
NASA
InSight Landing Day
11:53 – First acquisition of the radar signal
20 seconds later
0.5 second later
22 seconds later – InSight begins
landing
11:54 – Expected touchdown on the surface
12:01 PM – "Beep" from InSight's X-band
alive and functioning on the surface of
earlier than 12:04 PM
Mars
earlier than 5:35 PM – Confirm
solar arrays have deploy

1
00:02:15,968 --> 00:02:21,007
[Uplifting music]

2
00:03:01,747 --> 00:03:04,984
- After traveling through
space for more than six months

3
00:03:05,017 --> 00:03:07,987
and crossing 300 million miles

4
00:03:08,020 --> 00:03:10,856
InSight has reached
its destination,

5
00:03:10,889 --> 00:03:12,892
the red planet Mars,

6
00:03:12,925 --> 00:03:14,594
welcome to Mission Control

7
00:03:14,627 --> 00:03:17,964
at NASA's Jet Propulsion
Laboratory, I'm Gay Yee Hill.

8
00:03:17,997 --> 00:03:19,899
Less than an hour
from now InSight

9
00:03:19,932 --> 00:03:21,567
will begin the most harrowing

10
00:03:21,600 --> 00:03:24,637
six and a half minutes
of the entire mission,

11
00:03:24,670 --> 00:03:25,571
EDL,

12

00:03:25,604 --> 00:03:27,773
entry, descent and landing,

13
00:03:27,806 --> 00:03:30,076
the team is as
prepared as it can be,

14
00:03:30,109 --> 00:03:33,613
but who knows what Mars
has in store today.

15
00:03:33,646 --> 00:03:34,981
The cruise mission support area

16
00:03:35,014 --> 00:03:38,551
is filled with engineers
monitoring the situation,

17
00:03:38,584 --> 00:03:41,020
and for the first time
during a Mars landing

18
00:03:41,053 --> 00:03:43,055
you can be in the room too,

19
00:03:43,088 --> 00:03:46,859
we have a 360 degree camera
in this control room,

20
00:03:46,892 --> 00:03:48,728
allowing you to experience

21
00:03:48,761 --> 00:03:51,063
the landing right
along with the team.

22
00:03:51,096 --> 00:03:52,565
There you see it,

23

00:03:52,598 --> 00:03:53,799
and to look up the link,

24
00:03:53,832 --> 00:03:56,802
just go to the
InSight watch page

25
00:03:56,835 --> 00:03:58,705
you see there on the screen.

26
00:03:59,905 --> 00:04:02,842
And this mission has
actually two control rooms,

27
00:04:02,875 --> 00:04:04,877
the second is that
Lockheed Martin Space

28
00:04:04,910 --> 00:04:07,546
outside of Denver Colorado,

29
00:04:07,579 --> 00:04:10,850
engineers there
are on console two.

30
00:04:10,883 --> 00:04:14,020
Plus people all over
the world are tuning in

31
00:04:14,053 --> 00:04:17,056
at museums and libraries
and other locations,

32
00:04:17,089 --> 00:04:21,060
including this one at the
Pasadena Convention Center,

33
00:04:21,093 --> 00:04:24,130
and that's where friends
and family are watching now,

34
00:04:25,864 --> 00:04:28,567
there will also be an
opportunity to watch
in New York City,

35
00:04:28,600 --> 00:04:29,969
there they are cheering,

36
00:04:30,002 --> 00:04:32,872
there will also be
an opportunity to
watch in New York City

37
00:04:32,905 --> 00:04:36,042
when landing coverage gets
displayed on the NASDAQ Tower,

38
00:04:36,075 --> 00:04:37,977
you see there in Times Square.

39
00:04:38,010 --> 00:04:39,979
And of course if
you are watching

40
00:04:40,012 --> 00:04:42,715
please snap a picture
and share it with us,

41
00:04:42,748 --> 00:04:45,518
using the hashtag Mars landing,

42
00:04:45,551 --> 00:04:46,719
we'd love to see it.

43
00:04:46,752 --> 00:04:47,953
Now I'd like to introduce you

44
00:04:47,986 --> 00:04:50,823

to NASA administrator
Jim Bridenstine,

45
00:04:50,856 --> 00:04:51,991
thank you for coming.

46
00:04:52,024 --> 00:04:53,859
- Oh it's my honor,
thank you for having me.

47
00:04:53,892 --> 00:04:54,760
- We are so excited
to have you here.

48
00:04:54,793 --> 00:04:55,928
- Great to be here.

49
00:04:55,961 --> 00:04:56,829
- So this is your
first Mars landing?

50
00:04:56,862 --> 00:04:58,731
- It is in this job,

51
00:04:59,732 --> 00:05:02,068
I have witnessed these I should

52
00:05:02,101 --> 00:05:04,737
say from the sidelines
for many years,

53
00:05:04,770 --> 00:05:05,971
this is gonna be the eighth

54
00:05:06,004 --> 00:05:08,541
time we have a successful
landing on Mars,

55
00:05:08,574 --> 00:05:09,675

everybody knock on wood.

56
00:05:09,708 --> 00:05:10,643
- That's right.

57
00:05:10,676 --> 00:05:11,811
- But this is the first time

58
00:05:11,844 --> 00:05:14,080
for me to participate
as the administrator,

59
00:05:14,113 --> 00:05:14,980
so it's very exciting.

60
00:05:15,013 --> 00:05:16,682
- Excited, nervous?

61
00:05:16,715 --> 00:05:18,050
- Not nervous, excited.
- Not nervous?

62
00:05:18,083 --> 00:05:19,719
- Look at the
amazing people here,

63
00:05:19,752 --> 00:05:21,821
no way I could be nervous.

64
00:05:21,854 --> 00:05:25,658
- Alright, so we hope to have
you back on set after landing

65
00:05:25,691 --> 00:05:28,527
and maybe take a couple
of social media questions.

66
00:05:28,560 --> 00:05:29,829
- Absolutely.

67
00:05:29,862 --> 00:05:32,064
- If you would like to ask
the administrator a question,

68
00:05:32,097 --> 00:05:34,700
use the hashtag askNASA.

69
00:05:34,733 --> 00:05:38,537
And before you go you did
ask about the lucky peanuts,

70
00:05:38,570 --> 00:05:42,608
so this is your bottle
to take in there.

71
00:05:42,641 --> 00:05:43,743
- I will be happily
munching on these.

72
00:05:43,776 --> 00:05:45,044
- Alright thanks for joining us.

73
00:05:45,077 --> 00:05:46,579
- Thank you.

74
00:05:46,612 --> 00:05:47,747
- Now let's give
you some background,

75
00:05:47,780 --> 00:05:50,883
InSight is short for
Interior Exploration

76
00:05:50,916 --> 00:05:55,755
using Seismic Investigations
Geodesy and Heat Transport,

77
00:05:55,788 --> 00:05:57,857

it's different from
other Mars missions

78
00:05:57,890 --> 00:05:59,925
which all studied the surface,

79
00:05:59,958 --> 00:06:01,627
InSight is the first mission

80
00:06:01,660 --> 00:06:04,797
to study the interior
of the red planet.

81
00:06:06,598 --> 00:06:07,833
The basic idea of InSight

82
00:06:07,866 --> 00:06:11,837
is to map out the deep
structure of March,

83
00:06:11,870 --> 00:06:13,672
we know a lot about
the surface of Mars,

84
00:06:13,705 --> 00:06:15,674
we know a lot about
its atmosphere,

85
00:06:15,707 --> 00:06:17,543
even about its ionosphere,

86
00:06:17,576 --> 00:06:18,677
but we don't know very much

87
00:06:18,710 --> 00:06:21,680
about what goes on a
mile below the surface,

88
00:06:21,713 --> 00:06:23,783

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

89
00:06:23,816 --> 00:06:24,984
and this will be
the first mission

90
00:06:25,017 --> 00:06:26,552
that is going to
Mars specifically

91
00:06:26,585 --> 00:06:29,989
to investigate the
deep inside of Mars.

92
00:06:30,022 --> 00:06:31,991
- We know that the
Earth is habitable,

93
00:06:32,024 --> 00:06:33,926
we know that Mars is not,

94
00:06:33,959 --> 00:06:35,828
there might be something
that we find out

95
00:06:35,861 --> 00:06:38,564
in terms of the
structure of Mars

96
00:06:38,597 --> 00:06:40,032
versus the structure of Earth,

97
00:06:40,065 --> 00:06:43,068
that maybe can help us
understand why that is.

98
00:06:43,101 --> 00:06:45,571
- InSight carries a
seismometer which measures

99
00:06:45,604 --> 00:06:47,039
the seismic waves
that have travel

100
00:06:47,072 --> 00:06:48,841
through Mars from Marsquakes,

101
00:06:48,874 --> 00:06:52,011
and maps out the deep
interior structure of Mars,

102
00:06:52,044 --> 00:06:54,880
we're gonna also
have a heat flow

103
00:06:54,913 --> 00:06:56,582
and physical properties probe,

104
00:06:56,615 --> 00:06:58,951
which will penetrate into the
Mars surface about five meters

105
00:06:58,984 --> 00:07:02,688
or 16 feet to take the
temperature on Mars.

106
00:07:02,721 --> 00:07:04,690
And it has a radio
science experiment

107
00:07:04,723 --> 00:07:06,725
which uses the radio
on the spacecraft

108
00:07:06,758 --> 00:07:11,030
to measure small variations
in the wobble of Mars' poles

109

00:07:11,063 --> 00:07:12,932
to understand more
about the structure

110
00:07:12,965 --> 00:07:14,934
and composition of the core.

111
00:07:18,570 --> 00:07:20,573
- InSight will be
the first mission

112
00:07:20,606 --> 00:07:22,741
to pick instruments off the deck

113
00:07:22,774 --> 00:07:25,544
of the Lander and place
them on the surface of Mars.

114
00:07:25,577 --> 00:07:26,645
I like to say that
we are playing

115
00:07:26,678 --> 00:07:28,981
the claw game on Mars
with no joystick.

116
00:07:30,649 --> 00:07:32,551
The seismometer needs to
be installed in one place

117
00:07:32,584 --> 00:07:36,722
and not move in order to
get the best seismic data.

118
00:07:36,755 --> 00:07:39,658
- [Bruce] We also have a
wind and thermal shield

119
00:07:39,691 --> 00:07:41,093
that we place on top

of that seismometer

120
00:07:41,126 --> 00:07:43,729
to protect it further
from the environment.

121
00:07:44,796 --> 00:07:47,700
- [Jaime] For the
heat flow probe, HPQ,

122
00:07:47,733 --> 00:07:49,635
it also needs to
sit in one place,

123
00:07:49,668 --> 00:07:52,838
take a while to hammer
itself down into the ground

124
00:07:52,871 --> 00:07:54,573
and acquire the
demo measurements

125
00:07:54,606 --> 00:07:55,908
over a long period of time.

126
00:07:59,811 --> 00:08:01,080
- InSight is a mission to Mars,

127
00:08:01,113 --> 00:08:02,948
but it's much, much more
than a Mars mission,

128
00:08:02,981 --> 00:08:04,950
in some sense it's
like a time machine,

129
00:08:04,983 --> 00:08:07,052
it's measuring the
structure of Mars

130
00:08:07,085 --> 00:08:09,955
that was put in place four
and a half billion years ago,

131
00:08:09,988 --> 00:08:13,025
so we can go back and
understand the processes

132
00:08:13,058 --> 00:08:14,860
that formed Mars just shortly

133
00:08:14,893 --> 00:08:17,830
after it was accreted
from the solar nebula.

134
00:08:17,863 --> 00:08:20,533
By studying Mars we'll
be able to learn more

135
00:08:20,566 --> 00:08:23,636
about Earth, Venus,
Mercury, even the moon,

136
00:08:23,669 --> 00:08:25,938
even exoplanets
around other stars.

137
00:08:28,073 --> 00:08:31,877
- Landing on Mars
is always difficult,

138
00:08:31,910 --> 00:08:34,547
more than half the
missions have failed,

139
00:08:34,580 --> 00:08:36,048
our experts in this field

140
00:08:36,081 --> 00:08:39,885

our systems engineers for
entry, descent and landing,

141
00:08:39,918 --> 00:08:41,620
they speak EDL.

142
00:08:41,653 --> 00:08:44,023
Let me introduce you to
two in our control room,

143
00:08:44,056 --> 00:08:46,058
Christine Szalai,
who will be making

144
00:08:46,091 --> 00:08:47,860
the mission callouts
during landing,

145
00:08:47,893 --> 00:08:49,562
and Julie Wertz Chen,

146
00:08:49,595 --> 00:08:51,530
She is our color commentator

147
00:08:51,563 --> 00:08:54,033
who will help explain
mission operations.

148
00:08:54,066 --> 00:08:55,868
Christine let's start with you,

149
00:08:55,901 --> 00:08:58,971
I understand that
there was a funnel

150
00:08:59,004 --> 00:09:01,006
software update and adjustment,

151
00:09:01,039 --> 00:09:02,541

what does that mean?

152
00:09:02,574 --> 00:09:03,809
- That's right,

153
00:09:03,842 --> 00:09:06,078
yesterday we sent the last
EDL software parameter

154
00:09:06,111 --> 00:09:08,847
update to the
spacecraft's computer,

155
00:09:08,880 --> 00:09:10,950
this update told the
spacecraft exactly

156
00:09:10,983 --> 00:09:13,786
when it will hit the
top of the atmosphere,

157
00:09:13,819 --> 00:09:17,923
and also fine tune things like
when to deploy the parachute,

158
00:09:17,956 --> 00:09:19,925
this ADL software
is very important,

159
00:09:19,958 --> 00:09:21,927
because InSight
uses this software

160
00:09:21,960 --> 00:09:26,098
to perform entry, descent and
landing completely on its own,

161
00:09:26,131 --> 00:09:28,033
Mars is so far away from Earth

162
00:09:28,066 --> 00:09:29,802
that when a command
is sent from Earth

163
00:09:29,835 --> 00:09:33,539
it takes about eight minutes
for it to reach the spacecraft,

164
00:09:33,572 --> 00:09:34,840
entry, descent and
landing from start

165
00:09:34,873 --> 00:09:37,676
to finish is less than
eight minutes long,

166
00:09:37,709 --> 00:09:40,079
so InSight has to do
this all by itself.

167
00:09:40,112 --> 00:09:42,915
- Alright, it's fate is sealed.

168
00:09:42,948 --> 00:09:44,917
Now I understand
that the team is

169
00:09:44,950 --> 00:09:46,919
about to do a readiness poll,

170
00:09:46,952 --> 00:09:49,054
Julie can you fill
us in on that?

171
00:09:49,087 --> 00:09:51,624
- Sure, so that's
gonna be a poll,

172
00:09:51,657 --> 00:09:53,659

between our EDL
communications engineer

173
00:09:53,692 --> 00:09:56,562
and several of the
different orbiters

174
00:09:56,595 --> 00:09:57,963
and antennas we
have here on Earth,

175
00:09:57,996 --> 00:10:00,599
so we have MarCO
listening in on us,

176
00:10:00,632 --> 00:10:02,935
and MRO, which is Mars
Reconnaissance Orbiter,

177
00:10:02,968 --> 00:10:05,971
will be listening to our
data and recording it for us,

178
00:10:06,004 --> 00:10:08,040
and then the radio
science engineers

179
00:10:08,073 --> 00:10:10,075
will be eavesdropping
in on our signal

180
00:10:10,108 --> 00:10:11,877
from all the way
back here on Earth,

181
00:10:11,910 --> 00:10:14,079
and Sandy, our EDL
communications engineer

182
00:10:14,112 --> 00:10:15,648

we'll be checking in with them,

183
00:10:15,681 --> 00:10:17,049
making sure that they
are all ready to go,

184
00:10:17,082 --> 00:10:20,519
ready to support us
in just a little under

185
00:10:20,552 --> 00:10:21,921
an hour to land on Mars.

186
00:10:23,889 --> 00:10:25,924
- Alright so we're
standing by for that,

187
00:10:25,957 --> 00:10:27,793
for that readiness poll.

188
00:10:27,826 --> 00:10:30,529
And I understand
that the peanuts

189
00:10:30,562 --> 00:10:32,698
are going to be passed
in there pretty soon?

190
00:10:32,731 --> 00:10:34,533
- I believe that's
the idea yeah,

191
00:10:34,566 --> 00:10:36,869
we'll be passing around the
peanuts very soon after that,

192
00:10:36,902 --> 00:10:38,537
for those of you who don't know,

193

00:10:38,570 --> 00:10:41,573
the JPL peanuts are a tradition,

194
00:10:41,606 --> 00:10:42,841
it gives us a
little bit of extra

195
00:10:42,874 --> 00:10:45,044
luck on our critical events,

196
00:10:45,077 --> 00:10:47,079
so if anybody out there
wants to join in on peanuts

197
00:10:47,112 --> 00:10:50,049
and give us some extra
good luck peanuts vibe,

198
00:10:50,082 --> 00:10:51,583
we'd love to have it.

199
00:10:51,616 --> 00:10:53,852
- Well there's a
story behind that,

200
00:10:53,885 --> 00:10:57,022
that way back when in
the early days of JPL

201
00:10:57,055 --> 00:10:58,791
there were several missions,

202
00:10:58,824 --> 00:11:03,663
and there were six
Ranger missions to
the moon that failed,

203
00:11:04,563 --> 00:11:05,698
but then with Ranger seven--

204
00:11:05,731 --> 00:11:06,865
- Ranger seven somebody--

205
00:11:06,898 --> 00:11:08,934
- [Gay] Somebody
passed around peanuts.

206
00:11:08,967 --> 00:11:10,069
- Yeah, and it worked,

207
00:11:10,102 --> 00:11:11,570
and you don't mess
with what works,

208
00:11:11,603 --> 00:11:14,039
it's not a superstition,
it's a tradition,

209
00:11:14,072 --> 00:11:17,743
and we just give yourselves
that little bit of extra luck.

210
00:11:17,776 --> 00:11:19,678
- So if you have
peanuts at home,

211
00:11:19,711 --> 00:11:20,646
please have some.

212
00:11:20,679 --> 00:11:21,213
- [Julie] That's right.

213
00:11:21,246 --> 00:11:23,048
- Alright, thanks Julie.

214
00:11:23,081 --> 00:11:26,118
NASA has had seven
successful Mars landings,

215
00:11:26,151 --> 00:11:30,789
but the EDL team never
ever becomes overconfident,

216
00:11:30,822 --> 00:11:32,925
JPL chief engineer Rob Manning

217
00:11:32,958 --> 00:11:35,661
says things have
to work just right

218
00:11:35,694 --> 00:11:38,864
during six and a half
critical minutes.

219
00:11:40,632 --> 00:11:43,569
[dramatic music]

220
00:11:43,602 --> 00:11:45,037
- Although we've done it before,

221
00:11:45,070 --> 00:11:46,872
landing on Mars is hard,

222
00:11:46,905 --> 00:11:48,908
and this mission
is no different.

223
00:11:50,575 --> 00:11:51,844
The process to get from the top

224
00:11:51,877 --> 00:11:53,879
of the atmosphere of
Mars to this surface,

225
00:11:53,912 --> 00:11:55,881
we call entry,
descent and landing,

226
00:11:55,914 --> 00:11:57,616
or EDL,

227
00:11:57,649 --> 00:11:59,918
it takes thousands
of steps to go

228
00:11:59,951 --> 00:12:02,020
from the top of the
atmosphere to the surface,

229
00:12:02,053 --> 00:12:03,689
and each one of them has

230
00:12:03,722 --> 00:12:06,759
to work perfectly to be
a successful mission.

231
00:12:07,692 --> 00:12:09,862
The process starts well above

232
00:12:09,895 --> 00:12:11,930
the top of the
atmosphere of Mars,

233
00:12:11,963 --> 00:12:14,867
the cruise stage faces the sun,

234
00:12:14,900 --> 00:12:19,605
it also has its radio
antenna which faces Earth,

235
00:12:19,638 --> 00:12:21,740
but now we don't need
the cruise stage,

236
00:12:21,773 --> 00:12:23,675
its job is done.

237
00:12:23,708 --> 00:12:25,077
The next step just seven minutes

238
00:12:25,110 --> 00:12:27,813
before arriving to the
top of the Mars atmosphere

239
00:12:27,846 --> 00:12:29,948
is to separate the cruise stage,

240
00:12:29,981 --> 00:12:32,985
before you hit the top
of the atmosphere though,

241
00:12:33,018 --> 00:12:35,621
the space capsule
has to orient itself

242
00:12:35,654 --> 00:12:39,792
so that the heat shield is
precisely facing the atmosphere.

243
00:12:40,826 --> 00:12:42,561
Now the fun begins,

244
00:12:42,594 --> 00:12:46,765
the vehicle is moving at
nearly 13,000 miles an hour,

245
00:12:46,798 --> 00:12:48,100
but it's hitting the
top of the atmosphere

246
00:12:48,133 --> 00:12:49,935
at a very shallow angle,

247
00:12:49,968 --> 00:12:51,537
12 degrees,

248
00:12:51,570 --> 00:12:52,771
any steeper,

249
00:12:52,804 --> 00:12:54,673
the vehicle will hit the
thicker part of the atmosphere

250
00:12:54,706 --> 00:12:56,608
and will melt and burn out,

251
00:12:56,641 --> 00:12:57,876
any shallower,

252
00:12:57,909 --> 00:13:00,679
the vehicle will bounce
off the atmosphere of Mars,

253
00:13:00,712 --> 00:13:02,080
at the very top the atmosphere

254
00:13:02,113 --> 00:13:05,651
it's about 70 miles above
the surface of Mars,

255
00:13:05,684 --> 00:13:07,953
and the air is starting to
get thicker and thicker,

256
00:13:07,986 --> 00:13:09,087
as it does that,

257
00:13:09,120 --> 00:13:10,656
the temperature
in the heat shield

258
00:13:10,689 --> 00:13:12,825
gets well over 1000
degrees centigrade,

259
00:13:12,858 --> 00:13:14,726
enough to melt steel,

260
00:13:14,759 --> 00:13:15,928
over the next two minutes,

261
00:13:15,961 --> 00:13:17,529
the vehicle decelerates

262
00:13:17,562 --> 00:13:19,998
at a backbreaking 12 Earth Gs,

263
00:13:20,031 --> 00:13:23,969
from 13,000 miles an hour
to about 1000 miles an hour,

264
00:13:24,002 --> 00:13:26,972
at about 10 miles above
the surface of Mars,

265
00:13:27,005 --> 00:13:29,775
a supersonic
parachute is launched

266
00:13:29,808 --> 00:13:31,577
out of the back of the vehicle,

267
00:13:31,610 --> 00:13:33,879
15 seconds after the
parachute inflates,

268
00:13:33,912 --> 00:13:35,781
it's time to get rid
of the heat shield,

269
00:13:35,814 --> 00:13:39,551
six pyrotechnic devices
fire simultaneously

270
00:13:39,584 --> 00:13:42,554
allowing the heat shield
to fall and tumble away

271
00:13:42,587 --> 00:13:46,892
from the vehicle exposing the
lander to the surface of Mars.

272
00:13:46,925 --> 00:13:48,594
10 seconds after the
heat shield is dropped,

273
00:13:48,627 --> 00:13:51,029
three pyrotechnically
deployed legs

274
00:13:51,062 --> 00:13:53,899
are released and
locked for landing.

275
00:13:53,932 --> 00:13:57,069
About a minute later, the
landing RADAR is turned on,

276
00:13:57,102 --> 00:14:00,072
sending pulses toward
the surface of Mars,

277
00:14:00,105 --> 00:14:02,574
as the vehicle starts
to try to measure

278
00:14:02,607 --> 00:14:04,576
how high it is
above the surface,

279
00:14:04,609 --> 00:14:06,111
and how fast it's going.

280

00:14:06,144 --> 00:14:08,780
At about a mile above
the surface of Mars,

281
00:14:08,813 --> 00:14:11,016
the lander falls away
from the back shell

282
00:14:11,049 --> 00:14:12,851
and lights its engines.

283
00:14:12,884 --> 00:14:16,722
And very quickly the vehicle
must rotate out of the way,

284
00:14:16,755 --> 00:14:17,956
so that the parachute

285
00:14:17,989 --> 00:14:20,726
and the back shield doesn't
come down to hit it,

286
00:14:20,759 --> 00:14:22,728
the last thing
that has to happen,

287
00:14:22,761 --> 00:14:24,897
is that in the moment of contact

288
00:14:24,930 --> 00:14:28,634
the engines have to
shut down immediately,

289
00:14:28,667 --> 00:14:31,536
if they don't the
vehicle will tip over.

290
00:14:31,569 --> 00:14:34,673
So with all the steps
of entry, descent

291
00:14:34,706 --> 00:14:36,775
and landing happen perfectly

292
00:14:36,808 --> 00:14:39,578
and we are safely on
the surface of Mars,

293
00:14:39,611 --> 00:14:42,781
we'll be ready to do some
exciting new science.

294
00:14:49,020 --> 00:14:50,722
- Person later on
in the program,

295
00:14:50,755 --> 00:14:52,858
meantime let me
introduce you to someone

296
00:14:52,891 --> 00:14:55,861
who has been working on
InSight for seven years,

297
00:14:55,894 --> 00:14:58,764
he's the project
manager Tom Hoffman,

298
00:14:58,797 --> 00:15:01,633
seven years and
today is the day.

299
00:15:01,666 --> 00:15:02,768
- That's right, seven years,

300
00:15:02,801 --> 00:15:05,070
but we're just a little
over 40 minutes now

301

00:15:05,103 --> 00:15:06,972
and we're gonna be on the
surface, it's gonna be awesome.

302
00:15:07,005 --> 00:15:08,641
- Really exciting stuff.

303
00:15:09,641 --> 00:15:11,543
So let's talk about InSight,

304
00:15:11,576 --> 00:15:13,679
it's using tried
and true technology,

305
00:15:13,712 --> 00:15:14,980
based on the Phoenix,

306
00:15:15,013 --> 00:15:19,084
this time there's a bigger
challenge with communication,

307
00:15:19,117 --> 00:15:20,852
normally we have an orbiter

308
00:15:20,885 --> 00:15:23,655
that can give us bent
pipe communications,

309
00:15:23,688 --> 00:15:25,590
but it's different this time.

310
00:15:25,623 --> 00:15:26,692
- That's right, most

311
00:15:26,725 --> 00:15:27,559
of the time when
we've landed recently,

312
00:15:27,592 --> 00:15:28,727

we've had Mars Odyssey

313
00:15:28,760 --> 00:15:30,028
which can do bent
pipe communications,

314
00:15:30,061 --> 00:15:32,931
and so we get real-time
data as we go through EDL,

315
00:15:32,964 --> 00:15:34,066
and we've come to expect that

316
00:15:34,099 --> 00:15:36,902
and actually we really,
really want that.

317
00:15:36,935 --> 00:15:38,870
In this case our
primary technology,

318
00:15:38,903 --> 00:15:41,673
primary orbiter is Mars
Reconnaissance Orbiter,

319
00:15:41,706 --> 00:15:43,675
and so what that's gonna
be doing is actually

320
00:15:43,708 --> 00:15:45,110
will be listening
to us on the UHF,

321
00:15:45,143 --> 00:15:47,746
if you go to the video
you can see this,

322
00:15:47,779 --> 00:15:49,581
MRO will be listening to us

323
00:15:49,614 --> 00:15:51,550
and be getting all
the primary data,

324
00:15:51,583 --> 00:15:52,985
and it will send it back to us,

325
00:15:53,018 --> 00:15:55,721
unfortunately only three
hours after we land.

326
00:15:55,754 --> 00:15:57,556
- So it doesn't give
us the bent pipe

327
00:15:57,589 --> 00:16:00,058
live information as it happens?

328
00:16:00,091 --> 00:16:01,727
- It doesn't,

329
00:16:01,760 --> 00:16:02,961
we have a couple of other
sources that we're looking at,

330
00:16:02,994 --> 00:16:05,030
we have at Green Bay
Observatory in West Virginia,

331
00:16:05,063 --> 00:16:07,666
Max Planck Observatory
in Effelsberg, Germany,

332
00:16:07,699 --> 00:16:09,067
which will be giving us UHF,

333
00:16:09,100 --> 00:16:11,903
but those only give us a couple
of different points in time,

334
00:16:11,936 --> 00:16:13,972
and so we did something
kind of cool this time,

335
00:16:14,005 --> 00:16:17,976
we brought along a couple
of Cubesats called MarCO,

336
00:16:18,009 --> 00:16:20,612
so hopefully they're
both working great today.

337
00:16:20,645 --> 00:16:21,747
- [Gay] Oh, fantastic.

338
00:16:21,780 --> 00:16:22,848
- So we're hoping
they're gonna continue

339
00:16:22,881 --> 00:16:24,082
to work all the way through EDL,

340
00:16:24,115 --> 00:16:26,752
and they will be giving
us real-time feed,

341
00:16:26,785 --> 00:16:30,522
so we can show how that
works on the next video here.

342
00:16:30,555 --> 00:16:32,024
So you can see here's InSight

343
00:16:32,057 --> 00:16:34,960
with its cruise stage
getting close to Mars,

344
00:16:34,993 --> 00:16:36,895

but we have two
stalkers following us,

345
00:16:36,928 --> 00:16:38,597
they've been following
us since we launched,

346
00:16:38,630 --> 00:16:40,732
they launched on the same
launch vehicle as us,

347
00:16:40,765 --> 00:16:41,867
so you can see the green there

348
00:16:41,900 --> 00:16:44,002
is we're sending
UHF signals to them,

349
00:16:44,035 --> 00:16:45,637
and then they turn
that around and send

350
00:16:45,670 --> 00:16:47,539
a much stronger
signal back to Earth,

351
00:16:47,572 --> 00:16:48,940
we can't communicate
on UHF direct

352
00:16:48,973 --> 00:16:50,609
to Earth with this signal,

353
00:16:50,642 --> 00:16:51,977
that tells us what's going
on in the spacecraft,

354
00:16:52,010 --> 00:16:53,678
but MarCO can,

355
00:16:53,711 --> 00:16:55,080
if it works for us all the
way down to the surface

356
00:16:55,113 --> 00:16:57,616
we're gonna have some great
information coming from MarCO.

357
00:16:57,649 --> 00:16:59,751
- So MarCO is basically
trying to fill

358
00:16:59,784 --> 00:17:01,153
that gap that we would have had

359
00:17:01,186 --> 00:17:04,723
if we had live communication
coming down to us.

360
00:17:04,756 --> 00:17:05,657
- Absolutely.

361
00:17:05,690 --> 00:17:06,825
- So if it does not work does

362
00:17:06,858 --> 00:17:09,628
it affect InSight's
mission at all?

363
00:17:09,661 --> 00:17:10,762
- No not at all,

364
00:17:10,795 --> 00:17:12,898
we'll just be doing a
little more nailbiting,

365
00:17:12,931 --> 00:17:15,567
but right now it looks
like it's gonna be working,

366
00:17:15,600 --> 00:17:17,069
but it doesn't impact
InSight at all,

367
00:17:17,102 --> 00:17:18,937
and we have one final
way that we're gonna

368
00:17:18,970 --> 00:17:21,673
know that we've got
successfully to the ground,

369
00:17:21,706 --> 00:17:22,908
which is the spacecraft
will phone home,

370
00:17:22,941 --> 00:17:24,009
once it gets down to the ground,

371
00:17:24,042 --> 00:17:26,078
it's gone seven
months through cruise,

372
00:17:26,111 --> 00:17:27,646
seven and a half
minutes of terror,

373
00:17:27,679 --> 00:17:29,047
and it's gonna call back and say

374
00:17:29,080 --> 00:17:31,550
I'm on the surface I'm
feeling pretty good,

375
00:17:31,583 --> 00:17:32,884
everything looks good so far.

376
00:17:32,917 --> 00:17:35,120

- And also to prep the audience,

377
00:17:35,153 --> 00:17:37,823
even after landing we're not out

378
00:17:37,856 --> 00:17:39,724
of the woods just yet, correct?

379
00:17:39,757 --> 00:17:40,859
- Not just yet,

380
00:17:40,892 --> 00:17:42,060
we have one more step
that we have to do,

381
00:17:42,093 --> 00:17:44,529
we have to let the dust
settle quite literally,

382
00:17:44,562 --> 00:17:46,565
we're gonna kick up a
lot of dust when we land,

383
00:17:46,598 --> 00:17:47,799
we need to let that dust settle,

384
00:17:47,832 --> 00:17:49,935
before we unfurl
our solar arrays,

385
00:17:49,968 --> 00:17:51,770
we're 100% solar powered,

386
00:17:51,803 --> 00:17:53,705
so it's very important
that we get those out,

387
00:17:53,738 --> 00:17:54,973
unfortunately,

388
00:17:55,006 --> 00:17:58,043
both MRO and MarCO
will be out of view,

389
00:17:58,076 --> 00:18:00,879
by the time that we have
those completely unfurled,

390
00:18:00,912 --> 00:18:04,015
and so we're gonna have to
wait five and a half hours

391
00:18:04,048 --> 00:18:05,784
until Odyssey comes by and tells

392
00:18:05,817 --> 00:18:08,019
us that yes indeed our
solar arrays are out.

393
00:18:08,052 --> 00:18:09,888
So we'll definitely
have a celebration

394
00:18:09,921 --> 00:18:11,556
when we get a
successful landing,

395
00:18:11,589 --> 00:18:13,658
but we're gonna have to
temper that just a little bit

396
00:18:13,691 --> 00:18:15,560
and wait about five
and a half hours

397
00:18:15,593 --> 00:18:17,829
to know absolutely for
sure we're in good shape.

398
00:18:17,862 --> 00:18:20,966
- So we have immediate
knowledge if we have MarCOs,

399
00:18:20,999 --> 00:18:24,569
so just to run it
through once again,

400
00:18:24,602 --> 00:18:26,571
what's gonna happen with EDL,

401
00:18:26,604 --> 00:18:28,974
we have the video of the show,

402
00:18:29,007 --> 00:18:31,610
how exactly is this
all gonna play out

403
00:18:31,643 --> 00:18:33,745
in six and a half minutes,
we can roll the video.

404
00:18:33,778 --> 00:18:35,013
- Okay,

405
00:18:35,046 --> 00:18:36,948
you can see here we are
attached to the cruise stage,

406
00:18:36,981 --> 00:18:38,116
we drop that off,

407
00:18:38,149 --> 00:18:39,951
say thank you for
the ride to Mars,

408
00:18:39,984 --> 00:18:41,653
it burns up in the atmosphere,

409
00:18:41,686 --> 00:18:44,623
you can see it gets very
hot on our heat shield,

410
00:18:44,656 --> 00:18:45,857
we're getting up in some places

411
00:18:45,890 --> 00:18:49,027
maybe 3000 degrees Fahrenheit
as we go through this,

412
00:18:49,060 --> 00:18:51,062
we're on the heat shield
for about four minutes,

413
00:18:51,095 --> 00:18:53,565
that dissipates about
90 percent of the energy

414
00:18:53,598 --> 00:18:55,767
that we need to dissipate
before we get to the surface,

415
00:18:55,800 --> 00:18:57,569
then we pop our parachute,

416
00:18:57,602 --> 00:18:58,870
we're going about 850 miles

417
00:18:58,903 --> 00:19:00,839
an hour when we
pop the parachute,

418
00:19:00,872 --> 00:19:02,607
we're on that for
about two minutes,

419
00:19:02,640 --> 00:19:04,643
then we'll drop off

the heat shield,

420
00:19:04,676 --> 00:19:06,678
we'll start acquiring the
ground with our RADAR,

421
00:19:06,711 --> 00:19:09,047
very much like an F-16
fighter jet RADAR,

422
00:19:09,080 --> 00:19:10,949
the legs will pop out,

423
00:19:10,982 --> 00:19:11,950
we'll start descending,

424
00:19:11,983 --> 00:19:13,652
we drop for just a second

425
00:19:13,685 --> 00:19:16,054
which is very terrifying for
me our descent thrusters,

426
00:19:16,087 --> 00:19:17,656
we have 12 of them,

427
00:19:17,689 --> 00:19:18,924
they are 16 pound thrusters,

428
00:19:18,957 --> 00:19:20,992
start thrusting and
dropping us to the ground,

429
00:19:21,025 --> 00:19:24,029
and slowly slowly we drop down,

430
00:19:24,062 --> 00:19:25,697
going only five miles an hour,

431
00:19:25,730 --> 00:19:27,532
so when that six and a
half minutes of terror,

432
00:19:27,565 --> 00:19:28,800
which is a little less
then seven minutes

433
00:19:28,833 --> 00:19:30,635
so that's great for me,

434
00:19:30,668 --> 00:19:32,537
we go from 12,300 miles

435
00:19:32,570 --> 00:19:35,707
an hour 75 miles above
the surface of Mars,

436
00:19:35,740 --> 00:19:36,875
we get to the surface

437
00:19:36,908 --> 00:19:38,043
we're at five and a
half miles an hour.

438
00:19:38,076 --> 00:19:39,544
- That's amazing,

439
00:19:39,577 --> 00:19:40,679
that's absolutely amazing,

440
00:19:40,712 --> 00:19:41,913
well before you go Tom,

441
00:19:41,946 --> 00:19:44,082
there was a couple of pictures
we wanted to show you,

442

00:19:44,115 --> 00:19:47,652
we have watch parties taking
place all over the country,

443
00:19:47,685 --> 00:19:49,087
and let's see if we can put one

444
00:19:49,120 --> 00:19:50,855
of these watch
parties up for you

445
00:19:50,888 --> 00:19:53,825
to see this is from Ohio,

446
00:19:53,858 --> 00:19:56,661
this is a person who
has a watch party,

447
00:19:56,694 --> 00:19:58,663
it looks like in a classroom.

448
00:19:58,696 --> 00:19:59,965
- [Tom] That is so awesome.

449
00:19:59,998 --> 00:20:01,733
- [Gay] Isn't that great that
folks are watching with us?

450
00:20:01,766 --> 00:20:02,867
- Yeah I know,

451
00:20:02,900 --> 00:20:04,603
people all across the
globe are watching this,

452
00:20:04,636 --> 00:20:05,870
and we really want to put a
good show on for them today.

453

00:20:05,903 --> 00:20:08,940
- Alright I'll let
you back in the room,

454
00:20:08,973 --> 00:20:10,542
- I gotta get back in there.
- I know you're excited.

455
00:20:10,575 --> 00:20:12,077
Alright take care,
thanks for joining us.

456
00:20:12,110 --> 00:20:13,845
- Thank you.

457
00:20:13,878 --> 00:20:16,715
[dramatic music]

458
00:20:42,874 --> 00:20:46,845
- Okay let's introduce you to
the people who built InSight,

459
00:20:46,878 --> 00:20:49,581
Lockheed Martin Space
outside of Denver,

460
00:20:49,614 --> 00:20:52,717
these are the folks who
built Viking in 1976,

461
00:20:52,750 --> 00:20:55,120
and Mars Phoenix in 2008,

462
00:20:55,153 --> 00:20:56,955
the operations team is there,

463
00:20:56,988 --> 00:21:01,626
and Lockheed InSight EDL
manager Tim Linn is standing by,

464
00:21:01,659 --> 00:21:02,961
Tim, what's going on in there?

465
00:21:05,596 --> 00:21:06,130
- The team is getting
really excited,

466
00:21:06,163 --> 00:21:07,666
we are just about ready,

467
00:21:07,699 --> 00:21:10,001
we're about half
an hour from entry,

468
00:21:10,034 --> 00:21:12,037
and the start of entry,
descent and landing,

469
00:21:12,070 --> 00:21:14,639
so the team is really
excited and focused,

470
00:21:14,672 --> 00:21:16,941
but also very excited
about the upcoming

471
00:21:16,974 --> 00:21:18,643
successful entry descent

472
00:21:18,676 --> 00:21:19,944
and landing we're
getting close to.

473
00:21:19,977 --> 00:21:21,946
- We talked about
the fact that InSight

474
00:21:21,979 --> 00:21:24,749
is based on tried

and true technology,

475
00:21:24,782 --> 00:21:26,551
it's based on Phoenix,

476
00:21:26,584 --> 00:21:29,921
but you've had to make a
couple of changes for InSight,

477
00:21:29,954 --> 00:21:30,856
what were they?

478
00:21:32,557 --> 00:21:33,992
- Yeah, so obviously
as you said,

479
00:21:34,025 --> 00:21:35,560
we leveraged Phoenix a lot,

480
00:21:35,593 --> 00:21:36,861
there was a lot of great things

481
00:21:36,894 --> 00:21:38,630
that we were able to take
from the Phoenix mission,

482
00:21:38,663 --> 00:21:40,832
but InSight is a unique mission,

483
00:21:40,865 --> 00:21:43,101
it's landing towards
the equator of Mars,

484
00:21:43,134 --> 00:21:45,537
and a number of
things are different,

485
00:21:45,570 --> 00:21:47,739
where we're landing,

486
00:21:47,772 --> 00:21:50,975
we are about one and a half
kilometers higher in altitude,

487
00:21:51,008 --> 00:21:53,044
in addition, so what
that required us to do

488
00:21:53,077 --> 00:21:55,747
it's come in a little
bit more shallow,

489
00:21:55,780 --> 00:21:59,884
in addition we are a little
bit heavier than Phoenix was,

490
00:21:59,917 --> 00:22:01,686
so we've had to increase
some of the strength

491
00:22:01,719 --> 00:22:02,987
of some of the lander itself,

492
00:22:03,020 --> 00:22:04,856
so the parachute, we had
to increase the strength,

493
00:22:04,889 --> 00:22:07,592
we have to deploy the
parachute a little bit higher

494
00:22:07,625 --> 00:22:10,061
because of some of
the differences in
our entry timeline,

495
00:22:10,094 --> 00:22:11,763
and because of
when we're landing,

496
00:22:11,796 --> 00:22:13,932
we're landing towards
the end of dust season,

497
00:22:13,965 --> 00:22:15,066
so we've also actually increased

498
00:22:15,099 --> 00:22:16,768
the thickness of
the heat shield,

499
00:22:16,801 --> 00:22:18,770
so we are about a quarter inch
thicker on our heat shield

500
00:22:18,803 --> 00:22:21,773
to accommodate that potential
sandblasting we could see

501
00:22:21,806 --> 00:22:23,742
when we actually do our
entry, descent and landing.

502
00:22:23,775 --> 00:22:24,876
So a number of
things we've changed,

503
00:22:24,909 --> 00:22:26,578
but we obviously leveraged

504
00:22:26,611 --> 00:22:29,114
a lot from the very successful
Phoenix mission as well.

505
00:22:29,147 --> 00:22:32,717
- That's fantastic so you
are able to customize it,

506

00:22:32,750 --> 00:22:34,819
because there were
some concerns earlier

507
00:22:34,852 --> 00:22:37,522
on that there was a
dust storm taking place,

508
00:22:37,555 --> 00:22:39,558
it was dust storm season.

509
00:22:40,792 --> 00:22:41,960
- That's right,

510
00:22:41,993 --> 00:22:44,062
in fact we've had a
lot of great support

511
00:22:44,095 --> 00:22:45,764
from our orbiting assets,

512
00:22:45,797 --> 00:22:46,998
MRO and Odyssey,

513
00:22:47,031 --> 00:22:49,067
a couple of spacecraft
that we've partnered

514
00:22:49,100 --> 00:22:51,569
with JPL and were built
here at Lockheed Martin,

515
00:22:51,602 --> 00:22:53,605
they have actually provided
a lot of great insight

516
00:22:53,638 --> 00:22:56,541
into the weather on Mars,

517

00:22:56,574 --> 00:22:58,576
the dust storms that are
potentially happening on Mars,

518
00:22:58,609 --> 00:23:00,011
and as of today,

519
00:23:00,044 --> 00:23:01,579
and actually the last couple

520
00:23:01,612 --> 00:23:03,782
of weeks it's been great
on the surface of Mars,

521
00:23:03,815 --> 00:23:05,884
we are anticipating
a very nominal,

522
00:23:05,917 --> 00:23:08,920
very seasonal weather in
terms of both density,

523
00:23:08,953 --> 00:23:10,722
atmosphere as well
as temperature,

524
00:23:10,755 --> 00:23:13,024
and dust storms appear
to be very benign,

525
00:23:13,057 --> 00:23:14,893
so we're very
optimistic it's gonna

526
00:23:14,926 --> 00:23:17,061
be a great day for landing
on the surface of Mars.

527
00:23:17,094 --> 00:23:18,997
- Alright that's great news,

528
00:23:19,030 --> 00:23:20,532
thanks Tim,

529
00:23:20,565 --> 00:23:21,933
and I know your team
is getting excited

530
00:23:21,966 --> 00:23:24,602
over there just
as much as we are.

531
00:23:24,635 --> 00:23:26,938
Take care.
- Absolutely, thanks a lot.

532
00:23:26,971 --> 00:23:29,741
- The time now is 11:21,

533
00:23:29,774 --> 00:23:31,709
it's about 20 minutes,

534
00:23:31,742 --> 00:23:34,679
the tension is building
in both control rooms,

535
00:23:34,712 --> 00:23:38,016
it's about 20 minutes before
cruise stage separation,

536
00:23:38,049 --> 00:23:39,751
it's not too far off,

537
00:23:39,784 --> 00:23:41,920
cruise stage
separation is expected

538
00:23:41,953 --> 00:23:44,055
at about 40 minutes

past the hour,

539
00:23:44,088 --> 00:23:47,058
so we are indeed getting close.

540
00:23:47,091 --> 00:23:50,028
So where is InSight
going to Mars?

541
00:23:50,061 --> 00:23:53,531
It's a place called
Elysium Planitia,

542
00:23:53,564 --> 00:23:54,899
Planitia is Latin for flat,

543
00:23:54,932 --> 00:23:58,970
Elysium is ancient Greek
for afterlife paradise,

544
00:23:59,003 --> 00:24:00,939
it's located near the equator,

545
00:24:00,972 --> 00:24:02,774
north of Gale Crater,

546
00:24:02,807 --> 00:24:05,743
not too far from
Curiosity Rover,

547
00:24:05,776 --> 00:24:09,547
the team calls it the
biggest parking lot on Mars,

548
00:24:09,580 --> 00:24:11,583
it's a place that's safe,

549
00:24:11,616 --> 00:24:14,752
got plenty of sunshine that

will power solar instruments

550
00:24:14,785 --> 00:24:17,923
to study the interior of Mars.

551
00:24:19,690 --> 00:24:21,759
[light music]

552
00:24:21,792 --> 00:24:23,695
- [Narrator] What's inside Mars?

553
00:24:23,728 --> 00:24:25,663
We know a lot about
what's inside the Earth,

554
00:24:25,696 --> 00:24:29,968
but at Mars we've only
just scratched the surface,

555
00:24:30,001 --> 00:24:33,738
to learn how Mars formed we
have to study its deep interior,

556
00:24:33,771 --> 00:24:37,075
NASA's InSight Lander was
designed to do just that,

557
00:24:37,108 --> 00:24:39,043
by taking the
planet's vital signs,

558
00:24:39,076 --> 00:24:42,881
listening to its pulse
for seismic activity,

559
00:24:42,914 --> 00:24:44,849
including any Marsquakes,

560
00:24:44,882 --> 00:24:46,851

taking its temperature

561
00:24:46,884 --> 00:24:49,588
to see how much heat is
flowing out from deep inside,

562
00:24:50,688 --> 00:24:52,724
and checking its
reflexes to see how much

563
00:24:52,757 --> 00:24:54,960
the planet wobbles as
it whips around the sun.

564
00:24:56,561 --> 00:24:57,662
These all provide clues to

565
00:24:57,695 --> 00:24:59,598
what the planet is
really like inside.

566
00:25:00,598 --> 00:25:02,634
So what's inside Mars?

567
00:25:02,667 --> 00:25:04,836
InSight can help us
find out by giving Mars

568
00:25:04,869 --> 00:25:06,638
its first thorough checkup since

569
00:25:06,671 --> 00:25:09,674
it formed four and a
half billion years ago,

570
00:25:09,707 --> 00:25:10,808
the more we learn,

571
00:25:10,841 --> 00:25:12,977

the better we understand
all the rocky planets,

572
00:25:13,010 --> 00:25:14,880
and the history of
our solar system.

573
00:25:19,016 --> 00:25:20,852
- Joining us now
is Bruce Banerdt,

574
00:25:20,885 --> 00:25:23,855
the principal investigator
of Mars InSight,

575
00:25:23,888 --> 00:25:26,524
InSight is a mission to Mars,

576
00:25:26,557 --> 00:25:28,626
but we keep hearing
again and again

577
00:25:28,659 --> 00:25:30,662
it's more than a
mission to Mars.

578
00:25:30,695 --> 00:25:31,963
- That's right Gay,

579
00:25:31,996 --> 00:25:35,533
I mean we are going to Mars
to study the Martian interior

580
00:25:35,566 --> 00:25:37,635
and to map out the
divisions inside Mars,

581
00:25:37,668 --> 00:25:39,671
but we want to use
that information

582
00:25:39,704 --> 00:25:42,040
to understand more
about the solar system

583
00:25:42,073 --> 00:25:45,577
as a whole and how
rocky planets form.

584
00:25:45,610 --> 00:25:46,544
- And rocky planets,

585
00:25:46,577 --> 00:25:48,046
we have an image to show folks,

586
00:25:48,079 --> 00:25:52,584
so we're talking about
Earth, the Moon, Mars.

587
00:25:52,617 --> 00:25:54,786
- Mercury, Venus, the planets

588
00:25:54,819 --> 00:25:57,055
of the inner solar system
that are made mostly of rocks,

589
00:25:57,088 --> 00:25:59,924
and they all share the
same basic structure

590
00:25:59,957 --> 00:26:01,893
with a dense iron core,

591
00:26:01,926 --> 00:26:03,861
a rocky mantle,

592
00:26:03,894 --> 00:26:07,565
and then a crust of
lighter silicate rocks,

593
00:26:07,598 --> 00:26:12,070
but the very details of the
thicknesses of those layers,

594
00:26:12,103 --> 00:26:15,974
the sizes and the compositions,

595
00:26:16,007 --> 00:26:18,876
give us a lot of clues as
to how those planets formed,

596
00:26:18,909 --> 00:26:20,878
and why they went down
very different paths

597
00:26:20,911 --> 00:26:23,815
into the different
planets we see today.

598
00:26:23,848 --> 00:26:24,949
- So explain to me,

599
00:26:24,982 --> 00:26:27,018
we are going to have a lander,

600
00:26:27,051 --> 00:26:28,553
you're gonna be on the surface,

601
00:26:28,586 --> 00:26:32,757
how will you be able
to study the interior?

602
00:26:32,790 --> 00:26:35,727
- We use what are called
geophysical instruments,

603
00:26:35,760 --> 00:26:36,861
they use the

principles of physics

604
00:26:36,894 --> 00:26:38,563
to actually see
through the rocks,

605
00:26:38,596 --> 00:26:40,031
we are using seismic waves,

606
00:26:40,064 --> 00:26:43,635
the same way you
might use a flashbulb

607
00:26:43,668 --> 00:26:45,903
to take pictures of something,

608
00:26:45,936 --> 00:26:47,872
we are using Marsquakes,

609
00:26:47,905 --> 00:26:51,643
which send out vibrational
waves through the planet,

610
00:26:51,676 --> 00:26:52,744
and as they go through

611
00:26:52,777 --> 00:26:54,646
the planet they
reflect off boundaries,

612
00:26:54,679 --> 00:26:55,780
they get bent,

613
00:26:55,813 --> 00:26:57,115
they change their velocity,

614
00:26:57,148 --> 00:27:01,886
and it changes the wiggles
that you see on a seismograph,

615
00:27:01,919 --> 00:27:03,988
when we go through the planet

616
00:27:04,021 --> 00:27:06,758
you can see that here it
hits the various boundaries,

617
00:27:06,791 --> 00:27:08,559
and those waves are reflected,

618
00:27:08,592 --> 00:27:09,727
sometimes they're bent,

619
00:27:09,760 --> 00:27:11,996
it becomes a pretty
complicated pattern,

620
00:27:12,029 --> 00:27:14,565
but scientifically
we have learned over

621
00:27:14,598 --> 00:27:18,036
the last hundred years
how to interpret the code

622
00:27:18,069 --> 00:27:21,572
of the signals that comes
back up to the surface,

623
00:27:21,605 --> 00:27:24,942
in the seismometers
that pick up that signal

624
00:27:24,975 --> 00:27:27,779
and then turn it into data
that we can use on Earth,

625
00:27:27,812 --> 00:27:30,581

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

626
00:27:30,614 --> 00:27:33,651
- So normally you use
three seismometers,

627
00:27:33,684 --> 00:27:35,687
in this case you're
bringing size,

628
00:27:35,720 --> 00:27:36,654
that's one,

629
00:27:36,687 --> 00:27:38,156
how are you going to be able

630
00:27:40,624 --> 00:27:41,726
to get that
information using one?

631
00:27:41,759 --> 00:27:42,960
- Well we had to
get kind of clever,

632
00:27:42,993 --> 00:27:44,996
because all the Earth usually

633
00:27:45,029 --> 00:27:46,531
you have plenty of seismometers,

634
00:27:46,564 --> 00:27:47,965
you can use multiple
seismometers

635
00:27:47,998 --> 00:27:51,035
to triangulate in on
where the Earthquake is,

636

00:27:51,068 --> 00:27:53,938
on Mars we're gonna do something
a little bit different,

637
00:27:53,971 --> 00:27:56,941
we're gonna use not only
the P and the S waves

638
00:27:56,974 --> 00:27:58,076
that you may have heard about,

639
00:27:58,109 --> 00:27:59,644
but we are using
the surface waves,

640
00:27:59,677 --> 00:28:01,612
and here you can see
the surface waves

641
00:28:01,645 --> 00:28:04,048
moving out from a Marsquake,

642
00:28:04,081 --> 00:28:06,117
and as it passes over
the InSight Lander

643
00:28:06,150 --> 00:28:07,919
you can see the seismograph

644
00:28:07,952 --> 00:28:10,788
up there in the upper
left-hand corner

645
00:28:10,821 --> 00:28:11,956
where you have the wiggles,

646
00:28:11,989 --> 00:28:14,659
now those waves keep on
going around the planet,

647
00:28:14,692 --> 00:28:17,028
and because Mars
is not so large,

648
00:28:17,061 --> 00:28:20,765
they still have a fair
amount of amplitude,

649
00:28:20,798 --> 00:28:23,968
they haven't gotten
completely damped out,

650
00:28:24,001 --> 00:28:26,537
by the time it's gone all
the way around the planet,

651
00:28:26,570 --> 00:28:28,973
passes over the
spacecraft again,

652
00:28:29,006 --> 00:28:31,809
and finally even the way
they went the other way

653
00:28:31,842 --> 00:28:35,580
around the planet comes across
and hits us yet a third time,

654
00:28:35,613 --> 00:28:37,582
and so we have extra information

655
00:28:37,615 --> 00:28:40,051
over the P and the S wave,

656
00:28:40,084 --> 00:28:41,753
we have these
surface wave arrivals

657
00:28:41,786 --> 00:28:46,023

that we can use to pinpoint
the distance from the Marsquake

658
00:28:46,056 --> 00:28:47,692
to our lander,

659
00:28:47,725 --> 00:28:49,727
and then we use something
called polarization analysis,

660
00:28:49,760 --> 00:28:51,863
to figure out which direction
the waves are coming from,

661
00:28:51,896 --> 00:28:53,564
and by doing that,

662
00:28:53,597 --> 00:28:54,832
we can do the same thing

663
00:28:54,865 --> 00:28:56,067
that we can do with three
stations on the Earth,

664
00:28:56,100 --> 00:28:57,802
just using the P
and the S waves.

665
00:28:57,835 --> 00:29:00,638
- And very quickly, there
is still another instrument

666
00:29:00,671 --> 00:29:03,708
built by DLR that's also
being carried up by InSight,

667
00:29:03,741 --> 00:29:05,610
can you talk a little
bit about that?

668
00:29:05,643 --> 00:29:06,744
- Yeah that's our
heat flow probe,

669
00:29:06,777 --> 00:29:08,746
and it's a pretty
cool instrument

670
00:29:08,779 --> 00:29:11,682
that uses a mechanical
mole we call it,

671
00:29:11,715 --> 00:29:13,951
to burrow its way
down into the surface,

672
00:29:13,984 --> 00:29:16,988
it has a motor that
winds up a hammer

673
00:29:17,021 --> 00:29:19,991
and knocks itself down just
a few millimeters at a time,

674
00:29:20,024 --> 00:29:24,028
but we do that 20 or
30,000 hammer strokes

675
00:29:24,061 --> 00:29:25,663
and it gets it down,

676
00:29:25,696 --> 00:29:28,599
we hope to get down to be about
16 feet below the surface,

677
00:29:28,632 --> 00:29:29,901
and once we get down there,

678
00:29:29,934 --> 00:29:32,537

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

679
00:29:32,570 --> 00:29:34,539
by measuring the
temperature along

680
00:29:34,572 --> 00:29:36,808
the cable as it comes
up to the surface,

681
00:29:36,841 --> 00:29:41,546
and looking at how
that temperature
increases as we go down,

682
00:29:41,579 --> 00:29:43,714
and extrapolate that
deep into the planet

683
00:29:43,747 --> 00:29:46,551
to understand how much energy
there is inside the planet

684
00:29:46,584 --> 00:29:50,655
to drive the geology and to
drive volcanism, Marsquakes,

685
00:29:50,688 --> 00:29:51,889
all kinds of activity.

686
00:29:51,922 --> 00:29:53,724
- It's amazing how
much you'll be able

687
00:29:53,757 --> 00:29:56,027
to learn from the surface
about the interior.

688
00:29:56,060 --> 00:29:58,563

- I think it is amazing,

689
00:29:58,596 --> 00:29:59,964
it's been something that I've

690
00:29:59,997 --> 00:30:02,567
been working on for my
whole professional career,

691
00:30:02,600 --> 00:30:05,670
and I find it fascinating.

692
00:30:05,703 --> 00:30:07,638
- Alright we'll talk about that,

693
00:30:07,671 --> 00:30:09,040
thanks Bruce.

694
00:30:09,073 --> 00:30:11,576
Bruce first thought of the
mission like this as he mentions

695
00:30:11,609 --> 00:30:15,112
40 years ago when he
was a graduate student,

696
00:30:15,145 --> 00:30:18,583
the rest of the team hasn't
waited quite that long,

697
00:30:18,616 --> 00:30:20,952
but this is a big
moment for them too,

698
00:30:20,985 --> 00:30:22,920
recently we sat down
with a few of the members

699
00:30:22,953 --> 00:30:25,923

and asked them what
is it going to be like

700
00:30:25,956 --> 00:30:27,759
as we get close to landing.

701
00:30:29,126 --> 00:30:31,529
[dramatic music]

702
00:30:31,562 --> 00:30:32,864
- It's a very
difficult thing to do,

703
00:30:32,897 --> 00:30:34,966
and everything has
to go perfectly,

704
00:30:34,999 --> 00:30:37,568
as humans we've sent
17 different missions

705
00:30:37,601 --> 00:30:40,705
to the surface of Mars and
10 of them have crashed.

706
00:30:40,738 --> 00:30:43,574
Before we can land on Mars
we have to get to Mars.

707
00:30:43,607 --> 00:30:44,876
How do we get to Mars?

708
00:30:44,909 --> 00:30:46,944
- The main responsibility
of the navigation team

709
00:30:46,977 --> 00:30:48,946
is to ensure that the
spacecraft is delivered

710
00:30:48,979 --> 00:30:51,048
to the right point on
the Martian atmosphere.

711
00:30:51,081 --> 00:30:54,552
The target location is
about 12 kilometers in size,

712
00:30:54,585 --> 00:30:56,120
our accuracy is
comparable to shooting

713
00:30:56,153 --> 00:30:59,056
a basketball from Staple
Center in downtown LA,

714
00:30:59,089 --> 00:31:00,558
and hitting nothing but net

715
00:31:00,591 --> 00:31:02,026
in a basketball hoop
in New York City,

716
00:31:02,059 --> 00:31:03,694
that is moving at a speed

717
00:31:03,727 --> 00:31:06,664
of about two feet per second
and is spinning about its axis.

718
00:31:06,697 --> 00:31:09,000
- The landing site we have an
ellipse that is pretty big,

719
00:31:09,033 --> 00:31:10,635
it's about 60 miles long,

720
00:31:10,668 --> 00:31:12,103
We could land anywhere

in that ellipse,

721
00:31:12,136 --> 00:31:14,639
there's a chance that we
could land right on a rock,

722
00:31:14,672 --> 00:31:16,107
and we don't have any
control over that,

723
00:31:16,140 --> 00:31:17,808
so that's what makes me nervous.

724
00:31:17,841 --> 00:31:20,578
- We have tested the RADAR
by flying it on a helicopter,

725
00:31:20,611 --> 00:31:22,079
we've tested pieces
of the heat shield

726
00:31:22,112 --> 00:31:24,081
by putting them in
an arc jet facility,

727
00:31:24,114 --> 00:31:26,851
we have tested the parachute
by testing it in a wind tunnel,

728
00:31:26,884 --> 00:31:28,085
and putting that all together

729
00:31:28,118 --> 00:31:30,588
in a very tightly
controlled sequence

730
00:31:30,621 --> 00:31:31,923
where every single
thing has to go right,

731
00:31:31,956 --> 00:31:33,658
we have never tested that,

732
00:31:33,691 --> 00:31:34,625
and the first time
it's gonna happen

733
00:31:34,658 --> 00:31:36,728
is once you deliver us to Mars.

734
00:31:42,599 --> 00:31:46,671
- It is about 11:29 AM Pacific,

735
00:31:46,704 --> 00:31:49,974
and you're watching live
coverage of the InSight landing

736
00:31:50,007 --> 00:31:52,076
from NASA's Jet
Propulsion Laboratory

737
00:31:52,109 --> 00:31:54,845
in Pasadena, California.

738
00:31:54,878 --> 00:31:57,848
We are about a half
hour away from landing,

739
00:31:57,881 --> 00:32:01,519
and people all over
the world are watching,

740
00:32:01,552 --> 00:32:04,755
take a look at a map
that we have for you,

741
00:32:04,788 --> 00:32:05,990
we can show you right now,

742
00:32:06,023 --> 00:32:08,526
this is a watch in person map

743
00:32:08,559 --> 00:32:11,896
where people have watch
parties all over the world,

744
00:32:11,929 --> 00:32:13,764
all over the United States,

745
00:32:13,797 --> 00:32:15,833
in Paris, in Berlin,

746
00:32:15,866 --> 00:32:18,970
even off the coast
of Madagascar,

747
00:32:19,003 --> 00:32:22,940
and folks in the Big Apple
will also be watching today,

748
00:32:22,973 --> 00:32:27,078
the NASDAQ Tower will switch
over to landing coverage

749
00:32:27,111 --> 00:32:29,547
for about an hour,

750
00:32:29,580 --> 00:32:32,683
that means people in Times
Square can watch too,

751
00:32:32,716 --> 00:32:34,785
and later today, NASA will have

752
00:32:34,818 --> 00:32:37,588
the honor of ringing
the closing bell,

753
00:32:37,621 --> 00:32:40,524
and that will be a little
over an hour from now.

754
00:32:40,557 --> 00:32:41,926
And if you are watching,

755
00:32:41,959 --> 00:32:43,995
take a picture
and send it to us,

756
00:32:44,028 --> 00:32:46,797
using hashtag Marslanding,

757
00:32:46,830 --> 00:32:48,866
here is one I believe it is

758
00:32:48,899 --> 00:32:52,570
from the California Science
Center in Los Angeles,

759
00:32:52,603 --> 00:32:57,608
and I am told Eric Garcetti
will be visiting later today.

760
00:32:58,709 --> 00:33:00,745
Things are getting more
active for the team now,

761
00:33:00,778 --> 00:33:03,114
let's check back in
with Julie Wertz Chen

762
00:33:03,147 --> 00:33:05,850
in the control room,
what's going on Julie?

763
00:33:07,117 --> 00:33:10,688
- Yeah so we have heard

from MRO a couple of times,

764
00:33:10,721 --> 00:33:12,556
that's Mars
Reconnaissance Orbiter,

765
00:33:12,589 --> 00:33:13,524
they are doing their slew,

766
00:33:13,557 --> 00:33:14,558
they are ready to support us,

767
00:33:14,591 --> 00:33:15,526
they are doing great,

768
00:33:15,559 --> 00:33:17,695
and we heard from both MarCO's,

769
00:33:17,728 --> 00:33:18,929
MarCO A and B that
they're out there,

770
00:33:18,962 --> 00:33:20,831
they've got telemetry lock

771
00:33:20,864 --> 00:33:22,867
with them from the
ground stations here,

772
00:33:22,900 --> 00:33:24,635
so they are doing great,

773
00:33:24,668 --> 00:33:27,772
and everybody is ready to
go, so we're pretty excited.

774
00:33:27,805 --> 00:33:28,906
- Fantastic,

775
00:33:28,939 --> 00:33:31,642
we will check back in
with Julie in a moment,

776
00:33:31,675 --> 00:33:34,545
meantime this is a good time
to tell you a little bit more

777
00:33:34,578 --> 00:33:37,014
about that technology experiment
we've been talking about,

778
00:33:37,047 --> 00:33:37,982
MarCO,

779
00:33:38,015 --> 00:33:39,617
as we mentioned earlier,

780
00:33:39,650 --> 00:33:41,852
InSight does not have an orbiter

781
00:33:41,885 --> 00:33:45,589
in position to send
EDL data back live,

782
00:33:45,622 --> 00:33:47,892
so the Cubesats hope
to fill that gap,

783
00:33:47,925 --> 00:33:49,627
here's how they'll work.

784
00:33:50,861 --> 00:33:52,830
- [Narrator] Communicating
between Mars and Earth requires

785
00:33:52,863 --> 00:33:54,799
a complicated choreography,

786
00:33:54,832 --> 00:33:58,002
with everything in the right
place at the right time.

787
00:33:58,035 --> 00:34:00,571
Sometimes hours can
pass before information

788
00:34:00,604 --> 00:34:02,706
is related from one
planet to another,

789
00:34:02,739 --> 00:34:05,076
that's why when NASA's Mars
InSight Lander launches

790
00:34:05,109 --> 00:34:06,877
this year the rocket will carry

791
00:34:06,910 --> 00:34:10,548
two tiny satellites for a
technology test of their own.

792
00:34:10,581 --> 00:34:11,949
Meet Mars Cube One,

793
00:34:11,982 --> 00:34:15,953
MarCO, NASA's first Cubesat
mission to deep space,

794
00:34:15,986 --> 00:34:17,788
these briefcase-sized satellites

795
00:34:17,821 --> 00:34:19,957
will travel separately
from the InSight Lander

796
00:34:19,990 --> 00:34:22,827
while they test out new

miniaturized technologies,

797
00:34:22,860 --> 00:34:23,994
and if they make it to Mars

798
00:34:24,027 --> 00:34:25,663
they could relate
information back

799
00:34:25,696 --> 00:34:28,599
to Earth about InSight's
descent and touchdown,

800
00:34:28,632 --> 00:34:30,868
and do it in mere minutes.

801
00:34:30,901 --> 00:34:33,003
Although this fast
communication isn't crucial

802
00:34:33,036 --> 00:34:34,939
to the success of
the InSight Lander,

803
00:34:34,972 --> 00:34:36,841
this Cubesat test could change

804
00:34:36,874 --> 00:34:39,577
the way future
spacecraft phone home.

805
00:34:42,946 --> 00:34:44,849
- Alright let's
check back with Julie

806
00:34:44,882 --> 00:34:46,984
to see if the MarCOs
are indeed ready

807

00:34:47,017 --> 00:34:49,887
to support and
listen for InSight,

808
00:34:49,920 --> 00:34:51,055
Julie what do you know?

809
00:34:52,623 --> 00:34:54,725
- So they are ready to go,

810
00:34:54,758 --> 00:34:56,894
I haven't heard about
their slew coming up yet,

811
00:34:56,927 --> 00:34:58,863
but they are ready to go,

812
00:34:58,896 --> 00:35:00,531
we have heard from them,
they are both healthy,

813
00:35:00,564 --> 00:35:01,499
and they're both doing great,

814
00:35:01,532 --> 00:35:03,534
which is just wonderful news.

815
00:35:03,567 --> 00:35:05,669
So I think they should
be doing a slew,

816
00:35:05,702 --> 00:35:07,004
actually I think they should

817
00:35:07,037 --> 00:35:08,572
be doing a slew
in just a minute.

818
00:35:08,605 --> 00:35:10,108

- [Gay] We'll stand
by and listen then.

819
00:35:50,981 --> 00:35:54,886
[men mumbling off-microphone]

820
00:36:44,067 --> 00:36:45,569
- [Woman] All
stations and systems,

821
00:36:45,602 --> 00:36:47,004
we can confirm we are
entry -20 minutes,

822
00:36:47,037 --> 00:36:49,807
EDL nav two has been initiated,

823
00:36:49,840 --> 00:36:51,776
the star tracker has
been powered off.

824
00:37:06,857 --> 00:37:09,793
- The nav two software
has been initiated,

825
00:37:09,826 --> 00:37:13,063
so when we're in cruise
we use a star tracker,

826
00:37:13,096 --> 00:37:17,101
in a similar manner to how
sailors navigated years ago,

827
00:37:17,134 --> 00:37:18,669
we look at the stars

828
00:37:18,702 --> 00:37:19,870
and get our relative
position from them,

829
00:37:19,903 --> 00:37:21,805
we use a star tracker for that,

830
00:37:21,838 --> 00:37:24,008
and now that we are
close enough to Mars,

831
00:37:24,041 --> 00:37:24,975
we don't need that anymore,

832
00:37:25,008 --> 00:37:26,877
so we're gonna transition

833
00:37:26,910 --> 00:37:29,046
to what's called
Nav two software,

834
00:37:29,079 --> 00:37:32,616
and that let's us
basically just use velocity

835
00:37:32,649 --> 00:37:33,784
and acceleration
from this point on,

836
00:37:33,817 --> 00:37:35,886
so we don't need the
star tracker any more.

837
00:37:39,790 --> 00:37:43,027
- [Man] MarCO clarify, slew to
inertia or start a bent pipe.

838
00:37:44,661 --> 00:37:46,998
- [Man] Slew to appropriate
altitude for bent pipe,

839
00:37:48,098 --> 00:37:49,600
bent pipe mode will

be entered shortly.

840
00:37:49,633 --> 00:37:50,801
- [Man] Okay thank
you very much.

841
00:37:52,803 --> 00:37:55,072
- And that was obviously
confirmation of
the slew for MarCO,

842
00:37:55,105 --> 00:37:56,740
so that's great news.

843
00:37:56,773 --> 00:37:58,609
- [Gay] Fantastic.

844
00:38:01,945 --> 00:38:03,914
- So as I was saying before,

845
00:38:03,947 --> 00:38:07,718
the Nav two software will
propagate from here on out,

846
00:38:07,751 --> 00:38:08,919
and we'll use velocity
and acceleration,

847
00:38:08,952 --> 00:38:10,688
so we've powered off
our star tracker,

848
00:38:10,721 --> 00:38:11,789
and we are on our
Nav two software

849
00:38:11,822 --> 00:38:13,791
and everything is looking great.

850

00:38:13,824 --> 00:38:15,826
- Okay thanks Julie.

851
00:38:17,761 --> 00:38:19,830
Alright the cruise
stage separation

852
00:38:19,863 --> 00:38:21,999
is just about four minutes away,

853
00:38:22,032 --> 00:38:24,568
and Rob Manning joins us now,

854
00:38:24,601 --> 00:38:27,571
Rob is the chief
engineer here at JPL,

855
00:38:27,604 --> 00:38:30,741
and an absolute veteran
of Mars landings.

856
00:38:30,774 --> 00:38:33,544
We are going to play a little
video for you right now,

857
00:38:33,577 --> 00:38:34,678
you haven't seen it yet,

858
00:38:34,711 --> 00:38:35,713
but we'll roll it.

859
00:38:38,782 --> 00:38:39,850
Let's go ahead.

860
00:38:39,883 --> 00:38:40,984
This is--

861
00:38:41,017 --> 00:38:41,952
- [Man] Lander

acceleration live,

862
00:38:41,985 --> 00:38:43,587
14 reports carrier lock at--

863
00:38:43,620 --> 00:38:46,590
- [Gay] There you are,
you were the phase lead.

864
00:38:48,024 --> 00:38:50,060
You were sitting
up from [laughs].

865
00:38:50,093 --> 00:38:52,863
[crowd cheers]

866
00:38:53,897 --> 00:38:54,799
- [Rob] Yeah,

867
00:38:57,567 --> 00:38:59,536
that's what I look like
when it's successful.

868
00:38:59,569 --> 00:39:01,105
- [Gay] Yes.

869
00:39:03,573 --> 00:39:04,675
- I'd hate to see
what I would have

870
00:39:04,708 --> 00:39:06,844
looked like if I
wasn't successful.

871
00:39:06,877 --> 00:39:08,078
- But talk about that,

872
00:39:08,111 --> 00:39:10,013
what is EDL like,

873
00:39:10,046 --> 00:39:11,882
why is it so hard?

874
00:39:11,915 --> 00:39:15,753
- Well its many years of
work by many many people

875
00:39:15,786 --> 00:39:18,122
who struggle to put all
the pieces together,

876
00:39:18,155 --> 00:39:21,058
and particularly because
we can't really test

877
00:39:21,091 --> 00:39:23,994
entry, descent and
landing on this planet,

878
00:39:24,027 --> 00:39:26,029
it's much more complicated,

879
00:39:26,062 --> 00:39:28,065
Mars has a lower atmosphere,

880
00:39:28,098 --> 00:39:29,066
thinner atmosphere,

881
00:39:29,099 --> 00:39:30,734
less gravity,

882
00:39:30,767 --> 00:39:31,869
you just can't put the pieces,

883
00:39:31,902 --> 00:39:34,838
so imagine you had a
big Broadway production,

884
00:39:34,871 --> 00:39:36,039
but you couldn't really

885
00:39:36,072 --> 00:39:39,643
do the show until all
the audience shows up,

886
00:39:39,676 --> 00:39:41,078
so that's what it feels like,

887
00:39:41,111 --> 00:39:44,748
so you never really know if
you've really done it right.

888
00:39:44,781 --> 00:39:47,851
- Well we've done
it seven times,

889
00:39:47,884 --> 00:39:52,089
can we say piece of cake,
we know what we're doing?

890
00:39:52,122 --> 00:39:53,791
- No I don't think so,

891
00:39:53,824 --> 00:39:55,592
we get better at it,

892
00:39:55,625 --> 00:39:56,827
and there's no doubt
we have learned,

893
00:39:56,860 --> 00:39:59,797
we've learned from both
successes and our own failures,

894
00:39:59,830 --> 00:40:01,665
including failures of other

895
00:40:01,698 --> 00:40:03,534
missions outside
of this country,

896
00:40:03,567 --> 00:40:05,969
so those pieces come
together in our minds eye,

897
00:40:06,002 --> 00:40:08,739
and we try to put what
we learned together,

898
00:40:08,772 --> 00:40:11,642
and just do the best we can,

899
00:40:11,675 --> 00:40:14,077
and if we don't succeed,

900
00:40:14,110 --> 00:40:15,746
we will learn,

901
00:40:15,779 --> 00:40:17,781
because we are collecting
data on the way down,

902
00:40:17,814 --> 00:40:20,083
if something bad happens today,

903
00:40:20,116 --> 00:40:21,785
we'll be able to
take what we learned,

904
00:40:21,818 --> 00:40:23,854
even though we may
fall on the ground

905
00:40:23,887 --> 00:40:25,856
after being kicked off the horse

906
00:40:25,889 --> 00:40:27,758
we'll get back up,
brush ourselves off,

907
00:40:27,791 --> 00:40:28,826
figure out what we did wrong,

908
00:40:28,859 --> 00:40:30,561
and get back on the horse.

909
00:40:30,594 --> 00:40:32,729
- Well there's a
lot of uncertainty,

910
00:40:32,762 --> 00:40:36,066
just very quickly give
some possible scenarios

911
00:40:36,099 --> 00:40:38,869
of what could happen
during EDL today,

912
00:40:38,902 --> 00:40:41,038
especially during
communications?

913
00:40:41,071 --> 00:40:44,007
- Well the great news about
having communications,

914
00:40:44,040 --> 00:40:46,677
almost anything could go wrong,

915
00:40:46,710 --> 00:40:48,745
there's a very good chance
we can figure it out,

916
00:40:48,778 --> 00:40:51,114
but things like the

parachute has to go right,

917
00:40:51,147 --> 00:40:52,683
you don't open parachutes

918
00:40:52,716 --> 00:40:55,752
on Earth going Mach
one and a half,

919
00:40:55,785 --> 00:40:57,588
one and a half times
the speed of sound,

920
00:40:57,621 --> 00:40:58,722
you just don't do that,

921
00:40:58,755 --> 00:40:59,823
you don't need to
on this planet,

922
00:40:59,856 --> 00:41:01,024
but we have to
because if we waited

923
00:41:01,057 --> 00:41:02,793
any longer we'd
be on the ground.

924
00:41:02,826 --> 00:41:05,963
A very complicated
RADAR system has to work

925
00:41:05,996 --> 00:41:07,831
from outer space all the way

926
00:41:07,864 --> 00:41:10,567
to the ground and
look for the ground,

927

00:41:10,600 --> 00:41:12,569
what if it locked up
on the heat shield,

928
00:41:12,602 --> 00:41:14,538
well we've tried to
avoid that problem,

929
00:41:14,571 --> 00:41:16,540
we fixed that problem we think

930
00:41:16,573 --> 00:41:17,975
to prevent that from happening,

931
00:41:18,008 --> 00:41:19,643
but what if we got it wrong,

932
00:41:19,676 --> 00:41:21,044
things like that can happen,

933
00:41:21,077 --> 00:41:24,681
and our vehicle could
have things bad happen,

934
00:41:24,714 --> 00:41:27,051
but we have worked
hard to prevent them.

935
00:41:28,084 --> 00:41:29,753
- So we're getting close,

936
00:41:29,786 --> 00:41:30,854
we're gonna go to the control

937
00:41:30,887 --> 00:41:32,823
room for cruise
stage separation Rob.

938
00:41:32,856 --> 00:41:33,757

- Okay.

939
00:41:40,664 --> 00:41:41,899
I need to take off.

940
00:41:43,934 --> 00:41:45,736
Yes, yes.

941
00:42:19,736 --> 00:42:20,738
- [Man] InSight
systems, EDL COMM.

942
00:42:22,038 --> 00:42:23,740
- [Woman] Go-ahead?

943
00:42:23,773 --> 00:42:25,042
- [Man] At this time MRO

944
00:42:25,075 --> 00:42:27,945
will have loaded their
electro sequences,

945
00:42:27,978 --> 00:42:31,882
and MarCO is expecting
carrier lock any time,

946
00:42:31,915 --> 00:42:34,018
MarCO B has recorded
they're in bent pipe,

947
00:42:35,118 --> 00:42:36,053
still waiting on A.

948
00:42:37,721 --> 00:42:39,023
- [Woman] Copy that, thank you.

949
00:42:49,599 --> 00:42:50,767
- [Man] Radio Science report,

950
00:42:50,800 --> 00:42:52,703
UHF carrier detected.

951
00:42:53,937 --> 00:42:57,007
- [Man] EDL COMM, MarCO
Alpha is an bent pipe mode,

952
00:42:57,040 --> 00:42:59,610
MarCO bravo has
locked on the carrier.

953
00:43:00,710 --> 00:43:02,513
MarCO Alpha has also
locked on carrier.

954
00:43:03,880 --> 00:43:06,717
[people applaud]

955
00:43:09,819 --> 00:43:10,988
- [Man] Systems based
on InSight court,

956
00:43:11,021 --> 00:43:14,091
as expected the DSN
has LS inside x-band.

957
00:43:15,725 --> 00:43:16,827
- Copy that, thank you.

958
00:43:44,020 --> 00:43:45,789
All station InSight
systems on InSight core,

959
00:43:45,822 --> 00:43:48,058
DSN has lost the X-band
signal from InSight,

960
00:43:48,091 --> 00:43:51,695
indicated at expected

cruise stage separation.

961
00:43:53,797 --> 00:43:55,866
Standing by for UHF
signal acquisition

962
00:43:55,899 --> 00:43:57,801
via MarCO radio science.

963
00:44:05,108 --> 00:44:06,977
We are about five
minutes from entry,

964
00:44:07,010 --> 00:44:08,879
and have confirmation
we have lost

965
00:44:08,912 --> 00:44:11,782
the X-band signal from InSight,

966
00:44:11,815 --> 00:44:13,984
this was expected because
we have transitioned

967
00:44:14,017 --> 00:44:15,952
from the antenna
on the cruise stage

968
00:44:15,985 --> 00:44:19,123
to the UHF antenna
aboard the spacecraft.

969
00:44:20,657 --> 00:44:22,793
Ground stations have
detected UHF signal

970
00:44:22,826 --> 00:44:25,062
and MarCO has locked
on the signal,

971
00:44:25,095 --> 00:44:26,763
this confirms that InSight

972
00:44:26,796 --> 00:44:29,800
is transmitting UHF
signals as expected.

973
00:44:30,867 --> 00:44:33,003
InSight telemetry
through the MarCO relay

974
00:44:33,036 --> 00:44:36,607
is not expected till about
two minutes before entry.

975
00:44:43,580 --> 00:44:45,082
- [Gay] So Rob that was exactly
what we were hoping here,

976
00:44:45,115 --> 00:44:47,050
that the MarCOs are--

977
00:44:47,083 --> 00:44:50,587
- The vehicle has also performed
the turn to entry maneuver,

978
00:44:50,620 --> 00:44:53,590
the vehicle is turning away
from the sun pointing altitude,

979
00:44:53,623 --> 00:44:56,794
and oriented itself to enter
the Martian atmosphere.

980
00:44:57,694 --> 00:44:59,063
- This is a big first step,

981
00:45:00,563 --> 00:45:03,600
just getting the

cruise stage separated,

982
00:45:03,633 --> 00:45:07,571
After the vehicle turns itself
to the right orientation,

983
00:45:07,604 --> 00:45:10,540
The cruise stage is now
going to get further

984
00:45:10,573 --> 00:45:11,975
and further away
till it's about three

985
00:45:12,008 --> 00:45:14,778
or four football fields
away and will burn

986
00:45:14,811 --> 00:45:17,714
up in parallel as the
vehicle enters Mars.

987
00:45:17,747 --> 00:45:19,916
- And Christine
mentioned turn to entry,

988
00:45:19,949 --> 00:45:21,651
what does that mean?

989
00:45:21,684 --> 00:45:22,819
- Well it's because
the cruise stage

990
00:45:22,852 --> 00:45:24,821
has to be pushed off
to one side like this,

991
00:45:24,854 --> 00:45:28,625
the rest of the vehicle has to
turn to face the atmosphere,

992
00:45:28,658 --> 00:45:32,062
and to be dead nuts on as it
hits the top of the atmosphere.

993
00:45:32,095 --> 00:45:33,997
- [Gay] So this is
taking all the heat

994
00:45:34,030 --> 00:45:35,565
coming into the atmosphere?

995
00:45:35,598 --> 00:45:36,733
- Exactly,

996
00:45:36,766 --> 00:45:37,768
it'll both provide
a source for drag,

997
00:45:37,801 --> 00:45:39,035
but also thermal protection,

998
00:45:39,068 --> 00:45:42,539
because it gets over
1500 degrees Celsius

999
00:45:42,572 --> 00:45:44,674
on this heat shield,

1000
00:45:44,707 --> 00:45:45,976
very, very hot,

1001
00:45:46,009 --> 00:45:47,744
but on the inside
of the heat shield,

1002
00:45:47,777 --> 00:45:52,048
it's maybe only a few degrees
above room temperature,

1003
00:45:52,081 --> 00:45:53,984
so it's a wonderful
protector device

1004
00:45:54,017 --> 00:45:55,852
to keep our lander safe.

1005
00:45:55,885 --> 00:45:59,656
- Alright so the next thing
were standing by for is,

1006
00:45:59,689 --> 00:46:00,924
- Is entry.
- Entry.

1007
00:46:00,957 --> 00:46:02,626
- Getting to the top
of the atmosphere

1008
00:46:02,659 --> 00:46:03,960
and gradually slowing down,

1009
00:46:03,993 --> 00:46:06,630
Right now the vehicle
is just now beginning,

1010
00:46:06,663 --> 00:46:09,599
very soon will be
beginning to feel

1011
00:46:09,632 --> 00:46:11,001
the atmosphere touching it,

1012
00:46:11,034 --> 00:46:13,537
actually entry is above
the atmosphere slightly,

1013
00:46:13,570 --> 00:46:16,873

so it's really not till
half a minute or so

1014
00:46:16,906 --> 00:46:20,043
after entry before we really
start detecting the fact

1015
00:46:20,076 --> 00:46:22,546
that that atmosphere
is slowing us down.

1016
00:46:22,579 --> 00:46:23,880
- Alright, we'll be standing by.

1017
00:46:23,913 --> 00:46:25,015
- Yes, exciting.

1018
00:47:20,703 --> 00:47:25,108
- [Gay] Rob, now entry
is scheduled for 11:47,

1019
00:47:25,141 --> 00:47:26,743
the cruise stage set

1020
00:47:26,776 --> 00:47:29,045
and the entry times
are locked in correct?

1021
00:47:29,078 --> 00:47:30,580
- [Rob] They are,

1022
00:47:30,613 --> 00:47:32,716
they are locked in when
we selected the target

1023
00:47:32,749 --> 00:47:34,584
and aimed the vehicle
very precisely,

1024

00:47:34,617 --> 00:47:37,087
that allows us to know exactly
when we hit the entry point,

1025
00:47:37,120 --> 00:47:41,057
which is 35 to 55 kilometers
from the center of Mars.

1026
00:47:41,090 --> 00:47:43,026
- [Gay] So we know those
times are locked in,

1027
00:47:43,059 --> 00:47:46,663
but what about all the other
events that take place--

1028
00:47:46,696 --> 00:47:48,031
- [Man] Radio Science
reports dropping

1029
00:47:48,064 --> 00:47:50,600
carrier power as expected.

1030
00:47:50,633 --> 00:47:52,936
- [Man] MarCO A and
MarCO B have telemetry.

1031
00:47:52,969 --> 00:47:55,806
[people applaud]

1032
00:47:59,709 --> 00:48:01,478
- [Gay] Just heard, both
MarCO's have telemetry.

1033
00:48:01,511 --> 00:48:02,879
- [Rob] They are
doing their job,

1034
00:48:02,912 --> 00:48:06,549
these small Cubesats are

relaying ones and zeros

1035
00:48:06,582 --> 00:48:09,085
with a few seconds lag From

1036
00:48:09,118 --> 00:48:12,589
the vehicle up to
these two vehicles,

1037
00:48:12,622 --> 00:48:14,591
and they forward
them back to Earth

1038
00:48:14,624 --> 00:48:17,761
to the deep space network
using X-band antennas,

1039
00:48:17,794 --> 00:48:20,096
- And keep in mind this
was all an experiment,

1040
00:48:20,129 --> 00:48:22,699
we weren't sure that
this was going to work,

1041
00:48:22,732 --> 00:48:25,068
but we had this
need that we didn't

1042
00:48:25,101 --> 00:48:28,538
have live communication in
this particular mission.

1043
00:48:28,571 --> 00:48:30,073
- Well we don't really
need communications,

1044
00:48:30,106 --> 00:48:31,841
we don't need their information,

1045
00:48:31,874 --> 00:48:33,543
except if something went wrong,

1046
00:48:33,576 --> 00:48:35,645
we would very much like
to get the data right now,

1047
00:48:35,678 --> 00:48:36,980
we have other spacecraft.

1048
00:48:37,013 --> 00:48:38,114
- [Christine] We are
now receiving InSight

1049
00:48:38,147 --> 00:48:40,050
telemetry via the MarCO really.

1050
00:48:40,083 --> 00:48:41,885
[people applaud]

1051
00:48:41,918 --> 00:48:45,956
- Ah, it's flowing
into it, fabulous.

1052
00:48:45,989 --> 00:48:47,891
That means the
team now can watch

1053
00:48:47,924 --> 00:48:50,694
the data flowing onto
their screens as if

1054
00:48:50,727 --> 00:48:52,629
they're communicating
directly with the vehicle.

1055
00:48:52,662 --> 00:48:54,564
- This data will provide
detailed information

1056
00:48:54,597 --> 00:48:56,800
about the state of the
spacecraft throughout EDL.

1057
00:49:02,705 --> 00:49:04,708
- [Gay] We were on pins and
needles waiting for that,

1058
00:49:04,741 --> 00:49:07,644
because we weren't really sure.

1059
00:49:07,677 --> 00:49:09,112
- [Rob] This is wonderful news,

1060
00:49:09,145 --> 00:49:12,983
if this continues
working all the way

1061
00:49:13,016 --> 00:49:14,784
to the ground and beyond,

1062
00:49:14,817 --> 00:49:18,088
we might even see a
first picture from
the surface of Mars.

1063
00:49:18,121 --> 00:49:19,656
- [Gay] Wouldn't that be great?

1064
00:49:19,689 --> 00:49:20,890
- [Rob] Very soon.

1065
00:49:20,923 --> 00:49:22,726
- [Christine] Atmospheric
entry on my mark,

1066
00:49:24,827 --> 00:49:27,164
three, two, one, mark.

1067
00:49:29,565 --> 00:49:30,734
- [Gay] Here we go.

1068
00:49:30,767 --> 00:49:32,535
- [Rob] So in a few seconds

1069
00:49:32,568 --> 00:49:34,838
the vehicle will start
sensing the atmosphere,

1070
00:49:34,871 --> 00:49:37,974
22 kilometers from
the center of Mars,

1071
00:49:38,007 --> 00:49:40,076
and it's gonna start
to slow down very

1072
00:49:40,109 --> 00:49:41,711
very slowly at first,

1073
00:49:41,744 --> 00:49:43,947
but then faster and
faster and faster,

1074
00:49:43,980 --> 00:49:46,983
till it reaches about seven Gs,

1075
00:49:47,016 --> 00:49:48,585
I made that mistake
on the video,

1076
00:49:48,618 --> 00:49:49,986
it's actually seven Gs not 12,

1077
00:49:50,019 --> 00:49:54,825
but it will still very,
very quickly slow down,

1078
00:49:57,026 --> 00:49:57,961
from 15--

1079
00:49:57,994 --> 00:49:59,629
- In approximately one minute,

1080
00:49:59,662 --> 00:50:02,832
InSight is expected to reach
its maximum heating rate,

1081
00:50:02,865 --> 00:50:06,569
plasma blackout is possible
during peak heating,

1082
00:50:06,602 --> 00:50:09,939
and could cause a temporary
drop out of telemetry,

1083
00:50:09,972 --> 00:50:12,943
this could last for as
long as two minutes.

1084
00:50:14,911 --> 00:50:16,046
- [Rob] The gas that comes

1085
00:50:16,079 --> 00:50:18,848
off the heat shield
as it's slowing down,

1086
00:50:18,881 --> 00:50:20,784
it looks like a meteor
if you're on Mars

1087
00:50:20,817 --> 00:50:22,552
watching the streak go by,

1088
00:50:22,585 --> 00:50:24,821
that brightness of

gas does interfere

1089
00:50:24,854 --> 00:50:26,023
with the radio reception,

1090
00:50:27,123 --> 00:50:28,758
so it's possible
that MarCO will lose

1091
00:50:28,791 --> 00:50:32,062
that signal while going
through this very hot entry.

1092
00:50:32,095 --> 00:50:33,930
- [Gay] But not to be alarmed.

1093
00:50:33,963 --> 00:50:34,931
- [Rob] Not to be alarmed,

1094
00:50:34,964 --> 00:50:36,066
it's part of the design,

1095
00:50:36,099 --> 00:50:37,834
we completely expect it.

1096
00:50:37,867 --> 00:50:39,869
- [Man] Radio science reports

1097
00:50:39,902 --> 00:50:41,971
plasma blackouts as expected.

1098
00:50:42,004 --> 00:50:43,974
- [Rob] Okay, oh wow.

1099
00:50:49,979 --> 00:50:51,748
- Ground stations have
reported plasma blackout,

1100

00:50:51,781 --> 00:50:54,584
still receiving InSight
telemetry via MarCO.

1101
00:50:55,985 --> 00:50:58,121
- [Man] MarCO Alpha has
carrier interruption.

1102
00:51:01,524 --> 00:51:04,161
- InSight should now
be experiencing the
peak heating rate,

1103
00:51:05,661 --> 00:51:07,530
portions of the heat
shield may reach

1104
00:51:07,563 --> 00:51:10,033
nearly 3000 degrees
Fahrenheit as it protects

1105
00:51:10,066 --> 00:51:12,636
the lander from the
heating environment.

1106
00:51:17,106 --> 00:51:18,075
- [Rob] That's hot.

1107
00:51:19,976 --> 00:51:21,678
- [Man] MarCO Bravo has
carrier interruption,

1108
00:51:21,711 --> 00:51:22,679
but still in lock.

1109
00:51:47,870 --> 00:51:50,940
- InSight has passed
through peak deceleration,

1110
00:51:50,973 --> 00:51:53,977

telemetry shows the
spacecraft at about 8 Gs.

1111
00:51:54,010 --> 00:51:56,546
- [Man] MarCO Alpha and
MarCO Bravo maintain lock.

1112
00:51:56,579 --> 00:51:59,015
- [Man] Radio science
reports carrier detected.

1113
00:52:03,819 --> 00:52:06,156
- [Gay] Several different
communications coming in.

1114
00:52:07,590 --> 00:52:08,858
- InSight is now
traveling at a velocity

1115
00:52:08,891 --> 00:52:10,927
of 2000 meters per second.

1116
00:52:14,764 --> 00:52:15,899
- [Rob] It seems to have
passed this very critical

1117
00:52:15,932 --> 00:52:18,668
point of peak heating
and peak deceleration.

1118
00:52:22,972 --> 00:52:25,075
The next big step is
parachute inflation.

1119
00:52:26,609 --> 00:52:28,611
- [Gay] You can see
that on our timeline

1120
00:52:28,644 --> 00:52:29,880
on the bottom of the screen,

1121
00:52:31,581 --> 00:52:33,983
the next event is
parachute deploy.

1122
00:52:34,016 --> 00:52:35,018
- InSight is now traveling

1123
00:52:35,051 --> 00:52:37,053
at 1000 meters per second.

1124
00:52:38,688 --> 00:52:40,990
Once InSight slows to
about 400 meters per second

1125
00:52:41,023 --> 00:52:45,795
it will deploy its 12 meter
diameter supersonic parachute,

1126
00:52:45,828 --> 00:52:48,765
the parachute will deploy
nominally at about Mach 1.7.

1127
00:52:54,604 --> 00:52:57,073
Standing by for
parachute deploy.

1128
00:53:15,992 --> 00:53:18,962
- [Man] Radio science reports
sudden change in Doppler.

1129
00:53:20,796 --> 00:53:22,098
- [Christine] Ground stations
are observing signals

1130
00:53:22,131 --> 00:53:23,967
consistent with
parachute deploy.

1131

00:53:24,000 --> 00:53:25,935
[people applaud]

1132
00:53:25,968 --> 00:53:27,036
- [Man] MarCO Alpha
and MarCO Bravo

1133
00:53:27,069 --> 00:53:28,605
maintain locked status.

1134
00:53:31,807 --> 00:53:33,743
- [Christine] Telemetry
shows parachute deployment,

1135
00:53:33,776 --> 00:53:35,111
RADAR powered on.

1136
00:53:36,646 --> 00:53:39,082
[people applaud]

1137
00:53:41,117 --> 00:53:42,886
Heat shield
separation commanded.

1138
00:53:53,763 --> 00:53:55,765
- [Rob] This is really
good news so far.

1139
00:53:56,699 --> 00:53:57,601
- [Gay] It's fantastic.

1140
00:53:59,568 --> 00:54:00,904
- [Rob] I'm on pins and needles.

1141
00:54:04,907 --> 00:54:06,576
- We have RADAR activation

1142
00:54:06,609 --> 00:54:09,078
where the RADAR is beginning

to search for the ground,

1143
00:54:09,111 --> 00:54:11,748
once the RADAR
locks on the ground,

1144
00:54:11,781 --> 00:54:13,750
and InSight is about one
kilometer above the surface,

1145
00:54:13,783 --> 00:54:15,985
the lander will separate
from the back shell

1146
00:54:16,018 --> 00:54:19,956
and begin terminal descent
using its 12 descent engines.

1147
00:54:47,750 --> 00:54:50,086
Altitude convergence, the
RADAR has locked on the ground.

1148
00:54:50,119 --> 00:54:52,956
[people applaud]

1149
00:54:55,057 --> 00:54:57,093
Standing by for the
lander separation.

1150
00:54:57,126 --> 00:54:58,795
- [Man] Carrier interruption

1151
00:54:58,828 --> 00:54:59,929
on MarCO Alpha and MarCO Bravo.

1152
00:55:03,966 --> 00:55:05,935
- [Christine] Lander
separation commanded,

1153

00:55:05,968 --> 00:55:07,771
altitude 600 meters.

1154
00:55:08,871 --> 00:55:12,575
Gravity turn,
altitude 400 meters.

1155
00:55:12,608 --> 00:55:13,810
- [Rob] We're getting there.

1156
00:55:13,843 --> 00:55:15,011
- 300 meters.

1157
00:55:18,881 --> 00:55:19,983
200 meters.

1158
00:55:22,017 --> 00:55:23,786
80 meters.

1159
00:55:23,819 --> 00:55:25,622
60 meters.

1160
00:55:27,089 --> 00:55:29,892
50 meters, constant velocity,

1161
00:55:29,925 --> 00:55:31,127
37 meters,

1162
00:55:32,094 --> 00:55:33,896
30 meters,

1163
00:55:33,929 --> 00:55:34,964
20 meters,

1164
00:55:35,965 --> 00:55:36,866
17 meters,

1165
00:55:36,899 --> 00:55:38,134

standing by for touchdown.

1166
00:55:52,615 --> 00:55:54,050
Touchdown confirmed.

1167
00:55:54,083 --> 00:55:57,821
[people cheer and applaud]

1168
00:56:16,605 --> 00:56:18,675
- [Gay] That's fantastic.

1169
00:56:21,076 --> 00:56:22,044
- [Rob] This never gets old.

1170
00:56:22,077 --> 00:56:24,147
- [Gay] No it doesn't Rob,

1171
00:56:27,016 --> 00:56:29,052
the control room just erupted.

1172
00:56:32,588 --> 00:56:33,689
- [Rob] Fabulous, fabulous.

1173
00:56:33,722 --> 00:56:35,625
- [Gay] Command of
the MarCO team there.

1174
00:56:36,725 --> 00:56:38,694
- [Rob] The MarCO
team did great,

1175
00:56:38,727 --> 00:56:40,897
Ted Reising, one of the
key designers of Lockheed.

1176
00:56:43,065 --> 00:56:44,634
Sandy Krasner,

1177

00:56:44,667 --> 00:56:45,702
they are a great team.

1178
00:56:51,006 --> 00:56:52,842
This is really fabulous.

1179
00:56:52,875 --> 00:56:53,977
- [Gay] Fantastic news.

1180
00:57:00,049 --> 00:57:03,953
- [Rob] [laughs] Thank you.

1181
00:57:03,986 --> 00:57:06,623
- [Gay] Lots of fist
pumping going on in there.

1182
00:57:08,023 --> 00:57:09,692
What a relief,

1183
00:57:09,725 --> 00:57:13,730
we have cut over to the
camera over in Times Square,

1184
00:57:14,830 --> 00:57:16,900
people are weathering
the rain to see this.

1185
00:57:34,617 --> 00:57:35,785
[people cheering]

1186
00:57:35,818 --> 00:57:37,987
- [Rob] They can't help it.

1187
00:57:58,707 --> 00:57:59,775
This is the hardest part,

1188
00:57:59,808 --> 00:58:00,943
getting to the
surface and landing,

1189
00:58:00,976 --> 00:58:03,680
this thing has a lot
more to do though,

1190
00:58:05,114 --> 00:58:07,817
there's a lot more
to go on both today

1191
00:58:07,850 --> 00:58:11,787
and the days that follow
before the science can begin,

1192
00:58:11,820 --> 00:58:14,991
but just getting a
vehicle from Earth

1193
00:58:15,024 --> 00:58:17,794
to the surface of
Mars is no mean feat.

1194
00:58:18,894 --> 00:58:20,129
- [Gay] And Rob, could
you talk about that,

1195
00:58:20,162 --> 00:58:23,833
just the mere accomplishment
here that we're seeing.

1196
00:58:23,866 --> 00:58:26,602
- You have to understand,

1197
00:58:26,635 --> 00:58:29,972
this vehicle is
very complicated,

1198
00:58:30,005 --> 00:58:31,941
it uses 12 engines,

1199

00:58:31,974 --> 00:58:34,977
each of those engines are
pulsed 10 times a second,

1200
00:58:35,010 --> 00:58:37,980
producing these
little tiny impulses,

1201
00:58:38,013 --> 00:58:40,049
almost like little
bullets that keep

1202
00:58:40,082 --> 00:58:42,818
the vehicle going at
a constant velocity

1203
00:58:42,851 --> 00:58:44,754
as it approaches the ground,

1204
00:58:44,787 --> 00:58:47,557
and still going over
five miles an hour,

1205
00:58:47,590 --> 00:58:49,692
so those legs feel a
fair amount of crush,

1206
00:58:49,725 --> 00:58:51,561
we still don't know the state
of the vehicle right now,

1207
00:58:51,594 --> 00:58:53,596
we need to look to make sure
there are no rocks nearby,

1208
00:58:53,629 --> 00:58:57,066
the solar panels in about five

1209
00:58:57,099 --> 00:59:00,736
to 10 minutes will

begin to open up,

1210
00:59:00,769 --> 00:59:02,004
they're waiting for
the dust to settle,

1211
00:59:02,037 --> 00:59:05,675
because there is certainly
a lot of dust being lifted

1212
00:59:05,708 --> 00:59:07,577
in the air around the
vehicle right now,

1213
00:59:07,610 --> 00:59:09,645
which is now just settling.

1214
00:59:09,678 --> 00:59:10,980
- [Gay] So we're standing by,

1215
00:59:12,081 --> 00:59:14,850
after touchdown
it waits a couple

1216
00:59:14,883 --> 00:59:17,587
of minutes to give
us an X-band beep,

1217
00:59:18,821 --> 00:59:20,823
so we are standing by for that,

1218
00:59:20,856 --> 00:59:22,858
it's a communication
that comes directly

1219
00:59:22,891 --> 00:59:24,594
to Earth from InSight.

1220
00:59:24,627 --> 00:59:25,795

- [Rob] Yes,

1221
00:59:25,828 --> 00:59:28,998
and it goes to the
Deep Space Network,

1222
00:59:29,031 --> 00:59:30,967
there's also something that
might be happening now,

1223
00:59:31,000 --> 00:59:32,635
if we are very lucky,

1224
00:59:32,668 --> 00:59:34,904
InSight might be able
to relay an image

1225
00:59:34,937 --> 00:59:37,540
or a partial image taken just

1226
00:59:37,573 --> 00:59:40,076
a couple of minutes
after landing,

1227
00:59:40,109 --> 00:59:43,579
so I'm standing by
hoping to see that,

1228
00:59:43,612 --> 00:59:44,847
but if that doesn't happen,

1229
00:59:44,880 --> 00:59:48,117
we'll certainly get more images
later in our Odyssey pass

1230
00:59:48,150 --> 00:59:49,652
in about five hours.

1231
00:59:49,685 --> 00:59:52,054

- [Gay] We see Bruce
Banerdt waiting for it,

1232
00:59:52,087 --> 00:59:54,557
I don't know if they see it yet.

1233
00:59:54,590 --> 00:59:55,691
- [Rob] They are waiting,

1234
00:59:55,724 --> 00:59:57,960
that's Justin Mackie
and Bruce Banerdt

1235
00:59:57,993 --> 01:00:01,664
looking carefully at the cameras
to see what they might see.

1236
01:00:01,697 --> 01:00:04,533
They're waiting for
the image to come back.

1237
01:00:04,566 --> 01:00:07,903
- [Gay] So this is the first
image from InSight itself,

1238
01:00:07,936 --> 01:00:11,907
InSight is taking a picture
with one of its two cameras,

1239
01:00:11,940 --> 01:00:15,778
it's probably a view
of what is directly

1240
01:00:15,811 --> 01:00:18,881
in front of the spacecraft,

1241
01:00:18,914 --> 01:00:20,583
right in front of the lander,

1242

01:00:20,616 --> 01:00:23,986
this is a camera that it
will be using to figure out

1243
01:00:24,019 --> 01:00:25,821
is this a good space,

1244
01:00:25,854 --> 01:00:28,658
is it a good place to
put down our instruments,

1245
01:00:28,691 --> 01:00:31,093
so it is going to take an image

1246
01:00:31,126 --> 01:00:33,996
and then send that
image to the MarCOs,

1247
01:00:34,029 --> 01:00:37,600
the MarCOs in turn will
relay it back to Earth.

1248
01:00:37,633 --> 01:00:38,934
- [Rob] That's
great, they got it.

1249
01:00:38,967 --> 01:00:41,037
[people cheer and applaud]

1250
01:00:41,070 --> 01:00:43,873
This is great, let's
see what they've got.

1251
01:00:43,906 --> 01:00:45,741
There it is.

1252
01:00:45,774 --> 01:00:47,944
- [Gay] There's the picture.

1253

01:00:55,084 --> 01:00:57,853
- [Rob] That's a good site,

1254
01:00:57,886 --> 01:00:58,954
that's not far from where

1255
01:00:58,987 --> 01:01:00,022
they'll be able to
deploy the instruments,

1256
01:01:00,055 --> 01:01:01,057
so it's great,

1257
01:01:01,090 --> 01:01:02,825
I don't see a lot of--

1258
01:01:02,858 --> 01:01:04,860
- [Gay] Let's
explain that image,

1259
01:01:04,893 --> 01:01:08,631
now this image has a
dust cover on top of it.

1260
01:01:08,664 --> 01:01:10,032
- [Man] EDL COMM, we have
lost the signal from MarCO.

1261
01:01:10,065 --> 01:01:12,868
- [Rob] You can see
potentially a lot of--

1262
01:01:12,901 --> 01:01:16,572
- [Man] Radio signs
reports loss for UHF.

1263
01:01:19,575 --> 01:01:20,976
- [Rob] So we don't know
what I'm looking at.

1264
01:01:21,009 --> 01:01:22,812
- Thank you everybody
on EDL COMM.

1265
01:01:25,614 --> 01:01:26,582
- [Man] Trusty job MarCO.

1266
01:01:26,615 --> 01:01:27,750
- [Rob] Yay, MarCO.

1267
01:01:27,783 --> 01:01:30,620
[people applaud]

1268
01:01:35,624 --> 01:01:36,826
Congratulations.

1269
01:01:39,795 --> 01:01:41,097
But there it is,

1270
01:01:41,130 --> 01:01:42,631
you can see a better view,

1271
01:01:42,664 --> 01:01:43,566
you can see that
really is debris,

1272
01:01:43,599 --> 01:01:44,667
there is the horizon back there,

1273
01:01:44,700 --> 01:01:46,102
the bluish sky,

1274
01:01:47,770 --> 01:01:49,939
that's part of the lander
deck on the front left,

1275
01:01:49,972 --> 01:01:51,107
I can't make out,

1276
01:01:51,140 --> 01:01:52,074
but it looks like
there's not a lot

1277
01:01:52,107 --> 01:01:53,642
of rocks in the field of view,

1278
01:01:53,675 --> 01:01:55,611
but those dots you see
there are very likely

1279
01:01:55,644 --> 01:01:59,849
to be dust particles
on the dust cover,

1280
01:01:59,882 --> 01:02:01,617
which will be removed.

1281
01:02:01,650 --> 01:02:04,553
- [Gay] And will get
another shot later on.

1282
01:02:04,586 --> 01:02:05,855
- [Rob] Yes.

1283
01:02:05,888 --> 01:02:08,825
And a better clearer view after
the dust cover is removed,

1284
01:02:12,594 --> 01:02:16,766
Cubesats relay
communications job is done,

1285
01:02:16,799 --> 01:02:18,033
they're now flying on,

1286
01:02:18,066 --> 01:02:20,770
they're now taking

pictures back toward Mars,

1287
01:02:20,803 --> 01:02:23,873
hopefully MRO
which flew overhead

1288
01:02:23,906 --> 01:02:27,042
might have been lucky enough
to capture the descent

1289
01:02:27,075 --> 01:02:30,546
of this InSight Lander
under its parachute,

1290
01:02:30,579 --> 01:02:33,549
while this was going on,

1291
01:02:33,582 --> 01:02:35,651
MRO was flying overhead
recording the data,

1292
01:02:35,684 --> 01:02:39,088
and also monitoring
the transactions,

1293
01:02:39,121 --> 01:02:41,690
and recording every
bit of signal it could,

1294
01:02:41,723 --> 01:02:43,659
but it also had the
ability to take a picture,

1295
01:02:43,692 --> 01:02:45,961
maybe like we did with Phoenix

1296
01:02:45,994 --> 01:02:48,798
and later for Curiosity Rover,

1297

01:02:48,831 --> 01:02:50,966
we might be able to see
the parachute inflated.

1298
01:02:50,999 --> 01:02:52,535
- [Gay] That would be fantastic,

1299
01:02:52,568 --> 01:02:55,671
we are standing by now
for that X-band beep,

1300
01:02:56,905 --> 01:03:00,877
InSight phoning home saying
I'm here, and I'm okay.

1301
01:03:03,512 --> 01:03:06,082
[crowd murmuring]

1302
01:03:39,882 --> 01:03:40,749
- [Man] Systems on InSight core,

1303
01:03:40,782 --> 01:03:42,018
the DSM and X-band.

1304
01:03:46,021 --> 01:03:48,891
- [Man] Radio science reports
X-band carrier detected.

1305
01:03:49,925 --> 01:03:52,828
[people cheer and applaud]

1306
01:03:52,861 --> 01:03:56,866
[man mumbles off microphone]

1307
01:03:56,899 --> 01:03:58,634
- [Man] Four and a half minutes

1308
01:03:58,667 --> 01:04:00,002
with InSight in nominal mode.

1309
01:04:00,035 --> 01:04:01,804
- [Woman] Copy that, thank you.

1310
01:04:03,805 --> 01:04:05,074
- [Rob] Flawless,

1311
01:04:05,107 --> 01:04:05,975
- [Gay] Perfect,

1312
01:04:06,008 --> 01:04:06,976
- [Rob] Flawless,

1313
01:04:07,009 --> 01:04:08,844
- [Gay] We've got the beep,

1314
01:04:08,877 --> 01:04:13,048
this was a perfect case
scenario in my book.

1315
01:04:13,081 --> 01:04:14,984
- [Rob] This is
what we really hoped

1316
01:04:15,017 --> 01:04:16,986
and imagined in our minds eye,

1317
01:04:17,019 --> 01:04:19,788
we spent a lot of
time visualizing

1318
01:04:19,821 --> 01:04:21,624
all these bad things can happen,

1319
01:04:21,657 --> 01:04:23,726
but sometimes things
work out in your favor.

1320

01:04:23,759 --> 01:04:24,827
And we'll look very
carefully at the data

1321
01:04:24,860 --> 01:04:28,063
and see how well it went,

1322
01:04:28,096 --> 01:04:29,865
but it certainly
looked like it was

1323
01:04:29,898 --> 01:04:31,901
a very successful
and perfect landing,

1324
01:04:31,934 --> 01:04:35,137
we'll have to see as we get
more data how well things go,

1325
01:04:36,805 --> 01:04:40,976
as the vehicle proceeds the
solar panels will be deployed,

1326
01:04:41,009 --> 01:04:42,711
hopefully were not on a tilt,

1327
01:04:42,744 --> 01:04:44,980
it doesn't look like
we are from the image,

1328
01:04:45,013 --> 01:04:48,584
but the solar panels will
be deployed safely we hope,

1329
01:04:48,617 --> 01:04:50,786
and we'll get
confirmation of that

1330
01:04:50,819 --> 01:04:53,589
around five o'clock local time

1331
01:04:53,622 --> 01:04:56,859
here in about four and a
half to five hours from now.

1332
01:04:56,892 --> 01:04:59,662
- [Gay] And this is
such a difficult feat,

1333
01:04:59,695 --> 01:05:02,498
in that because of
the one-way lag time,

1334
01:05:02,531 --> 01:05:04,967
there is no way that
any of these engineers

1335
01:05:05,000 --> 01:05:08,537
could possibly
control the vehicle,

1336
01:05:08,570 --> 01:05:12,074
it all has to be done in
commands and software.

1337
01:05:12,107 --> 01:05:13,642
- [Rob] Yes,

1338
01:05:13,675 --> 01:05:15,744
we have to train it to
do this work on its own.

1339
01:05:15,777 --> 01:05:20,549
- [Man] Radio science
reports nominal carrier

1340
01:05:20,582 --> 01:05:23,886
30 seconds past the
first acquisition,

1341
01:05:24,987 --> 01:05:26,889
so we are nominal
on the surface.

1342
01:05:28,790 --> 01:05:30,592
- [Rob] So the vehicle
is completely nominal,

1343
01:05:30,625 --> 01:05:31,794
reported nominal,

1344
01:05:31,827 --> 01:05:32,995
it's happy,

1345
01:05:33,028 --> 01:05:34,863
the lander is not complaining,

1346
01:05:34,896 --> 01:05:38,934
we had a way to tell
us if it was unhappy,

1347
01:05:38,967 --> 01:05:39,935
and it wasn't,

1348
01:05:39,968 --> 01:05:41,603
it's not unhappy,

1349
01:05:41,636 --> 01:05:43,772
it's in normal mode,

1350
01:05:43,805 --> 01:05:46,575
and so it's gonna chug
along for the rest

1351
01:05:46,608 --> 01:05:49,812
of the afternoon on Mars
and finish the activities.

1352

01:05:50,912 --> 01:05:52,548
- [Gay] Alright well Rob
I know you're anxious

1353
01:05:52,581 --> 01:05:55,551
to get in and
congratulate the crew,

1354
01:05:55,584 --> 01:05:58,620
thank you so much for sitting
here and helping us out.

1355
01:05:58,653 --> 01:06:00,556
- It was my pleasure.
- And explaining EDL.

1356
01:06:00,589 --> 01:06:01,257
- Thank you.

1357
01:06:01,290 --> 01:06:02,558
- Alright, well I'll let you go,

1358
01:06:02,591 --> 01:06:04,560
and go congratulate
your friend's.

1359
01:06:04,593 --> 01:06:06,729
- Thank you.
- Alright, take care.

1360
01:06:37,993 --> 01:06:41,597
- [Man] EDL COMM on
InSight ops recording

1361
01:06:41,630 --> 01:06:44,000
completed at 20:04:34.

1362
01:08:01,076 --> 01:08:02,678
- Alright,

1363
01:08:02,711 --> 01:08:04,980
as we had promised we said we
bring back the administrator

1364
01:08:05,013 --> 01:08:07,850
to get your take
on what was it like

1365
01:08:07,883 --> 01:08:08,984
to be in that control room,

1366
01:08:09,017 --> 01:08:09,985
Jim, what was it like?

1367
01:08:10,018 --> 01:08:11,086
- Well I'll tell you,

1368
01:08:11,119 --> 01:08:12,788
it was intense,

1369
01:08:12,821 --> 01:08:14,957
and you could feel the emotion,

1370
01:08:14,990 --> 01:08:17,960
it was very, very quiet when
it was time to be quiet,

1371
01:08:17,993 --> 01:08:21,663
and of course very
celebratory with every little

1372
01:08:21,696 --> 01:08:23,799
new piece of information
that was received,

1373
01:08:23,832 --> 01:08:25,934
it's very different being here

1374

01:08:25,967 --> 01:08:27,903
than watching it on TV by far,

1375
01:08:27,936 --> 01:08:31,707
I can tell you that for sure
now that I've experienced both,

1376
01:08:31,740 --> 01:08:32,775
and then of course,

1377
01:08:34,075 --> 01:08:35,978
what's amazing is as
soon as it was over,

1378
01:08:36,011 --> 01:08:37,746
I got a call on my cell phone,

1379
01:08:37,779 --> 01:08:40,616
and the phone number
with all zeros,

1380
01:08:40,649 --> 01:08:42,618
and whenever I get a phone
call that's all zeros

1381
01:08:42,651 --> 01:08:43,986
it's got to be
somebody important,

1382
01:08:44,019 --> 01:08:44,953
I answered it,

1383
01:08:44,986 --> 01:08:46,788
and it was the vice president,

1384
01:08:46,821 --> 01:08:48,090
he watched the whole thing,

1385
01:08:48,123 --> 01:08:50,792

he is absolutely ecstatic
about our program,

1386
01:08:50,825 --> 01:08:52,794
as you are aware,
he's the chairman

1387
01:08:52,827 --> 01:08:54,763
of the National Space Council,

1388
01:08:54,796 --> 01:08:59,001
and he's been of course a
keen advocate for what we do,

1389
01:08:59,034 --> 01:09:02,905
and to have him call within
seconds of mission success,

1390
01:09:02,938 --> 01:09:03,872
is tremendous,

1391
01:09:03,905 --> 01:09:05,741
and just so everybody knows,

1392
01:09:05,774 --> 01:09:07,776
he wants me to say
congratulations

1393
01:09:07,809 --> 01:09:08,911
to everybody here at NASA,

1394
01:09:08,944 --> 01:09:10,579
and all of our
international partners,

1395
01:09:10,612 --> 01:09:14,550
and everybody who has
contributed to this mission,

1396

01:09:14,583 --> 01:09:16,051
what an amazing day for NASA.

1397
01:09:16,084 --> 01:09:18,754
- It is an amazing
accomplishment,

1398
01:09:18,787 --> 01:09:22,591
in that this is something
that is happening millions

1399
01:09:22,624 --> 01:09:24,927
and millions and
millions of miles away,

1400
01:09:24,960 --> 01:09:26,895
and these people
are able to do it.

1401
01:09:26,928 --> 01:09:27,830
- Incredible,

1402
01:09:28,830 --> 01:09:30,032
and what's fascinating is,

1403
01:09:30,065 --> 01:09:31,667
the whole time I'm
watching it I'm thinking,

1404
01:09:31,700 --> 01:09:33,635
every milestone is something

1405
01:09:33,668 --> 01:09:35,003
that happened eight minutes ago,

1406
01:09:35,036 --> 01:09:36,838
because that's
the timelag to get

1407

01:09:36,871 --> 01:09:38,607
a signal from Mars to Earth,

1408
01:09:41,810 --> 01:09:43,579
so it's exciting,

1409
01:09:43,612 --> 01:09:45,013
but then you have to
step back and realize

1410
01:09:45,046 --> 01:09:47,716
that this has already
occurred in history,

1411
01:09:47,749 --> 01:09:49,952
so it's an unique experience,

1412
01:09:49,985 --> 01:09:54,790
incredible, just the
enthusiasm here is incredible.

1413
01:09:54,823 --> 01:09:56,858
- So what's for the future,

1414
01:09:56,891 --> 01:09:58,627
looking ahead, 2020?

1415
01:09:58,660 --> 01:10:00,596
- Well let's get
through December,

1416
01:10:00,629 --> 01:10:02,698
so for the rest,

1417
01:10:02,731 --> 01:10:04,733
we think about happening next,

1418
01:10:04,766 --> 01:10:07,636
December 3rd, we're lunching

another American astronaut

1419
01:10:08,837 --> 01:10:09,972
to the International
Space Station,

1420
01:10:10,005 --> 01:10:11,540
so that's gonna be
a big achievement,

1421
01:10:11,573 --> 01:10:12,975
and it's gonna be on a
Russian Soyuz rocket,

1422
01:10:13,008 --> 01:10:15,777
the last time we launched
a human was not successful.

1423
01:10:15,810 --> 01:10:16,678
- [Gay] That was scary.

1424
01:10:16,711 --> 01:10:17,846
- It was scary,

1425
01:10:17,879 --> 01:10:19,648
but we figured out
what the problem is,

1426
01:10:19,681 --> 01:10:21,550
we're moving forward,

1427
01:10:21,583 --> 01:10:22,884
and now we've got that
underway on December 3rd.

1428
01:10:22,917 --> 01:10:24,019
Going forward from there,

1429
01:10:24,052 --> 01:10:25,787

we're gonna get the
first science data back

1430
01:10:25,820 --> 01:10:28,757
from the Parker Solar
Probe on December 7th,

1431
01:10:28,790 --> 01:10:30,058
so that's not too
far away either,

1432
01:10:30,091 --> 01:10:33,629
and then we've got Osiris Rex,

1433
01:10:33,662 --> 01:10:34,963
that will be in orbit around

1434
01:10:34,996 --> 01:10:37,065
Benu shortly after Christmas,

1435
01:10:37,098 --> 01:10:39,701
so no shortage of
exciting things.

1436
01:10:39,734 --> 01:10:42,104
And then on January 1st,

1437
01:10:42,137 --> 01:10:44,606
we're gonna to fly the
New Horizons mission,

1438
01:10:44,639 --> 01:10:45,974
which for people
who are not aware,

1439
01:10:46,007 --> 01:10:48,944
that's the mission that
went to Pluto back in 2014,

1440

01:10:48,977 --> 01:10:53,983
give us stunning images and
data and science on Pluto,

1441
01:10:55,083 --> 01:10:57,586
and now that mission
is still going strong,

1442
01:10:57,619 --> 01:11:00,555
it's in what we call
the Kuiper Belt now,

1443
01:11:00,588 --> 01:11:03,025
which is an asteroid
belt well beyond Pluto,

1444
01:11:03,058 --> 01:11:05,594
and it's gonna be taking
images of Ultima Thule,

1445
01:11:05,627 --> 01:11:09,965
which is an object
in the Khyber belt

1446
01:11:09,998 --> 01:11:13,068
which we have never been
able to go out there

1447
01:11:13,101 --> 01:11:15,737
and take images of anything
at close range before,

1448
01:11:15,770 --> 01:11:16,872
and now we're doing it,

1449
01:11:16,905 --> 01:11:18,573
so you ask what's
happening next.

1450
01:11:18,606 --> 01:11:19,842

- I'm sorry I asked.

1451
01:11:21,009 --> 01:11:23,745
- We have right now at NASA,

1452
01:11:23,778 --> 01:11:25,814
there is more underway,

1453
01:11:25,847 --> 01:11:29,785
probably than I don't
know how many years past,

1454
01:11:29,818 --> 01:11:30,752
but it's like there's a drought,

1455
01:11:30,785 --> 01:11:31,787
and then all of a sudden there's

1456
01:11:31,820 --> 01:11:32,954
all of these
activities all at once,

1457
01:11:32,987 --> 01:11:34,089
so we're busy,

1458
01:11:34,122 --> 01:11:35,991
we're gonna be working
through the holiday,

1459
01:11:36,024 --> 01:11:38,694
but a lot of amazing
discoveries to be made,

1460
01:11:38,727 --> 01:11:39,695
and we're looking forward to it.

1461
01:11:39,728 --> 01:11:40,962
- It's so funny,

1462
01:11:40,995 --> 01:11:43,999
because our ask NASA question
you basically answered,

1463
01:11:45,066 --> 01:11:46,868
is does the success of
NASA InSight influence

1464
01:11:46,901 --> 01:11:51,740
the timeline for future
manned lunar or Mars missions?

1465
01:11:52,974 --> 01:11:54,910
- Well certainly everything
we learn about Mars

1466
01:11:54,943 --> 01:11:57,045
at this point is gonna
help us understand

1467
01:11:57,078 --> 01:11:59,648
how to do in situ
resource utilization,

1468
01:11:59,681 --> 01:12:01,917
so InSight could
actually provide

1469
01:12:01,950 --> 01:12:03,618
some really good
information about whether

1470
01:12:03,651 --> 01:12:05,721
or not there is
liquid water on Mars,

1471
01:12:05,754 --> 01:12:08,757
and maybe even where it
is and how to get to it,

1472
01:12:08,790 --> 01:12:11,560
we strongly believe that
there's liquid water

1473
01:12:11,593 --> 01:12:13,128
10 kilometers under
the surface of Mars,

1474
01:12:13,161 --> 01:12:16,665
so the key is,

1475
01:12:16,698 --> 01:12:17,933
the answer is yes,

1476
01:12:17,966 --> 01:12:19,701
the more we learn the more
we're able to achieve,

1477
01:12:19,734 --> 01:12:21,737
so to get to Mars yes.

1478
01:12:21,770 --> 01:12:23,672
But the lunar missions,

1479
01:12:23,705 --> 01:12:25,707
the president's space
first policy directive,

1480
01:12:25,740 --> 01:12:26,775
is to go to the moon,

1481
01:12:27,909 --> 01:12:28,777
to go sustainably
with international

1482
01:12:28,810 --> 01:12:29,911
and commercial partners,

1483

01:12:29,944 --> 01:12:31,079
so when we say sustainably,

1484
01:12:31,112 --> 01:12:33,048
that means we're
gonna have reusability

1485
01:12:33,081 --> 01:12:34,750
built into the system,

1486
01:12:34,783 --> 01:12:37,886
and we're gonna test and prove
technologies at the moon,

1487
01:12:37,919 --> 01:12:40,856
which ultimately we
can replicate at Mars,

1488
01:12:40,889 --> 01:12:42,624
so we're gonna retire at risk,

1489
01:12:42,657 --> 01:12:44,593
prove human physiology
at the moon,

1490
01:12:44,626 --> 01:12:46,061
which is only a
three day journey,

1491
01:12:46,094 --> 01:12:48,063
which means if
something goes wrong,

1492
01:12:48,096 --> 01:12:49,064
you can get home safely,

1493
01:12:49,097 --> 01:12:51,600
we saw that with Apollo 13,

1494

01:12:51,633 --> 01:12:54,069
but we need to use the
moon as a proving ground

1495
01:12:54,102 --> 01:12:55,837
to accelerate our path to Mars,

1496
01:12:55,870 --> 01:12:56,905
in the meantime,

1497
01:12:56,938 --> 01:12:58,073
we're doing missions
like InSight

1498
01:12:58,106 --> 01:13:00,108
to learn as much about
Mars as possible,

1499
01:13:00,141 --> 01:13:01,576
InSight is gonna help us

1500
01:13:01,609 --> 01:13:03,879
understand asteroid
impacts as well,

1501
01:13:03,912 --> 01:13:05,981
because it's got a seismometer,

1502
01:13:06,014 --> 01:13:07,749
which is gonna help us know

1503
01:13:07,782 --> 01:13:09,851
how often is Mars getting
impacted with asteroids,

1504
01:13:09,884 --> 01:13:11,753
and if we're gonna
send humans there,

1505

01:13:11,786 --> 01:13:13,054
it would be important to know,

1506
01:13:13,087 --> 01:13:16,792
if those humans are gonna
experience asteroid impacts.

1507
01:13:16,825 --> 01:13:17,959
- And that's pretty
much our goal,

1508
01:13:17,992 --> 01:13:19,694
is always learned
from our missions

1509
01:13:19,727 --> 01:13:21,563
and build upon those missions.

1510
01:13:21,596 --> 01:13:22,697
- One after another,

1511
01:13:22,730 --> 01:13:24,800
and NASA has a long
history of doing amazing

1512
01:13:24,833 --> 01:13:27,536
work in building on
its past successes,

1513
01:13:27,569 --> 01:13:28,870
and in fact its past failures.

1514
01:13:28,903 --> 01:13:30,005
- That's true.

1515
01:13:30,905 --> 01:13:32,040
- I'll tell you,

1516
01:13:32,073 --> 01:13:33,842

what an amazing time
to be at the helm

1517
01:13:33,875 --> 01:13:36,678
of this extraordinary agency.

1518
01:13:36,711 --> 01:13:38,647
- Well we are so glad that you

1519
01:13:38,680 --> 01:13:40,549
are here to share it with us,

1520
01:13:40,582 --> 01:13:41,683
thanks for joining us.

1521
01:13:41,716 --> 01:13:42,851
- Well Gay, it's
been a true pleasure.

1522
01:13:42,884 --> 01:13:44,653
- And I'm sure you
need to go in there

1523
01:13:44,686 --> 01:13:45,954
and celebrate with those folks,

1524
01:13:45,987 --> 01:13:47,656
but thank you for
stepping out for us.

1525
01:13:47,689 --> 01:13:48,924
- Absolutely, thank you so much.

1526
01:13:48,957 --> 01:13:50,025
- Alright, take care.

1527
01:13:50,058 --> 01:13:52,661
Now Mars exploration
is cool stuff,

1528
01:13:52,694 --> 01:13:55,630
but if you're not
convinced just yet,

1529
01:13:55,663 --> 01:13:58,900
just talk to the InSight
scientists and engineers,

1530
01:13:58,933 --> 01:14:01,069
no one conveys the
excitement more

1531
01:14:01,102 --> 01:14:03,905
than the people who actually
work on the mission,

1532
01:14:03,938 --> 01:14:07,642
so earlier this year the
outreach team filled up a van

1533
01:14:07,675 --> 01:14:10,579
and went to 15
Californian cities,

1534
01:14:10,612 --> 01:14:12,981
they called it the
InSight Roadshow.

1535
01:14:14,082 --> 01:14:17,085
[upbeat music]

1536
01:14:17,118 --> 01:14:20,121
- So we are here in San
Francisco at the Exploratorium,

1537
01:14:20,154 --> 01:14:23,592
and this is part of
InSight's roadshow,

1538
01:14:23,625 --> 01:14:25,794
since it's the first
inter-planetary mission

1539
01:14:25,827 --> 01:14:27,963
we've ever launched
from California,

1540
01:14:27,996 --> 01:14:31,032
we're actually doing a lot of
public engagement activities

1541
01:14:31,065 --> 01:14:32,767
along California.

1542
01:14:32,800 --> 01:14:34,536
- We're just talking
to the public,

1543
01:14:34,569 --> 01:14:36,671
and talking to them
about InSight and
getting them excited,

1544
01:14:36,704 --> 01:14:38,874
and sharing information
that they probably

1545
01:14:38,907 --> 01:14:41,643
wouldn't get just
from the website.

1546
01:14:41,676 --> 01:14:43,845
- We have Mars globes
and technical kits,

1547
01:14:43,878 --> 01:14:46,715
we have replicas of the
actual launch vehicle

1548
01:14:46,748 --> 01:14:48,950
that's gonna be taking
InSight to Mars,

1549
01:14:48,983 --> 01:14:51,720
we have a selfie
station with fun props,

1550
01:14:51,753 --> 01:14:53,021
people can take pictures.

1551
01:14:53,054 --> 01:14:56,591
Children really,
really like Mars.

1552
01:14:56,624 --> 01:14:57,792
- We have a jump station,

1553
01:14:57,825 --> 01:15:00,562
where we invite kids
to come in and jump,

1554
01:15:00,595 --> 01:15:02,497
we have a little
seismometer on the floor,

1555
01:15:02,530 --> 01:15:03,932
which measures ground motion,

1556
01:15:03,965 --> 01:15:06,735
so if students can come
and jump next to it,

1557
01:15:06,768 --> 01:15:09,070
they can actually see their
own recording on the screen,

1558
01:15:09,103 --> 01:15:11,573
and they can make

their own quake.

1559
01:15:11,606 --> 01:15:13,041
- I've had people come
to me and say this

1560
01:15:13,074 --> 01:15:15,944
is the most I've ever understood
about a space mission,

1561
01:15:15,977 --> 01:15:17,946
I'm so happy I came,

1562
01:15:17,979 --> 01:15:20,081
because now I understand
what you're doing,

1563
01:15:20,114 --> 01:15:21,716
I understand why it's important,

1564
01:15:21,749 --> 01:15:22,851
and I'm really excited.

1565
01:15:22,884 --> 01:15:24,753
- You kind of
imagine how it looks,

1566
01:15:24,786 --> 01:15:27,556
but seeing it in person
actually puts it in perspective.

1567
01:15:27,589 --> 01:15:30,559
She was able to explain
a lot of what happens,

1568
01:15:30,592 --> 01:15:32,761
the cameras, what
goes into the ground,

1569

01:15:32,794 --> 01:15:34,563
it's a great exhibit you know,

1570
01:15:34,596 --> 01:15:36,698
both for myself,
and also for kids

1571
01:15:36,731 --> 01:15:39,001
that want to learn about Mars.

1572
01:15:42,971 --> 01:15:44,739
- Okay, we want you to meet

1573
01:15:44,772 --> 01:15:47,609
another Mars
veteran here at JPL,

1574
01:15:47,642 --> 01:15:49,678
hardware director Mike Hawkins.

1575
01:15:49,711 --> 01:15:52,614
You are a mission
manager for curiosity.

1576
01:15:52,647 --> 01:15:53,915
- Absolutely,

1577
01:15:53,948 --> 01:15:55,083
I think this is the fifth
Mars mission I've worked on,

1578
01:15:55,116 --> 01:15:56,585
the fifth Mars lander,

1579
01:15:57,819 --> 01:15:59,721
so maybe we are getting
the hang of it finally.

1580
01:15:59,754 --> 01:16:01,756

- Does it ever get better,

1581
01:16:01,789 --> 01:16:02,991
does it get old,

1582
01:16:03,024 --> 01:16:04,960
is it always the same?

1583
01:16:04,993 --> 01:16:06,094
- No it doesn't,

1584
01:16:06,127 --> 01:16:07,562
I think we are just
as nervous every time,

1585
01:16:07,595 --> 01:16:08,697
the whole landing sequence,

1586
01:16:08,730 --> 01:16:10,699
it's just such a crazy time,

1587
01:16:10,732 --> 01:16:11,866
and we can't do anything,

1588
01:16:11,899 --> 01:16:12,934
it's this feeling
of helplessness

1589
01:16:12,967 --> 01:16:14,536
because the spacecraft
is on its own,

1590
01:16:14,569 --> 01:16:17,072
and everything we could
do we did a day ago,

1591
01:16:17,105 --> 01:16:20,675
and so I think you always
have that nervousness,

1592
01:16:20,708 --> 01:16:21,977
but we have confidence
in the team,

1593
01:16:22,010 --> 01:16:23,845
we have confidence in the
engineers and scientists

1594
01:16:23,878 --> 01:16:25,880
that they did everything
that they could do,

1595
01:16:25,913 --> 01:16:28,883
and you have to put
it in their hands.

1596
01:16:28,916 --> 01:16:30,819
- And it's our eighth
successful landing,

1597
01:16:30,852 --> 01:16:32,654
so we learn from this,

1598
01:16:32,687 --> 01:16:34,656
we learn a little more and we do

1599
01:16:34,689 --> 01:16:36,958
it better the next
time pretty much.

1600
01:16:36,991 --> 01:16:37,859
- Absolutely,

1601
01:16:37,892 --> 01:16:38,793
we have had one failure,

1602
01:16:38,826 --> 01:16:40,595
we learn from the failures too,

1603
01:16:40,628 --> 01:16:43,798
we learned from all the
failures from all the missions,

1604
01:16:43,831 --> 01:16:46,101
even if they are not JPL
missions or NASA missions,

1605
01:16:46,134 --> 01:16:47,669
each one of them tells
you a little something,

1606
01:16:47,702 --> 01:16:48,970
an extra test you should do,

1607
01:16:49,003 --> 01:16:51,006
an extra thing you
should guard against

1608
01:16:51,039 --> 01:16:53,108
in the Mars atmosphere
or on touchdown,

1609
01:16:53,141 --> 01:16:54,776
and so we have learned
from all of these,

1610
01:16:54,809 --> 01:16:58,079
and luckily we have recently
been very successful.

1611
01:16:58,112 --> 01:16:59,781
- And we're always
trying something new,

1612
01:16:59,814 --> 01:17:01,516
we're always trying to
learn something new,

1613
01:17:01,549 --> 01:17:02,884
we had a situation this time,

1614
01:17:02,917 --> 01:17:04,786
Odyssey couldn't be in place

1615
01:17:04,819 --> 01:17:07,689
to give us bent
pipe communications,

1616
01:17:07,722 --> 01:17:10,058
and so MarCO came about.

1617
01:17:10,091 --> 01:17:11,926
- MarCO is just a
incredible success story,

1618
01:17:11,959 --> 01:17:14,763
as you said we couldn't
have Mars Odyssey

1619
01:17:14,796 --> 01:17:15,997
do the real-time bent pipe

1620
01:17:16,030 --> 01:17:17,799
for the EDL events,

1621
01:17:18,866 --> 01:17:20,068
we would have had to
wait a couple of hours,

1622
01:17:20,101 --> 01:17:22,771
and get the replay from
Mars Reconnaissance Orbiter,

1623
01:17:22,804 --> 01:17:24,539
so we embarked on
this crazy idea

1624
01:17:24,572 --> 01:17:26,675
to build these two
little Cubesats,

1625
01:17:26,708 --> 01:17:27,876
and Cubesats or something

1626
01:17:27,909 --> 01:17:29,844
that high school kids
can build these days,

1627
01:17:29,877 --> 01:17:31,846
they go up and go
around the Earth,

1628
01:17:31,879 --> 01:17:34,849
these are the first
interplanetary Cubesats,

1629
01:17:34,882 --> 01:17:35,984
first time we've
ever sent Cubesats

1630
01:17:36,017 --> 01:17:37,852
outside the Earth's orbit,

1631
01:17:37,885 --> 01:17:39,788
and their sole purpose
was to do the relay,

1632
01:17:39,821 --> 01:17:43,591
so they had this very
cool expand planar
flat antenna there,

1633
01:17:43,624 --> 01:17:47,796
and they relayed the UHF
signals in real time for us,

1634

01:17:47,829 --> 01:17:49,798
and it was just amazing,

1635
01:17:49,831 --> 01:17:51,099
it was built by a lot
of early career folks

1636
01:17:51,132 --> 01:17:53,001
here at JPL with a little
bit of adult supervision,

1637
01:17:53,034 --> 01:17:56,071
but no the engineers just
did a fantastic job on MarCO,

1638
01:17:56,104 --> 01:17:58,873
they exceeded all of our
wildest expectations,

1639
01:17:58,906 --> 01:18:00,542
they worked perfectly,

1640
01:18:00,575 --> 01:18:01,976
we built two because we thought
maybe one will get there,

1641
01:18:02,009 --> 01:18:02,877
they both got there,

1642
01:18:02,910 --> 01:18:04,579
they both worked,

1643
01:18:04,612 --> 01:18:06,681
it's just a great tribute
to the whole MarCO team,

1644
01:18:06,714 --> 01:18:08,550
you saw them in there,

1645

01:18:08,583 --> 01:18:09,584
they had the special
black shirts,

1646
01:18:09,617 --> 01:18:10,752
just a fantastic thing,

1647
01:18:10,785 --> 01:18:12,687
and not only did it
work for this mission,

1648
01:18:12,720 --> 01:18:14,556
but I think it opens up the door

1649
01:18:14,589 --> 01:18:16,658
for more small
missions like that,

1650
01:18:16,691 --> 01:18:17,792
we could actually put cameras

1651
01:18:17,825 --> 01:18:18,893
on them and other
instruments on them,

1652
01:18:18,926 --> 01:18:20,662
they're much less expensive,

1653
01:18:20,695 --> 01:18:22,697
so there's I think
a whole new door,

1654
01:18:22,730 --> 01:18:23,832
we just opened a door to

1655
01:18:23,865 --> 01:18:25,567
a whole new class of
planetary science,

1656

01:18:25,600 --> 01:18:26,234
thanks to the MarCOs.

1657
01:18:26,268 --> 01:18:27,802
- And the Cubesats they were

1658
01:18:27,835 --> 01:18:30,939
just made with
off-the-shelf parts.

1659
01:18:30,972 --> 01:18:33,007
- Some combination of
off-the-shelf parts,

1660
01:18:33,040 --> 01:18:34,542
and some new stuff that we did,

1661
01:18:34,575 --> 01:18:35,944
we had to build the
special radio of course

1662
01:18:35,977 --> 01:18:37,779
because it has to talk to
the deep space network,

1663
01:18:37,812 --> 01:18:40,014
The antennas are a little
bit new technology,

1664
01:18:40,047 --> 01:18:42,050
but a lot of the stuff
is pretty standard stuff

1665
01:18:42,083 --> 01:18:44,853
that you could replicate
at much lower cost.

1666
01:18:44,886 --> 01:18:46,988
- So what do you think
in terms of the future

1667
01:18:47,021 --> 01:18:50,859
that other missions will be
carrying their own relays

1668
01:18:50,892 --> 01:18:54,095
and not having to depend on
a bent pipe from an orbiter?

1669
01:18:54,128 --> 01:18:55,797
- They might carry relays,

1670
01:18:55,830 --> 01:18:58,133
they might actually carry
scientific instrumentation,

1671
01:18:58,166 --> 01:18:59,834
they can do more
than just do relay,

1672
01:18:59,867 --> 01:19:00,969
they can actually take pictures,

1673
01:19:01,002 --> 01:19:02,971
they could do spectrometry,

1674
01:19:03,004 --> 01:19:04,506
they could do lots
of other stuff

1675
01:19:04,539 --> 01:19:07,742
that we would like
to do with orbiters,

1676
01:19:07,775 --> 01:19:09,577
so there's a chance we
could send them to Venus,

1677
01:19:09,610 --> 01:19:10,678

we could send them to asteroids,

1678
01:19:10,711 --> 01:19:12,080
we could send them to Mars,

1679
01:19:12,113 --> 01:19:13,615
there's lots of stuff
that we could do

1680
01:19:13,648 --> 01:19:15,083
and I think we're just
learning the capability

1681
01:19:15,116 --> 01:19:16,851
of what we could miniaturize

1682
01:19:16,884 --> 01:19:18,620
and what we could put
on these Cubesats.

1683
01:19:18,653 --> 01:19:21,890
But this is a
great first effort.

1684
01:19:21,923 --> 01:19:23,591
- Absolutely,

1685
01:19:23,624 --> 01:19:25,660
well we have one
question for you,

1686
01:19:25,693 --> 01:19:29,798
it's a social media question
from George Kay, aged nine

1687
01:19:29,831 --> 01:19:31,065
from the UK,

1688
01:19:31,098 --> 01:19:33,001

how long did it take to plan

1689
01:19:33,034 --> 01:19:35,804
and build this mission, InSight?

1690
01:19:35,837 --> 01:19:36,771
- Well that's a great question,

1691
01:19:36,804 --> 01:19:37,972
so I have two answers to that,

1692
01:19:38,005 --> 01:19:39,641
InSight itself,

1693
01:19:39,674 --> 01:19:41,609
typically our missions take,

1694
01:19:41,642 --> 01:19:43,912
from the time we start
the mission to the
time we launch it,

1695
01:19:43,945 --> 01:19:45,947
it's about four to five years,

1696
01:19:45,980 --> 01:19:47,982
in the case of InSight
two things happened.

1697
01:19:48,015 --> 01:19:50,552
One to our advantage and
one not to our advantage.

1698
01:19:50,585 --> 01:19:51,653
The first is we had a lot

1699
01:19:51,686 --> 01:19:54,122
of heritage from a
mission called Phoenix.

1700
01:19:54,155 --> 01:19:56,891
So a lot of the design
work had already been done,

1701
01:19:56,924 --> 01:19:58,760
because it was done for
this mission Phoenix,

1702
01:19:58,793 --> 01:20:00,929
and even before that
for Mars Polar Lander,

1703
01:20:00,962 --> 01:20:04,065
so a lot of the basic design
we inherited for this mission.

1704
01:20:04,098 --> 01:20:06,901
On the other hand we had
a little bit of bad luck

1705
01:20:06,934 --> 01:20:08,069
In that the instruments,

1706
01:20:08,102 --> 01:20:10,972
the seismometer is so
unbelievably precise,

1707
01:20:11,005 --> 01:20:12,974
it's so incredibly
accurate and hard to build

1708
01:20:13,007 --> 01:20:14,943
that we couldn't
quite get it ready,

1709
01:20:14,976 --> 01:20:16,778
so we're doing that in
partnership with the French

1710
01:20:16,811 --> 01:20:19,047
and a lot of other
countries in Europe,

1711
01:20:19,080 --> 01:20:22,984
including the UK and
Switzerland and other folks,

1712
01:20:23,017 --> 01:20:25,587
we couldn't quite get that
ready to go for launch,

1713
01:20:25,620 --> 01:20:27,088
so we had to actually
wait two years,

1714
01:20:27,121 --> 01:20:28,990
it took an extra two years
then because of that,

1715
01:20:29,023 --> 01:20:30,625
so Mars and the
Earth are only lined

1716
01:20:30,658 --> 01:20:32,560
up to launch about
every 26 months,

1717
01:20:32,593 --> 01:20:34,095
so we had to wait
another 26 months,

1718
01:20:34,128 --> 01:20:36,831
so that took us a
little bit longer.

1719
01:20:36,864 --> 01:20:38,132
- Well speaking of
the internationals

1720
01:20:38,165 --> 01:20:40,668
that's a perfect segue for
where we're going next,

1721
01:20:40,701 --> 01:20:41,936
throughout this program
we've been trying

1722
01:20:41,969 --> 01:20:45,073
to introduce you to the
people behind the scenes,

1723
01:20:45,106 --> 01:20:46,774
and for the InSight mission

1724
01:20:46,807 --> 01:20:49,811
it requires that we
go beyond our borders,

1725
01:20:49,844 --> 01:20:52,847
this is truly an
international mission,

1726
01:20:52,880 --> 01:20:56,050
let me introduce you
to Dominico Giardini,

1727
01:20:56,083 --> 01:20:58,052
a Swiss Italian scientist

1728
01:20:58,085 --> 01:21:01,523
who studies Earthquakes
and Marsquakes.

1729
01:22:02,049 --> 01:22:03,885
- And that partnership goes

1730
01:22:03,918 --> 01:22:06,788
far beyond individual

scientists,

1731
01:22:06,821 --> 01:22:08,556
take a look at this,

1732
01:22:08,589 --> 01:22:10,658
it is a picture
of the calibration

1733
01:22:10,691 --> 01:22:13,628
tool on the deck of
the InSight Lander,

1734
01:22:13,661 --> 01:22:16,864
it's what the team uses to
calibrate the cameras on Mars,

1735
01:22:16,897 --> 01:22:19,067
and notice the flags and logos,

1736
01:22:19,100 --> 01:22:22,670
its recognition of our
international partnerships

1737
01:22:22,703 --> 01:22:26,941
with the French Government
Space Agency CNES,

1738
01:22:26,974 --> 01:22:30,044
and also the German
Aerospace Center DLR,

1739
01:22:30,077 --> 01:22:32,580
and it is my pleasure to welcome

1740
01:22:32,613 --> 01:22:35,116
site project manager
Philippe Laudet

1741

01:22:35,149 --> 01:22:36,818
from CNES,

1742
01:22:36,851 --> 01:22:41,022
and executive board member
Hans Dittus from DLR.

1743
01:22:41,989 --> 01:22:44,759
So I can't imagine a better day,

1744
01:22:44,792 --> 01:22:47,095
what was your reaction.

1745
01:22:47,128 --> 01:22:48,997
- A really great day, yeah.

1746
01:22:49,030 --> 01:22:50,732
- So I am very enthusiastic,

1747
01:22:50,765 --> 01:22:53,134
I am very grateful for all
the people on the mission,

1748
01:22:53,167 --> 01:22:56,637
also my folk who are
going to the team,

1749
01:22:56,670 --> 01:22:58,807
the CNES team and the
science team [mumbles],

1750
01:23:00,641 --> 01:23:03,978
now we have a barebones
picture of the ground,

1751
01:23:04,011 --> 01:23:07,682
and now the work to deploy
the seismometer is beginning,

1752

01:23:07,715 --> 01:23:10,551
so a new adventure in
the best conditions,

1753
01:23:10,584 --> 01:23:11,586
thank you for that.

1754
01:23:11,619 --> 01:23:12,954
- Definitely a new adventure.

1755
01:23:12,987 --> 01:23:15,556
Hans Dittus, what
you're feeling,

1756
01:23:15,589 --> 01:23:18,793
the HP cube is on that deck,

1757
01:23:18,826 --> 01:23:20,628
it will be ready to go.

1758
01:23:20,661 --> 01:23:22,063
- Yes, now it's our job now,

1759
01:23:22,096 --> 01:23:23,798
but first the fall I'd like

1760
01:23:23,831 --> 01:23:26,667
to congratulate our
partners here in the US,

1761
01:23:26,700 --> 01:23:29,003
and this was a great day
and a great job they did,

1762
01:23:29,036 --> 01:23:30,671
it's not easy to land on Mars,

1763
01:23:30,704 --> 01:23:31,672
that's what we know,

1764
01:23:31,705 --> 01:23:33,541
and it's a dream for me as well,

1765
01:23:33,574 --> 01:23:36,611
because the first time
that we land on Mars

1766
01:23:36,644 --> 01:23:39,847
with an instrument, at least
as I has experienced it,

1767
01:23:39,880 --> 01:23:41,649
so it's a great day,

1768
01:23:41,682 --> 01:23:44,052
and it's really exciting so far,

1769
01:23:44,085 --> 01:23:46,721
now the job starts for us.

1770
01:23:46,754 --> 01:23:48,056
- Philippe you had once said,

1771
01:23:48,089 --> 01:23:50,691
you are a musician as well,

1772
01:23:50,724 --> 01:23:51,993
he plays jazz,

1773
01:23:52,026 --> 01:23:55,763
you see exploration
and music very similar,

1774
01:23:55,796 --> 01:23:57,065
how's that?

1775
01:23:57,098 --> 01:23:58,666

- Yes they are very similar,

1776
01:23:58,699 --> 01:23:59,834
because human management

1777
01:23:59,867 --> 01:24:02,703
of all that activity
is exactly the same,

1778
01:24:02,736 --> 01:24:04,806
the technique it's different,

1779
01:24:04,839 --> 01:24:07,775
you have a seismometer
or you have an orchestra,

1780
01:24:07,808 --> 01:24:09,710
but the raw theme to find

1781
01:24:09,743 --> 01:24:12,647
the best talents and things
like that are the same,

1782
01:24:12,680 --> 01:24:13,948
and to deliver on time,

1783
01:24:13,981 --> 01:24:15,083
to be ready,

1784
01:24:15,116 --> 01:24:17,018
and to have the
best performances,

1785
01:24:17,051 --> 01:24:18,653
everything is similar.

1786
01:24:18,686 --> 01:24:20,922
- And we should let people know

1787
01:24:20,955 --> 01:24:24,092
that we won't be able to
collect science right away,

1788
01:24:24,125 --> 01:24:25,660
is that correct?

1789
01:24:25,693 --> 01:24:26,828
- Yeah.

1790
01:24:26,861 --> 01:24:27,862
- We will be will be
collecting science,

1791
01:24:27,895 --> 01:24:29,664
what several months from now?

1792
01:24:30,898 --> 01:24:34,602
- The deployment is going to
take about two or three months,

1793
01:24:34,635 --> 01:24:37,538
of course we will have some
data during the deployments,

1794
01:24:37,571 --> 01:24:39,740
but the best data to
make the best science

1795
01:24:39,773 --> 01:24:43,644
will be about the
beginning of March.

1796
01:24:43,677 --> 01:24:44,712
- Alright so--

1797
01:24:45,679 --> 01:24:46,547
- So we prepared now.

1798
01:24:46,580 --> 01:24:47,582
- We prepare are now.

1799
01:24:47,615 --> 01:24:49,016
- Yeah now it's the time,

1800
01:24:49,049 --> 01:24:52,687
but it was a great job
so far also for our team,

1801
01:24:52,720 --> 01:24:53,588
and our teams,

1802
01:24:53,621 --> 01:24:54,689
all the teams,

1803
01:24:54,722 --> 01:24:56,090
and as you said it
needs a lot of people

1804
01:24:56,123 --> 01:24:59,994
to bring it up to Mars and
make a successful mission.

1805
01:25:01,061 --> 01:25:01,996
- Well I have to
say congratulations.

1806
01:25:02,029 --> 01:25:03,631
- Thank you.
- Thank you.

1807
01:25:03,664 --> 01:25:05,566
- Thank you for joining us.

1808
01:25:05,599 --> 01:25:06,901
Well here's another profile now,

1809

01:25:06,934 --> 01:25:09,003
Meet Ravi Prakash,

1810
01:25:09,036 --> 01:25:12,974
it's his job to keep
InSight healthy on Mars.

1811
01:25:13,941 --> 01:25:16,844
- We get to explore the universe

1812
01:25:16,877 --> 01:25:18,779
and see things that no
one has ever seen before,

1813
01:25:18,812 --> 01:25:20,748
my name is Ravi Prakash,

1814
01:25:20,781 --> 01:25:22,617
and my job is to keep InSight
healthy when it's on Mars.

1815
01:25:22,650 --> 01:25:25,586
InSight is the first spacecraft
that is going to go to Mars,

1816
01:25:25,619 --> 01:25:28,056
and try to understand how
rocky planets have formed.

1817
01:25:29,890 --> 01:25:33,060
A healthy InSight spacecraft
is healthy batteries,

1818
01:25:33,093 --> 01:25:34,762
we have heaters all
over our spacecraft

1819
01:25:34,795 --> 01:25:35,997
that keep our
spacecraft warm enough

1820
01:25:36,030 --> 01:25:37,966
so that it operates
the way it should.

1821
01:25:40,134 --> 01:25:41,802
We look at these things as well

1822
01:25:41,835 --> 01:25:43,771
as many other parts of our
spacecraft on a daily basis

1823
01:25:43,804 --> 01:25:45,740
to make sure we have
a successful mission.

1824
01:25:45,773 --> 01:25:47,675
There are thousands of
people working on InSight,

1825
01:25:47,708 --> 01:25:48,976
so the systems
engineers responsible

1826
01:25:49,009 --> 01:25:50,678
for understanding
how changing one part

1827
01:25:50,711 --> 01:25:52,580
of the spacecraft ripples
through the entire system,

1828
01:25:52,613 --> 01:25:54,615
and how that affects all the
other parts of the spacecraft.

1829
01:25:54,648 --> 01:25:56,717
I actually worked at
JPL for eight years,

1830
01:25:56,750 --> 01:25:57,985
and then left for
about three years

1831
01:25:58,018 --> 01:25:59,587
to work for a non-profit,

1832
01:25:59,620 --> 01:26:00,888
where I used my engineering
and design skills

1833
01:26:00,921 --> 01:26:03,491
that I learned at NASA to
help people in poverty.

1834
01:26:03,524 --> 01:26:04,792
I realize that the stuff we

1835
01:26:04,825 --> 01:26:06,861
do here impacts billions
of people around the world,

1836
01:26:06,894 --> 01:26:07,795
every single person,

1837
01:26:07,828 --> 01:26:08,896
whether they realize it

1838
01:26:08,929 --> 01:26:10,998
or not has been impacted
by NASA technology.

1839
01:26:11,031 --> 01:26:13,034
We are the next
generation of explorers.

1840
01:26:14,101 --> 01:26:17,538
- Alright let's meet
Ravi Prakash in person.

1841
01:26:17,571 --> 01:26:22,577
Ravi is in our sandbox at JPL
In Situ Instrument Laboratory,

1842
01:26:23,811 --> 01:26:27,048
and wait a minute Ravi, where
did that beard come from?

1843
01:26:27,081 --> 01:26:30,117
- Hi Gay, there were about
10 of us that decided

1844
01:26:30,150 --> 01:26:32,687
on the day we launched to
Mars that we we're gonna shave

1845
01:26:32,720 --> 01:26:33,788
and then not shave again

1846
01:26:33,821 --> 01:26:35,856
for seven months
until we land on Mars,

1847
01:26:35,889 --> 01:26:37,858
so I am extra-excited
that we landed,

1848
01:26:37,891 --> 01:26:39,860
not only because we have a
mission on the surface of Mars,

1849
01:26:39,893 --> 01:26:41,028
but I have two little girls

1850
01:26:41,061 --> 01:26:42,730
at home who love
to pull my beard,

1851

01:26:42,763 --> 01:26:44,599
so I can finally
put an end to that.

1852
01:26:44,632 --> 01:26:46,567
- Alright so Ravi help us out,

1853
01:26:46,600 --> 01:26:47,702
what happens next,

1854
01:26:47,735 --> 01:26:49,937
now clearly InSight is not out

1855
01:26:49,970 --> 01:26:51,872
of the woods just yet, correct?

1856
01:26:51,905 --> 01:26:53,107
- Yeah right,

1857
01:26:53,140 --> 01:26:54,809
so we have some very
important steps ahead of us,

1858
01:26:54,842 --> 01:26:56,611
the first is that we have
to deploy our solar arrays,

1859
01:26:56,644 --> 01:26:58,913
this is what the spacecraft
is doing right now,

1860
01:26:58,946 --> 01:27:00,581
it's deploying these
two solar arrays

1861
01:27:00,614 --> 01:27:02,516
so we get energy from the sun,

1862
01:27:02,549 --> 01:27:03,484

this is one of the
most important things

1863
01:27:03,517 --> 01:27:05,019
that we have to do right now.

1864
01:27:05,052 --> 01:27:07,088
After that, we're gonna
do a serious of checkups

1865
01:27:07,121 --> 01:27:08,823
on our spacecraft to make
sure that everything survived

1866
01:27:08,856 --> 01:27:12,560
this harrowing entry, descent
and landing onto Mars,

1867
01:27:12,593 --> 01:27:13,928
and then once that's
complete after

1868
01:27:13,961 --> 01:27:15,563
the next few days
will start deploying

1869
01:27:15,596 --> 01:27:17,064
our instruments onto
the surface of Mars.

1870
01:27:17,097 --> 01:27:18,899
- So what exactly is involved

1871
01:27:18,932 --> 01:27:21,669
with the instrument deployment?

1872
01:27:21,702 --> 01:27:23,004
- So this is the
first time we're using

1873
01:27:23,037 --> 01:27:26,907
a robotic arm to put instruments
on the surface of Mars.

1874
01:27:26,940 --> 01:27:30,044
This is a process that will
put our seismometer on Mars

1875
01:27:30,077 --> 01:27:31,746
as well as the heat flow probe,

1876
01:27:31,779 --> 01:27:33,714
and it ends up taking
about three months,

1877
01:27:33,747 --> 01:27:35,683
which sounds like
a really long time,

1878
01:27:35,716 --> 01:27:38,586
but this is because we
have to be very careful

1879
01:27:38,619 --> 01:27:40,755
and make sure everything happens
just the way it needs to,

1880
01:27:40,788 --> 01:27:41,856
unlike Earth we can't send

1881
01:27:41,889 --> 01:27:43,658
a technician if
something goes wrong,

1882
01:27:43,691 --> 01:27:45,926
and so we just want to get
it right the first time.

1883
01:27:45,959 --> 01:27:48,029

- Alright, and in our interview

1884
01:27:48,062 --> 01:27:50,131
we just heard that
we may be looking

1885
01:27:50,164 --> 01:27:53,701
at not until March
before we get science.

1886
01:27:53,734 --> 01:27:55,803
- That's right, we get some
amount of science immediately

1887
01:27:55,836 --> 01:27:57,071
as far as the
environment of Mars,

1888
01:27:57,104 --> 01:27:59,774
we get wind data,
temperature data,

1889
01:27:59,807 --> 01:28:01,042
magnetometer data,

1890
01:28:01,075 --> 01:28:03,477
but then once we start
getting seismic data,

1891
01:28:03,510 --> 01:28:05,846
that will be in the
March timeframe.

1892
01:28:05,879 --> 01:28:09,850
- And can you explain
to me Ravi, the ISL,

1893
01:28:09,883 --> 01:28:10,985
the testbed that you're at,

1894
01:28:11,018 --> 01:28:12,687
what do you do there?

1895
01:28:12,720 --> 01:28:14,655
- So this is a Martian sandbox,

1896
01:28:14,688 --> 01:28:15,856
for the past two years we've had

1897
01:28:15,889 --> 01:28:17,091
a great team that's been testing

1898
01:28:17,124 --> 01:28:18,793
deploying our instruments

1899
01:28:18,826 --> 01:28:21,095
on a variety of different
slopes and rocks,

1900
01:28:21,128 --> 01:28:22,963
now that we actually
are on Mars,

1901
01:28:22,996 --> 01:28:24,565
we're gonna transform this area

1902
01:28:24,598 --> 01:28:26,600
to look exactly like
the place we landed,

1903
01:28:26,633 --> 01:28:27,768
and test out deploying
our instruments

1904
01:28:27,801 --> 01:28:30,671
one more time before we
do it on the real thing.

1905

01:28:30,704 --> 01:28:33,607
- Alright thanks
Ravi, congratulations.

1906
01:28:33,640 --> 01:28:34,575
- Thanks so much.

1907
01:28:34,608 --> 01:28:36,544
- Now that InSight is on Mars,

1908
01:28:36,577 --> 01:28:37,678
it means some changes,

1909
01:28:37,711 --> 01:28:40,114
InSight is no longer
cruising to Mars,

1910
01:28:40,147 --> 01:28:44,685
so the team no longer needs the
cruise mission support area,

1911
01:28:44,718 --> 01:28:47,822
in a little while the team
will handover operations

1912
01:28:47,855 --> 01:28:51,959
to a new group sitting in
another JPL control room,

1913
01:28:53,060 --> 01:28:55,062
this is the Surface
Mission Support Area.

1914
01:28:55,095 --> 01:28:57,131
It's in another
building here at JPL,

1915
01:28:57,164 --> 01:28:58,833
this is where the team will

1916
01:28:58,866 --> 01:29:02,002
be operating InSight
from here on.

1917
01:29:02,035 --> 01:29:04,638
So the handover
is the final step,

1918
01:29:04,671 --> 01:29:07,942
and that will take place at
about one o'clock our time,

1919
01:29:07,975 --> 01:29:09,877
that's about a half hour away,

1920
01:29:09,910 --> 01:29:12,079
for us it's time to say goodbye,

1921
01:29:12,112 --> 01:29:14,882
our congratulations
to the InSight team,

1922
01:29:14,915 --> 01:29:17,785
and special thanks to
our EDL system engineers,

1923
01:29:17,818 --> 01:29:20,654
Christine Szalai and
Julie Wertz Chen,

1924
01:29:20,687 --> 01:29:23,657
stand by for a news
briefing on NASA TV

1925
01:29:23,690 --> 01:29:26,060
at two PM Pacific,
five PM Eastern,

1926
01:29:26,093 --> 01:29:27,962

and for those of you who want

1927
01:29:27,995 --> 01:29:31,098
the latest information
on InSight and Mars,

1928
01:29:31,131 --> 01:29:35,069
go to Mars.NASA.gov/InSight,

1929
01:29:35,102 --> 01:29:37,972
and NASA.gov/Mars,

1930
01:29:38,005 --> 01:29:41,876
and thank you all who shared
pictures on social media,

1931
01:29:41,909 --> 01:29:45,679
it was wonderful to share
this historic event with you,

1932
01:29:45,712 --> 01:29:48,649
we have some pictures for you
that we'll leave you with,

1933
01:29:48,682 --> 01:29:49,717
enjoy,