607
01:15:56,918 --> 01:15:58,920
an extra thing you
should guard against

1608
01:15:58,953 --> 01:16:01,056
in the Mars atmosphere
or on touchdown,

1609
01:16:01,089 --> 01:16:02,490
and so we have learned
from all of these,

1610
01:16:02,523 --> 01:16:06,027
and luckily we have recently
been very successful.

1611
01:16:06,060 --> 01:16:07,495
- And we're always
trying something new,

1612
01:16:07,528 --> 01:16:09,164
we're always trying to
learn something new,

1613
01:16:09,197 --> 01:16:10,799
we had a situation this time,

1614
01:16:10,832 --> 01:16:12,500
Odyssey couldn't be in place

1615
01:16:12,533 --> 01:16:15,370
to give us bent
pipe communications,

1616
01:16:15,403 --> 01:16:17,939
and so MarCO came about.

1617
01:16:17,972 --> 01:16:19,741
- MarCO is just a
incredible success story,

1618
01:16:19,774 --> 01:16:22,444
as you said we couldn't
have Mars Odyssey

1619
01:16:22,477 --> 01:16:23,845
do the real-time bent pipe

1620
01:16:23,878 --> 01:16:25,480
for the EDL events,

1621
01:16:26,614 --> 01:16:28,049
we would have had to
wait a couple of hours,

1622
01:16:28,082 --> 01:16:30,552
and get the replay from
Mars Reconnaissance Orbiter,

1623
01:16:30,585 --> 01:16:32,120
so we embarked on
this crazy idea

1624
01:16:32,153 --> 01:16:34,356
to build these two
little Cubesats,

1625
01:16:34,389 --> 01:16:35,657
and Cubesats or something

1626
01:16:35,690 --> 01:16:37,626
that high school kids
can build these days,

1627
01:16:37,659 --> 01:16:39,594
they go up and go
around the Earth,

1628
01:16:39,627 --> 01:16:42,631
these are the first
interplanetary Cubesats,

1629
01:16:42,664 --> 01:16:43,865
first time we've
ever sent Cubesats

1630
01:16:43,898 --> 01:16:45,634
outside the Earth's orbit,

1631
01:16:45,667 --> 01:16:47,535
and their sole purpose
was to do the relay,

1632
01:16:47,568 --> 01:16:51,206
so they had this very
cool expand planar
flat antenna there,

1633
01:16:51,239 --> 01:16:55,510
and they relayed the UHF
signals in real time for us,

1634

01:16:55,543 --> 01:16:57,512
and it was just amazing,

1635
01:16:57,545 --> 01:16:59,047
it was built by a lot
of early career folks

1636
01:16:59,080 --> 01:17:00,882
here at JPL with a little
bit of adult supervision,

1637
01:17:00,915 --> 01:17:04,019
but no the engineers just
did a fantastic job on MarCO,

1638
01:17:04,052 --> 01:17:06,688
they exceeded all of our
wildest expectations,

1639
01:17:06,721 --> 01:17:08,123
they worked perfectly,

1640
01:17:08,156 --> 01:17:09,924
we built two because we thought
maybe one will get there,

1641
01:17:09,957 --> 01:17:10,759
they both got there,

1642
01:17:10,792 --> 01:17:12,260
they both worked,

1643
01:17:12,293 --> 01:17:14,362
it's just a great tribute
to the whole MarCO team,

1644
01:17:14,395 --> 01:17:16,097
you saw them in there,

1645

01:17:16,130 --> 01:17:17,198
they had the special
black shirts,

1646
01:17:17,231 --> 01:17:18,433
just a fantastic thing,

1647
01:17:18,466 --> 01:17:20,335
and not only did it
work for this mission,

1648
01:17:20,368 --> 01:17:22,103
but I think it opens up the door

1649
01:17:22,136 --> 01:17:24,305
for more small
missions like that,

1650
01:17:24,338 --> 01:17:25,540
we could actually put cameras

1651
01:17:25,573 --> 01:17:26,708
on them and other
instruments on them,

1652
01:17:26,741 --> 01:17:28,309
they're much less expensive,

1653
01:17:28,342 --> 01:17:30,345
so there's I think
a whole new door,

1654
01:17:30,378 --> 01:17:31,579
we just opened a door to

1655
01:17:31,612 --> 01:17:33,148
a whole new class of
planetary science,

1656

01:17:33,181 --> 01:17:34,082
thanks to the MarCOs.

1657
01:17:34,115 --> 01:17:35,583
- And the Cubesats they were

1658
01:17:35,616 --> 01:17:38,787
just made with
off-the-shelf parts.

1659
01:17:38,820 --> 01:17:40,889
- Some combination of
off-the-shelf parts,

1660
01:17:40,922 --> 01:17:42,090
and some new stuff that we did,

1661
01:17:42,123 --> 01:17:43,758
we had to build the
special radio of course

1662
01:17:43,791 --> 01:17:45,493
because it has to talk to
the deep space network,

1663
01:17:45,526 --> 01:17:47,896
The antennas are a little
bit new technology,

1664
01:17:47,929 --> 01:17:49,931
but a lot of the stuff
is pretty standard stuff

1665
01:17:49,964 --> 01:17:52,634
that you could replicate
at much lower cost.

1666
01:17:52,667 --> 01:17:54,836
- So what do you think
in terms of the future

1667
01:17:54,869 --> 01:17:58,640
that other missions will be
carrying their own relays

1668
01:17:58,673 --> 01:18:02,010
and not having to depend on
a bent pipe from an orbiter?

1669
01:18:02,043 --> 01:18:03,511
- They might carry relays,

1670
01:18:03,544 --> 01:18:06,081
they might actually carry
scientific instrumentation,

1671
01:18:06,114 --> 01:18:07,582
they can do more
than just do relay,

1672
01:18:07,615 --> 01:18:08,850
they can actually take pictures,

1673
01:18:08,883 --> 01:18:10,985
they could do spectrometry,

1674
01:18:11,018 --> 01:18:12,220
they could do lots
of other stuff

1675
01:18:12,253 --> 01:18:15,423
that we would like
to do with orbiters,

1676
01:18:15,456 --> 01:18:17,192
so there's a chance we
could send them to Venus,

1677
01:18:17,225 --> 01:18:18,326

we could send them to asteroids,

1678
01:18:18,359 --> 01:18:19,994
we could send them to Mars,

1679
01:18:20,027 --> 01:18:21,229
there's lots of stuff
that we could do

1680
01:18:21,262 --> 01:18:22,997
and I think we're just
learning the capability

1681
01:18:23,030 --> 01:18:24,599
of what we could miniaturize

1682
01:18:24,632 --> 01:18:26,234
and what we could put
on these Cubesats.

1683
01:18:26,267 --> 01:18:29,704
But this is a
great first effort.

1684
01:18:29,737 --> 01:18:31,172
- Absolutely,

1685
01:18:31,205 --> 01:18:33,308
well we have one
question for you,

1686
01:18:33,341 --> 01:18:37,545
it's a social media question
from George Kay, aged nine

1687
01:18:37,578 --> 01:18:38,947
from the UK,

1688
01:18:38,980 --> 01:18:40,882

how long did it take to plan

1689
01:18:40,915 --> 01:18:43,585
and build this mission, InSight?

1690
01:18:43,618 --> 01:18:44,519
- Well that's a great question,

1691
01:18:44,552 --> 01:18:45,854
so I have two answers to that,

1692
01:18:45,887 --> 01:18:47,288
InSight itself,

1693
01:18:47,321 --> 01:18:49,224
typically our missions take,

1694
01:18:49,257 --> 01:18:51,726
from the time we start
the mission to the
time we launch it,

1695
01:18:51,759 --> 01:18:53,762
it's about four to five years,

1696
01:18:53,795 --> 01:18:55,864
in the case of InSight
two things happened.

1697
01:18:55,897 --> 01:18:58,099
One to our advantage and
one not to our advantage.

1698
01:18:58,132 --> 01:18:59,300
The first is we had a lot

1699
01:18:59,333 --> 01:19:02,070
of heritage from a
mission called Phoenix.

1700
01:19:02,103 --> 01:19:04,672
So a lot of the design
work had already been done,

1701
01:19:04,705 --> 01:19:06,474
because it was done for
this mission Phoenix,

1702
01:19:06,507 --> 01:19:08,743
and even before that
for Mars Polar Lander,

1703
01:19:08,776 --> 01:19:11,980
so a lot of the basic design
we inherited for this mission.

1704
01:19:12,013 --> 01:19:14,682
On the other hand we had
a little bit of bad luck

1705
01:19:14,715 --> 01:19:16,050
In that the instruments,

1706
01:19:16,083 --> 01:19:18,887
the seismometer is so
unbelievably precise,

1707
01:19:18,920 --> 01:19:20,855
it's so incredibly
accurate and hard to build

1708
01:19:20,888 --> 01:19:22,757
that we couldn't
quite get it ready,

1709
01:19:22,790 --> 01:19:24,526
so we're doing that in
partnership with the French

1710
01:19:24,559 --> 01:19:26,928
and a lot of other
countries in Europe,

1711
01:19:26,961 --> 01:19:30,865
including the UK and
Switzerland and other folks,

1712
01:19:30,898 --> 01:19:33,201
we couldn't quite get that
ready to go for launch,

1713
01:19:33,234 --> 01:19:35,003
so we had to actually
wait two years,

1714
01:19:35,036 --> 01:19:36,871
it took an extra two years
then because of that,

1715
01:19:36,904 --> 01:19:38,239
so Mars and the
Earth are only lined

1716
01:19:38,272 --> 01:19:40,108
up to launch about
every 26 months,

1717
01:19:40,141 --> 01:19:42,010
so we had to wait
another 26 months,

1718
01:19:42,043 --> 01:19:44,579
so that took us a
little bit longer.

1719
01:19:44,612 --> 01:19:46,080
- Well speaking of
the internationals

1720
01:19:46,113 --> 01:19:48,283
that's a perfect segue for
where we're going next,

1721
01:19:48,316 --> 01:19:49,784
throughout this program
we've been trying

1722
01:19:49,817 --> 01:19:53,021
to introduce you to the
people behind the scenes,

1723
01:19:53,054 --> 01:19:54,522
and for the InSight mission

1724
01:19:54,555 --> 01:19:57,559
it requires that we
go beyond our borders,

1725
01:19:57,592 --> 01:20:00,628
this is truly an
international mission,

1726
01:20:00,661 --> 01:20:03,965
let me introduce you
to Dominico Giardini,

1727
01:20:03,998 --> 01:20:05,934
a Swiss Italian scientist

1728
01:20:05,967 --> 01:20:09,171
who studies Earthquakes
and Marsquakes.

1729
01:21:10,064 --> 01:21:11,766
- And that partnership goes

1730
01:21:11,799 --> 01:21:14,535
far beyond individual

scientists,

1731
01:21:14,568 --> 01:21:16,137
take a look at this,

1732
01:21:16,170 --> 01:21:18,306
it is a picture
of the calibration

1733
01:21:18,339 --> 01:21:21,242
tool on the deck of
the InSight Lander,

1734
01:21:21,275 --> 01:21:24,646
it's what the team uses to
calibrate the cameras on Mars,

1735
01:21:24,679 --> 01:21:26,948
and notice the flags and logos,

1736
01:21:26,981 --> 01:21:30,351
its recognition of our
international partnerships

1737
01:21:30,384 --> 01:21:34,789
with the French Government
Space Agency CNES,

1738
01:21:34,822 --> 01:21:37,959
and also the German
Aerospace Center DLR,

1739
01:21:37,992 --> 01:21:40,161
and it is my pleasure to welcome

1740
01:21:40,194 --> 01:21:43,064
site project manager
Philippe Laudet

1741

01:21:43,097 --> 01:21:44,565
from CNES,

1742
01:21:44,598 --> 01:21:48,904
and executive board member
Hans Dittus from DLR.

1743
01:21:49,804 --> 01:21:52,440
So I can't imagine a better day,

1744
01:21:52,473 --> 01:21:55,043
what was your reaction.

1745
01:21:55,076 --> 01:21:56,878
- A really great day, yeah.

1746
01:21:56,911 --> 01:21:58,413
- So I am very enthusiastic,

1747
01:21:58,446 --> 01:22:01,082
I am very grateful for all
the people on the mission,

1748
01:22:01,115 --> 01:22:04,285
also my folk who are
going to the team,

1749
01:22:04,318 --> 01:22:06,588
the CNES team and the
science team [mumbles],

1750
01:22:08,255 --> 01:22:11,960
now we have a barebones
picture of the ground,

1751
01:22:11,993 --> 01:22:15,330
and now the work to deploy
the seismometer is beginning,

1752

01:22:15,363 --> 01:22:18,132
so a new adventure in
the best conditions,

1753
01:22:18,165 --> 01:22:19,167
thank you for that.

1754
01:22:19,200 --> 01:22:20,802
- Definitely a new adventure.

1755
01:22:20,835 --> 01:22:23,104
Hans Dittus, what
you're feeling,

1756
01:22:23,137 --> 01:22:26,507
the HP cube is on that deck,

1757
01:22:26,540 --> 01:22:28,242
it will be ready to go.

1758
01:22:28,275 --> 01:22:29,978
- Yes, now it's our job now,

1759
01:22:30,011 --> 01:22:31,546
but first the fall I'd like

1760
01:22:31,579 --> 01:22:34,315
to congratulate our
partners here in the US,

1761
01:22:34,348 --> 01:22:36,918
and this was a great day
and a great job they did,

1762
01:22:36,951 --> 01:22:38,386
it's not easy to land on Mars,

1763
01:22:38,419 --> 01:22:39,320
that's what we know,

1764
01:22:39,353 --> 01:22:41,122
and it's a dream for me as well,

1765
01:22:41,155 --> 01:22:44,225
because the first time
that we land on Mars

1766
01:22:44,258 --> 01:22:47,628
with an instrument, at least
as I has experienced it,

1767
01:22:47,661 --> 01:22:49,263
so it's a great day,

1768
01:22:49,296 --> 01:22:51,933
and it's really exciting so far,

1769
01:22:51,966 --> 01:22:54,402
now the job starts for us.

1770
01:22:54,435 --> 01:22:55,937
- Philippe you had once said,

1771
01:22:55,970 --> 01:22:58,339
you are a musician as well,

1772
01:22:58,372 --> 01:22:59,874
he plays jazz,

1773
01:22:59,907 --> 01:23:03,478
you see exploration
and music very similar,

1774
01:23:03,511 --> 01:23:04,946
how's that?

1775
01:23:04,979 --> 01:23:06,314

- Yes they are very similar,

1776
01:23:06,347 --> 01:23:07,582
because human management

1777
01:23:07,615 --> 01:23:10,518
of all that activity
is exactly the same,

1778
01:23:10,551 --> 01:23:12,687
the technique it's different,

1779
01:23:12,720 --> 01:23:15,490
you have a seismometer
or you have an orchestra,

1780
01:23:15,523 --> 01:23:17,392
but the raw theme to find

1781
01:23:17,425 --> 01:23:20,294
the best talents and things
like that are the same,

1782
01:23:20,327 --> 01:23:21,763
and to deliver on time,

1783
01:23:21,796 --> 01:23:22,997
to be ready,

1784
01:23:23,030 --> 01:23:24,899
and to have the
best performances,

1785
01:23:24,932 --> 01:23:26,300
everything is similar.

1786
01:23:26,333 --> 01:23:28,736
- And we should let people know

1787
01:23:28,769 --> 01:23:32,040
that we won't be able to
collect science right away,

1788
01:23:32,073 --> 01:23:33,307
is that correct?

1789
01:23:33,340 --> 01:23:34,575
- Yeah.

1790
01:23:34,608 --> 01:23:35,643
- We will be will be
collecting science,

1791
01:23:35,676 --> 01:23:37,278
what several months from now?

1792
01:23:38,679 --> 01:23:42,183
- The deployment is going to
take about two or three months,

1793
01:23:42,216 --> 01:23:45,119
of course we will have some
data during the deployments,

1794
01:23:45,152 --> 01:23:47,455
but the best data to
make the best science

1795
01:23:47,488 --> 01:23:51,259
will be about the
beginning of March.

1796
01:23:51,292 --> 01:23:52,360
- Alright so--

1797
01:23:53,327 --> 01:23:54,128
- So we prepared now.

1798
01:23:54,161 --> 01:23:55,196
- We prepare are now.

1799
01:23:55,229 --> 01:23:56,898
- Yeah now it's the time,

1800
01:23:56,931 --> 01:24:00,334
but it was a great job
so far also for our team,

1801
01:24:00,367 --> 01:24:01,169
and our teams,

1802
01:24:01,202 --> 01:24:02,370
all the teams,

1803
01:24:02,403 --> 01:24:04,005
and as you said it
needs a lot of people

1804
01:24:04,038 --> 01:24:07,809
to bring it up to Mars and
make a successful mission.

1805
01:24:08,943 --> 01:24:09,944
- Well I have to
say congratulations.

1806
01:24:09,977 --> 01:24:11,379
- Thank you.
- Thank you.

1807
01:24:11,412 --> 01:24:13,114
- Thank you for joining us.

1808
01:24:13,147 --> 01:24:14,715
Well here's another profile now,

1809

01:24:14,748 --> 01:24:16,884
Meet Ravi Prakash,

1810
01:24:16,917 --> 01:24:20,789
it's his job to keep
InSight healthy on Mars.

1811
01:24:21,755 --> 01:24:24,625
- We get to explore the universe

1812
01:24:24,658 --> 01:24:26,527
and see things that no
one has ever seen before,

1813
01:24:26,560 --> 01:24:28,429
my name is Ravi Prakash,

1814
01:24:28,462 --> 01:24:30,231
and my job is to keep InSight
healthy when it's on Mars.

1815
01:24:30,264 --> 01:24:33,167
InSight is the first spacecraft
that is going to go to Mars,

1816
01:24:33,200 --> 01:24:35,937
and try to understand how
rocky planets have formed.

1817
01:24:37,638 --> 01:24:40,942
A healthy InSight spacecraft
is healthy batteries,

1818
01:24:40,975 --> 01:24:42,443
we have heaters all
over our spacecraft

1819
01:24:42,476 --> 01:24:43,845
that keep our
spacecraft warm enough

1820
01:24:43,878 --> 01:24:45,780
so that it operates
the way it should.

1821
01:24:48,048 --> 01:24:49,517
We look at these things as well

1822
01:24:49,550 --> 01:24:51,519
as many other parts of our
spacecraft on a daily basis

1823
01:24:51,552 --> 01:24:53,454
to make sure we have
a successful mission.

1824
01:24:53,487 --> 01:24:55,356
There are thousands of
people working on InSight,

1825
01:24:55,389 --> 01:24:56,824
so the systems
engineers responsible

1826
01:24:56,857 --> 01:24:58,359
for understanding
how changing one part

1827
01:24:58,392 --> 01:25:00,194
of the spacecraft ripples
through the entire system,

1828
01:25:00,227 --> 01:25:02,230
and how that affects all the
other parts of the spacecraft.

1829
01:25:02,263 --> 01:25:04,398
I actually worked at
JPL for eight years,

1830
01:25:04,431 --> 01:25:05,833
and then left for
about three years

1831
01:25:05,866 --> 01:25:07,201
to work for a non-profit,

1832
01:25:07,234 --> 01:25:08,703
where I used my engineering
and design skills

1833
01:25:08,736 --> 01:25:11,139
that I learned at NASA to
help people in poverty.

1834
01:25:11,172 --> 01:25:12,607
I realize that the stuff we

1835
01:25:12,640 --> 01:25:14,642
do here impacts billions
of people around the world,

1836
01:25:14,675 --> 01:25:15,510
every single person,

1837
01:25:15,543 --> 01:25:16,711
whether they realize it

1838
01:25:16,744 --> 01:25:18,846
or not has been impacted
by NASA technology.

1839
01:25:18,879 --> 01:25:20,882
We are the next
generation of explorers.

1840
01:25:22,016 --> 01:25:25,119
- Alright let's meet
Ravi Prakash in person.

1841
01:25:25,152 --> 01:25:30,158
Ravi is in our sandbox at JPL
In Situ Instrument Laboratory,

1842
01:25:31,559 --> 01:25:34,929
and wait a minute Ravi, where
did that beard come from?

1843
01:25:34,962 --> 01:25:38,065
- Hi Gay, there were about
10 of us that decided

1844
01:25:38,098 --> 01:25:40,368
on the day we launched to
Mars that we we're gonna shave

1845
01:25:40,401 --> 01:25:41,536
and then not shave again

1846
01:25:41,569 --> 01:25:43,604
for seven months
until we land on Mars,

1847
01:25:43,637 --> 01:25:45,640
so I am extra-excited
that we landed,

1848
01:25:45,673 --> 01:25:47,642
not only because we have a
mission on the surface of Mars,

1849
01:25:47,675 --> 01:25:48,910
but I have two little girls

1850
01:25:48,943 --> 01:25:50,411
at home who love
to pull my beard,

1851

01:25:50,444 --> 01:25:52,213
so I can finally
put an end to that.

1852
01:25:52,246 --> 01:25:54,115
- Alright so Ravi help us out,

1853
01:25:54,148 --> 01:25:55,383
what happens next,

1854
01:25:55,416 --> 01:25:57,785
now clearly InSight is not out

1855
01:25:57,818 --> 01:25:59,654
of the woods just yet, correct?

1856
01:25:59,687 --> 01:26:01,055
- Yeah right,

1857
01:26:01,088 --> 01:26:02,557
so we have some very
important steps ahead of us,

1858
01:26:02,590 --> 01:26:04,225
the first is that we have
to deploy our solar arrays,

1859
01:26:04,258 --> 01:26:06,727
this is what the spacecraft
is doing right now,

1860
01:26:06,760 --> 01:26:08,196
it's deploying these
two solar arrays

1861
01:26:08,229 --> 01:26:10,164
so we get energy from the sun,

1862
01:26:10,197 --> 01:26:11,132

this is one of the
most important things

1863
01:26:11,165 --> 01:26:13,034
that we have to do right now.

1864
01:26:13,067 --> 01:26:15,002
After that, we're gonna
do a serious of checkups

1865
01:26:15,035 --> 01:26:16,571
on our spacecraft to make
sure that everything survived

1866
01:26:16,604 --> 01:26:20,141
this harrowing entry, descent
and landing onto Mars,

1867
01:26:20,174 --> 01:26:21,742
and then once that's
complete after

1868
01:26:21,775 --> 01:26:23,144
the next few days
will start deploying

1869
01:26:23,177 --> 01:26:24,979
our instruments onto
the surface of Mars.

1870
01:26:25,012 --> 01:26:26,714
- So what exactly is involved

1871
01:26:26,747 --> 01:26:29,317
with the instrument deployment?

1872
01:26:29,350 --> 01:26:30,851
- So this is the
first time we're using

1873
01:26:30,884 --> 01:26:34,722
a robotic arm to put instruments
on the surface of Mars.

1874
01:26:34,755 --> 01:26:37,959
This is a process that will
put our seismometer on Mars

1875
01:26:37,992 --> 01:26:39,427
as well as the heat flow probe,

1876
01:26:39,460 --> 01:26:41,395
and it ends up taking
about three months,

1877
01:26:41,428 --> 01:26:43,331
which sounds like
a really long time,

1878
01:26:43,364 --> 01:26:46,200
but this is because we
have to be very careful

1879
01:26:46,233 --> 01:26:48,469
and make sure everything happens
just the way it needs to,

1880
01:26:48,502 --> 01:26:49,637
unlike Earth we can't send

1881
01:26:49,670 --> 01:26:51,272
a technician if
something goes wrong,

1882
01:26:51,305 --> 01:26:53,741
and so we just want to get
it right the first time.

1883
01:26:53,774 --> 01:26:55,910

- Alright, and in our interview

1884
01:26:55,943 --> 01:26:58,079
we just heard that
we may be looking

1885
01:26:58,112 --> 01:27:01,349
at not until March
before we get science.

1886
01:27:01,382 --> 01:27:03,551
- That's right, we get some
amount of science immediately

1887
01:27:03,584 --> 01:27:05,019
as far as the
environment of Mars,

1888
01:27:05,052 --> 01:27:07,488
we get wind data,
temperature data,

1889
01:27:07,521 --> 01:27:08,923
magnetometer data,

1890
01:27:08,956 --> 01:27:11,125
but then once we start
getting seismic data,

1891
01:27:11,158 --> 01:27:13,628
that will be in the
March timeframe.

1892
01:27:13,661 --> 01:27:17,598
- And can you explain
to me Ravi, the ISL,

1893
01:27:17,631 --> 01:27:18,833
the testbed that you're at,

1894
01:27:18,866 --> 01:27:20,368
what do you do there?

1895
01:27:20,401 --> 01:27:22,303
- So this is a Martian sandbox,

1896
01:27:22,336 --> 01:27:23,638
for the past two years we've had

1897
01:27:23,671 --> 01:27:25,006
a great team that's been testing

1898
01:27:25,039 --> 01:27:26,507
deploying our instruments

1899
01:27:26,540 --> 01:27:29,010
on a variety of different
slopes and rocks,

1900
01:27:29,043 --> 01:27:30,811
now that we actually
are on Mars,

1901
01:27:30,844 --> 01:27:32,113
we're gonna transform this area

1902
01:27:32,146 --> 01:27:34,181
to look exactly like
the place we landed,

1903
01:27:34,214 --> 01:27:35,483
and test out deploying
our instruments

1904
01:27:35,516 --> 01:27:38,319
one more time before we
do it on the real thing.

1905

01:27:38,352 --> 01:27:41,222
- Alright thanks
Ravi, congratulations.

1906
01:27:41,255 --> 01:27:42,156
- Thanks so much.

1907
01:27:42,189 --> 01:27:44,125
- Now that InSight is on Mars,

1908
01:27:44,158 --> 01:27:45,359
it means some changes,

1909
01:27:45,392 --> 01:27:48,062
InSight is no longer
cruising to Mars,

1910
01:27:48,095 --> 01:27:52,366
so the team no longer needs the
cruise mission support area,

1911
01:27:52,399 --> 01:27:55,569
in a little while the team
will handover operations

1912
01:27:55,602 --> 01:27:59,774
to a new group sitting in
another JPL control room,

1913
01:28:00,941 --> 01:28:02,977
this is the Surface
Mission Support Area.

1914
01:28:03,010 --> 01:28:05,079
It's in another
building here at JPL,

1915
01:28:05,112 --> 01:28:06,580
this is where the team will

1916
01:28:06,613 --> 01:28:09,950
be operating InSight
from here on.

1917
01:28:09,983 --> 01:28:12,386
So the handover
is the final step,

1918
01:28:12,419 --> 01:28:15,756
and that will take place at
about one o'clock our time,

1919
01:28:15,789 --> 01:28:17,692
that's about a half hour away,

1920
01:28:17,725 --> 01:28:19,994
for us it's time to say goodbye,

1921
01:28:20,027 --> 01:28:22,663
our congratulations
to the InSight team,

1922
01:28:22,696 --> 01:28:25,499
and special thanks to
our EDL system engineers,

1923
01:28:25,532 --> 01:28:28,302
Christine Szalai and
Julie Wertz Chen,

1924
01:28:28,335 --> 01:28:31,305
stand by for a news
briefing on NASA TV

1925
01:28:31,338 --> 01:28:33,941
at two PM Pacific,
five PM Eastern,

1926
01:28:33,974 --> 01:28:35,810

and for those of you who want

1927
01:28:35,843 --> 01:28:39,046
the latest information
on InSight and Mars,

1928
01:28:39,079 --> 01:28:42,983
go to Mars.NASA.gov/InSight,

1929
01:28:43,016 --> 01:28:45,820
and NASA.gov/Mars,

1930
01:28:45,853 --> 01:28:49,690
and thank you all who shared
pictures on social media,

1931
01:28:49,723 --> 01:28:53,327
it was wonderful to share
this historic event with you,

1932
01:28:53,360 --> 01:28:56,263
we have some pictures for you
that we'll leave you with,

1933
01:28:56,296 --> 01:28:57,398
enjoy,