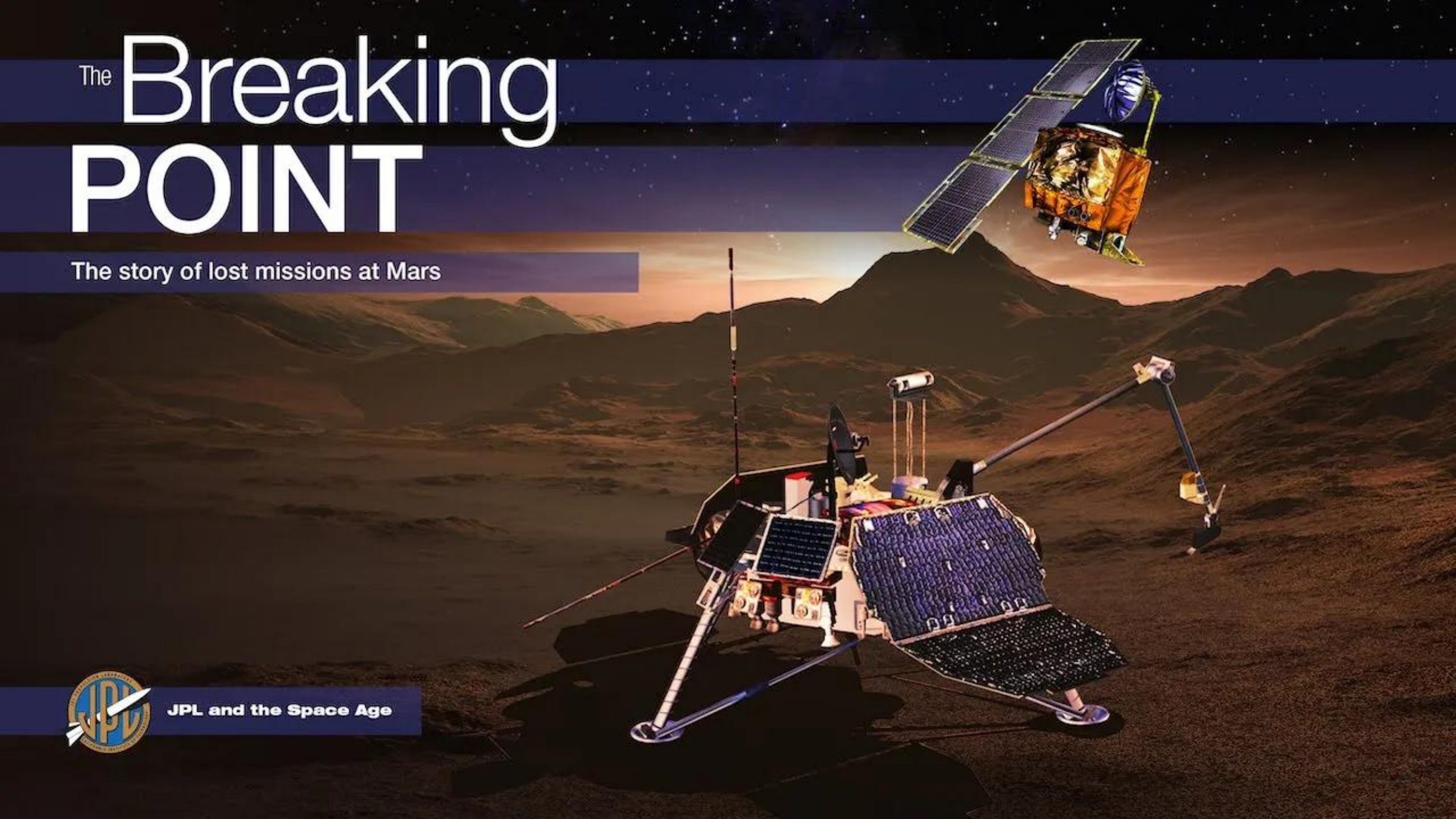
The Breaking POINT

The story of lost missions at Mars



JPL and the Space Age

1
00:00:03,075 --> 00:00:05,658
(gentle music)

2
00:00:12,980 --> 00:00:15,920
- [Man 1] I don't think
we can afford to fail.

3
00:00:15,920 --> 00:00:18,020
I don't think failure should be an option.

4
00:00:23,500 --> 00:00:26,873
- [Man 2] No. Failure has
to be part of the equation.

5
00:00:28,130 --> 00:00:32,600
You can't have stunning
science without failure.

6
00:00:32,600 --> 00:00:34,933
(whooshing)

7
00:00:39,690 --> 00:00:43,020
- [Man 3] I think the
people who have success

8
00:00:43,020 --> 00:00:45,280
without having failure,

9
00:00:45,280 --> 00:00:47,730
don't appreciate it nearly as much

10
00:00:47,730 --> 00:00:50,663
as those of us that have
lived through the failures.

11
00:00:55,000 --> 00:00:57,750
- [Man 4] The laboratory
doesn't seem to acknowledge...

12
00:00:57,750 --> 00:01:00,903
the failed missions have
kind of disappeared.

13
00:01:05,070 --> 00:01:08,060
- [Woman 1] It's interesting
when there is a loss,

14
00:01:08,060 --> 00:01:10,360
people who suddenly go away,

15
00:01:10,360 --> 00:01:12,750
who don't want to be
associated with the failure

16
00:01:12,750 --> 00:01:15,660
or who don't want to
set the record straight.

17
00:01:15,660 --> 00:01:18,443
We want to bury our losses.

18
00:01:22,560 --> 00:01:27,390
- [Man 1] I think that it's
the pain we can't accept.

19
00:01:27,390 --> 00:01:29,290
I think it's the personal anguish.

20
00:01:29,290 --> 00:01:32,530
It's the damage to the reputation.

21
00:01:32,530 --> 00:01:35,230
That fear has kept us
from being even bolder

22
00:01:35,230 --> 00:01:36,223
than we have been.

23
00:01:37,160 --> 00:01:38,693
Although we've been very bold.

24
00:01:42,170 --> 00:01:44,900
- [Man 5] We hurt ourselves
by describing the process

25
00:01:44,900 --> 00:01:47,040
in terms of winners and losers.

26
00:01:47,040 --> 00:01:49,310
- [Man 6] You don't know how
close you are to the edge.

27
00:01:49,310 --> 00:01:50,470
The output of the
successes and the failure

28
00:01:50,470 --> 00:01:52,939
is about an eighth of an inch apart.

29
00:01:52,939 --> 00:01:55,522
(gentle music)

30
00:01:57,200 --> 00:01:59,760
- [Man 7] So we stumbled.
But let's go back

31
00:01:59,760 --> 00:02:03,211
and see what we can learn
from that and try it again.

32
00:02:03,211 --> 00:02:05,794
(gentle music)

33
00:02:23,403 --> 00:02:25,128
(soft music)

34

00:02:27,237 --> 00:02:28,828
(bongos)

35
00:02:31,690 --> 00:02:33,460
- The lab's kind of a neat place to work

36
00:02:33,460 --> 00:02:38,460
because it really rewards
energetic, smart people.

37
00:02:38,924 --> 00:02:40,970
(upbeat music)

38
00:02:40,970 --> 00:02:42,020
You have people in the lab

39
00:02:42,020 --> 00:02:43,590
that have been working here a few years

40
00:02:43,590 --> 00:02:45,590
and they talk about, you know, they ask:

41
00:02:46,897 --> 00:02:48,307
"How do you advance?"

42
00:02:49,180 --> 00:02:50,860
There's two keys to success at the lab,

43
00:02:50,860 --> 00:02:52,360
really only two.

44
00:02:52,360 --> 00:02:54,433
Credibility and visibility.

45
00:02:57,970 --> 00:03:00,050
Sometimes, easily gotten,

46
00:03:00,050 --> 00:03:02,053

certainly easily lost.

47
00:03:05,690 --> 00:03:07,381
The lab's nestled in these hills.

48
00:03:07,381 --> 00:03:08,750
It's pretty, it's a big place.

49
00:03:08,750 --> 00:03:10,380
A lot of walking.

50
00:03:10,380 --> 00:03:12,890
(upbeat music)

51
00:03:12,890 --> 00:03:16,123
And you get to use these cool badges.

52
00:03:16,983 --> 00:03:19,140
(upbeat music)

53
00:03:19,140 --> 00:03:20,750
- [Narrator] In the late 1990's

54
00:03:20,750 --> 00:03:22,960
NASA's Jet Propulsion Laboratory

55
00:03:22,960 --> 00:03:24,810
was on the verge of a new era

56
00:03:24,810 --> 00:03:27,733
of exploring the solar system and beyond.

57
00:03:29,235 --> 00:03:32,380
(upbeat jazz music)

58
00:03:32,380 --> 00:03:34,280
Just ahead were six new missions,

59
00:03:34,280 --> 00:03:36,960
slated for launch in just six months.

60
00:03:36,960 --> 00:03:38,723
An unprecedented achievement.

61
00:03:40,420 --> 00:03:43,950
There were two new
spacecraft to target comets.

62
00:03:43,950 --> 00:03:46,110
One would test a new propulsion method

63
00:03:46,110 --> 00:03:48,923
that sounded right out of
an episode of Star Trek.

64
00:03:50,030 --> 00:03:52,580
While the second mission
would be capturing particles

65
00:03:52,580 --> 00:03:55,470
from a comet and bringing
them back to earth,

66
00:03:55,470 --> 00:03:57,133
something never before done.

67
00:03:58,840 --> 00:04:02,233
A space telescope would search
for the birth of galaxies.

68
00:04:04,090 --> 00:04:06,220
For our own planet, there was a satellite

69
00:04:06,220 --> 00:04:08,793
to measure wind speeds across the oceans.

70

00:04:12,910 --> 00:04:15,733
And for Mars, there were two new missions.

71
00:04:17,790 --> 00:04:20,410
The red planet became a major destination

72
00:04:20,410 --> 00:04:23,180
following the discovery of a Martian rock

73
00:04:23,180 --> 00:04:27,373
that some believed contained
fossilized microbial life.

74
00:04:28,300 --> 00:04:30,040
- Something really, really huge,

75
00:04:30,040 --> 00:04:32,380
that's going to be taking
place over the next 10 years

76
00:04:32,380 --> 00:04:35,620
as we send many missions
to the red planet.

77
00:04:35,620 --> 00:04:38,060
And usually one of the
most asked questions

78
00:04:38,060 --> 00:04:41,130
regarding Mars is, is there life on Mars?

79
00:04:41,130 --> 00:04:45,010
I think there is life out there
somewhere in the universe.

80
00:04:45,010 --> 00:04:47,860
I don't believe that we
can be the only beings

81

00:04:47,860 --> 00:04:49,250
in the universe.

82
00:04:49,250 --> 00:04:52,943
So I definitely think there's
somebody out there watching.

83
00:04:52,943 --> 00:04:55,526
(upbeat music)

84
00:04:58,407 --> 00:05:01,074
(water pouring)

85
00:05:03,970 --> 00:05:05,160
- [Narrator] These new missions

86
00:05:05,160 --> 00:05:07,940
were signs of how far director Ed Stone

87
00:05:07,940 --> 00:05:11,350
had steered JPL in a new direction.

88
00:05:11,350 --> 00:05:14,100
One that emphasized
smaller, less expensive,

89
00:05:14,100 --> 00:05:16,163
but more numerous missions.

90
00:05:17,364 --> 00:05:19,960
- I had come to believe that we had done

91
00:05:19,960 --> 00:05:22,930
the major global exploration missions

92
00:05:22,930 --> 00:05:26,960
and we really needed to
move on to a new frontier.

93
00:05:26,960 --> 00:05:29,710
And the question is what was
that frontier going to be?

94
00:05:31,670 --> 00:05:34,080
- [Narrator] The new frontier had a name:

95
00:05:34,080 --> 00:05:36,560
Faster, better, cheaper.

96
00:05:36,560 --> 00:05:39,930
It required embracing
aerospace companies as partners

97
00:05:39,930 --> 00:05:42,030
and giving work over to them.

98
00:05:42,030 --> 00:05:45,180
And agency officials were
to be viewed as customers

99
00:05:45,180 --> 00:05:47,230
to be satisfied.

100
00:05:47,230 --> 00:05:51,740
The new watch word was:
make a deal and stick to it.

101
00:05:51,740 --> 00:05:54,130
- If we're going to continue
exploring the solar system,

102
00:05:54,130 --> 00:05:57,370
our engineering challenge,
our science challenge

103
00:05:57,370 --> 00:06:01,330
is to find ways to do that at lower costs.

104
00:06:01,330 --> 00:06:02,650
- [Narrator] The changes underway

105
00:06:02,650 --> 00:06:05,340
also included staff reductions.

106
00:06:05,340 --> 00:06:08,050
Even as missions were going
out the door to industry

107
00:06:08,050 --> 00:06:11,653
that was hungry for work
following the end of the Cold War.

108
00:06:13,320 --> 00:06:17,110
- We agreed to reduce the
size of the staff at JPL

109
00:06:17,110 --> 00:06:20,980
by a thousand, over a several year period.

110
00:06:20,980 --> 00:06:23,790
Well, when that was
announced, it was a bombshell.

111
00:06:23,790 --> 00:06:27,550
The laboratory had never
voluntarily reduced the staff.

112
00:06:27,550 --> 00:06:31,650
I'd like to hear from you on,
what are you concerned about?

113
00:06:31,650 --> 00:06:33,330
What are you worried about?

114
00:06:33,330 --> 00:06:35,020
What are you fearing at this time?

115
00:06:35,020 --> 00:06:39,010
It was very difficult to explain

116
00:06:39,010 --> 00:06:40,550
or justify to the employees.

117
00:06:40,550 --> 00:06:42,960
They were concerned about their job

118
00:06:42,960 --> 00:06:45,607
and said, "Look, why are you doing this?

119
00:06:45,607 --> 00:06:47,287
"You don't have to do this.

120
00:06:47,287 --> 00:06:49,140
"My budget hasn't been cut. Why me?"

121
00:06:49,140 --> 00:06:51,310
- One of my concerns is---

122
00:06:51,310 --> 00:06:53,800
- It colored everything we tried to do.

123
00:06:53,800 --> 00:06:56,460
It was a grinding downsizing.

124
00:06:56,460 --> 00:06:58,960
You know, every year you'd
ratchet down a little more,

125
00:06:58,960 --> 00:07:00,200
a little more, a little more.

126
00:07:00,200 --> 00:07:01,950
Back in the back there.

127

00:07:01,950 --> 00:07:02,783
- What should I be doing?

128
00:07:02,783 --> 00:07:06,289
Where should I be going for
careers? Things like that.

129
00:07:06,289 --> 00:07:09,483
Are we going to build a
spacecraft or is that industry?

130
00:07:10,620 --> 00:07:13,190
Where to go and what to
look for in the future,

131
00:07:13,190 --> 00:07:15,050
is a real confusion.

132
00:07:15,050 --> 00:07:16,050
Not sure where to go with it.

133
00:07:16,050 --> 00:07:16,910
- Yeah, well, you might ask,

134
00:07:16,910 --> 00:07:20,090
what does our customer in
Washington expect of us?

135
00:07:20,090 --> 00:07:20,923
All right?

136
00:07:22,040 --> 00:07:23,784
- [Man 8] From my level I
haven't the slightest idea

137
00:07:23,784 --> 00:07:26,668
about that.
(crowd laughing)

138

00:07:26,668 --> 00:07:30,040
- [Man 9] Faster, better, cheaper.

139
00:07:30,040 --> 00:07:33,970
- Really comes back to the
basic point though, that JPL,

140
00:07:33,970 --> 00:07:35,650
the reason there is a JPL,

141
00:07:35,650 --> 00:07:37,440
the reason there is a
federally funded research

142
00:07:37,440 --> 00:07:39,600
and development center for NASA,

143
00:07:39,600 --> 00:07:42,100
is to do things nobody else can do.

144
00:07:42,100 --> 00:07:44,510
And so we have to always keep in mind

145
00:07:44,510 --> 00:07:47,660
that is really the reason we're here.

146
00:07:47,660 --> 00:07:49,860
And if industry can do it,

147
00:07:49,860 --> 00:07:53,410
then in fact it's much less appropriate

148
00:07:53,410 --> 00:07:55,400
for us to continue to do it.

149
00:07:55,400 --> 00:07:58,320
So we have to find a way
to always move forward.

150
00:07:58,320 --> 00:08:00,600
But we are certainly not
in an era where we can say,

151
00:08:00,600 --> 00:08:04,250
this is ours and
therefore we get to do it.

152
00:08:04,250 --> 00:08:07,530
In fact, we're being
encouraged very strongly

153
00:08:07,530 --> 00:08:09,470
to make sure that where we can,

154
00:08:09,470 --> 00:08:12,040
we involve the wider community.

155
00:08:12,040 --> 00:08:13,620
And that really is a challenge for us.

156
00:08:13,620 --> 00:08:15,270
'Cause that means just at the time

157
00:08:15,270 --> 00:08:17,450
we get our arms around something,

158
00:08:17,450 --> 00:08:20,157
we're told, "That's
great, go somewhere else.

159
00:08:20,157 --> 00:08:22,057
"Do something else. Do something new."

160
00:08:26,025 --> 00:08:29,520
(engine roaring)

161
00:08:29,520 --> 00:08:31,190

- [Narrator] There would
be no better example

162
00:08:31,190 --> 00:08:34,310
of doing something new than
the 4th of July landing

163
00:08:34,310 --> 00:08:36,583
on Mars in 1997.

164
00:08:36,583 --> 00:08:40,000
(pop, engine roaring)

165
00:08:40,000 --> 00:08:42,460
- [Man 10] The spacecraft
should have passed the 600 mark.

166
00:08:42,460 --> 00:08:44,824
Airbags should be inflated.

167
00:08:44,824 --> 00:08:46,720
- [Narrator] Pathfinder's airbag touchdown

168
00:08:46,720 --> 00:08:49,363
was as unconventional as it was daring.

169
00:08:50,887 --> 00:08:52,838
- [Man 11] Roger, confirm signal.

170
00:08:52,838 --> 00:08:56,755
(people cheering and clapping)

171
00:09:00,469 --> 00:09:04,777
(inspirational music)
(machine buzzing)

172
00:09:06,210 --> 00:09:09,090
- [Narrator] And after bouncing
to a halt and unfolding,

173
00:09:09,090 --> 00:09:12,220
a tiny rover had trundled off the Lander.

174
00:09:12,220 --> 00:09:14,827
The first wheels ever to roll on Mars.

175
00:09:14,827 --> 00:09:16,797
(rover buzzing)

176
00:09:16,797 --> 00:09:19,230
- It's my distinct
pleasure to present to you

177
00:09:20,230 --> 00:09:22,536
the first Rover on the surface of Mars.

178
00:09:22,536 --> 00:09:27,536
(people cheering)
(inspirational music)

179
00:09:30,690 --> 00:09:32,870
- [Narrator] The combination
of an airbag landing,

180
00:09:32,870 --> 00:09:36,400
the tiny rover and emoting
engineers and scientists

181
00:09:36,400 --> 00:09:38,160
made for something very different

182
00:09:38,160 --> 00:09:39,953
than the typical NASA mission.

183
00:09:40,820 --> 00:09:42,850
- Yeah, opening a new era of exploration,

184

00:09:42,850 --> 00:09:45,890
as in the framework of the
faster, better, cheaper,

185
00:09:45,890 --> 00:09:47,019
actually starts tonight.

186
00:09:47,019 --> 00:09:49,769
(crowd cheering)

187
00:09:53,770 --> 00:09:55,460
- [Narrator] Pathfinder
captured the hearts

188
00:09:55,460 --> 00:09:57,120
of people everywhere.

189
00:09:57,120 --> 00:09:59,580
And the mission quickly
became the poster child

190
00:09:59,580 --> 00:10:03,130
for faster, better, cheaper's
most forceful proponent,

191
00:10:03,130 --> 00:10:05,800
NASA administrator, Dan Goldin.

192
00:10:05,800 --> 00:10:06,670
- But now when you get the---

193
00:10:06,670 --> 00:10:08,940
- [Narrator] His ambition
was to darken the skies

194
00:10:08,940 --> 00:10:12,350
with inexpensive, but
innovative spacecraft.

195

00:10:12,350 --> 00:10:15,150
And should a few of
them occasionally fail,

196
00:10:15,150 --> 00:10:18,923
that, he had declared,
was an acceptable risk.

197
00:10:18,923 --> 00:10:22,840
(crowd chatting indistinctly)

198
00:10:22,840 --> 00:10:26,360
- I think all the elements
are right here at JPL.

199
00:10:26,360 --> 00:10:29,220
And I think if you have
confidence in yourselves

200
00:10:29,220 --> 00:10:32,420
to go to the cutting
edge and not be afraid,

201
00:10:32,420 --> 00:10:36,480
not be afraid of failure,
just don't be afraid,

202
00:10:36,480 --> 00:10:38,420
I think great things will happen.

203
00:10:38,420 --> 00:10:41,540
- [Narrator] Goldin's
pronouncements were always forceful,

204
00:10:41,540 --> 00:10:44,130
but they could also be contradictory.

205
00:10:44,130 --> 00:10:46,110
- It was such an exciting mission.

206
00:10:46,110 --> 00:10:49,530
It was the first mission
in the whole series

207
00:10:49,530 --> 00:10:51,870
of faster, better, cheaper.

208
00:10:51,870 --> 00:10:54,610
I really wanted that to come through.

209
00:10:54,610 --> 00:10:58,640
So I thought it would be okay
to tell them, "Don't fail."

210
00:10:58,640 --> 00:11:00,713
And I have to admit I did that.

211
00:11:02,100 --> 00:11:05,163
But I wanted to see where
the breaking point was.

212
00:11:06,170 --> 00:11:09,130
- [Narrator] Risk taking
was one Goldin message.

213
00:11:09,130 --> 00:11:10,720
There was a second one.

214
00:11:10,720 --> 00:11:12,270
What the consequences would be

215
00:11:12,270 --> 00:11:15,813
for not delivering missions
on time and on budget.

216
00:11:16,840 --> 00:11:19,740
- So he would come out and berate us

217

00:11:19,740 --> 00:11:23,850
for the old NASA policies and practices.

218
00:11:23,850 --> 00:11:26,890
- Our record of overrun is beyond belief.

219
00:11:26,890 --> 00:11:31,310
Our record of not delivering
on our promises is very open.

220
00:11:31,310 --> 00:11:32,900
And there's a sense of all we have to do

221
00:11:32,900 --> 00:11:35,720
is get it working and
launch it, all is forgiven.

222
00:11:35,720 --> 00:11:39,443
Hopeless. That will never occur again.

223
00:11:40,590 --> 00:11:45,130
And we'll cancel, the sick
chickens and we'll prioritize.

224
00:11:45,130 --> 00:11:49,023
Darwin is going to reign
supreme at NASA of the future.

225
00:11:51,160 --> 00:11:54,090
- And then he would jump
up and down with joy

226
00:11:54,090 --> 00:11:56,930
at the liberties we were taking.

227
00:11:56,930 --> 00:12:01,630
- Remember, question
authority? You've got to do it.

228

00:12:01,630 --> 00:12:04,230
And if you're afraid,
you don't belong here.

229
00:12:04,230 --> 00:12:05,470
And if we at headquarters

230
00:12:05,470 --> 00:12:08,840
or anyone forces a contract
down your throat that's stupid,

231
00:12:08,840 --> 00:12:09,673
how do they say it?

232
00:12:09,673 --> 00:12:12,270
Just say, no.
(crowd laughing)

233
00:12:12,270 --> 00:12:13,400
I'm serious about that.

234
00:12:13,400 --> 00:12:15,740
You better not take it, than take it,

235
00:12:15,740 --> 00:12:17,147
and then when a problem occurs, say,

236
00:12:17,147 --> 00:12:18,560
"I have an excuse."

237
00:12:18,560 --> 00:12:20,383
No excuses are accepted.

238
00:12:21,690 --> 00:12:23,423
Don't take shortcuts.

239
00:12:24,410 --> 00:12:26,090
And if you have got a problem, say it.

240
00:12:26,090 --> 00:12:29,803
And if you overrun more
than 15%, we cancel it.

241
00:12:30,990 --> 00:12:34,880
I want you to be sure
you understand the rules.

242
00:12:34,880 --> 00:12:37,023
This is how Darwin works.

243
00:12:37,930 --> 00:12:40,390
- This was very tense.

244
00:12:40,390 --> 00:12:43,580
And he would come here
and he would scream at us.

245
00:12:43,580 --> 00:12:45,780
You know, very, quite literally scream

246
00:12:45,780 --> 00:12:47,850
that we were not taking risks,

247
00:12:47,850 --> 00:12:50,560
that we were too conservative.

248
00:12:50,560 --> 00:12:53,847
And you know, you walk
away from that and you ask,

249
00:12:53,847 --> 00:12:55,810
"You know, I wonder if he's right?"

250
00:12:55,810 --> 00:12:59,467
A much as you're defensive,
you ask, "Was he right?"

251

00:13:04,960 --> 00:13:07,377
(soft music)

252
00:13:09,370 --> 00:13:11,140
- [Narrator] Pushing hard on JPL

253
00:13:11,140 --> 00:13:15,630
was one part of Dan Goldin's
plan to reinvent NASA.

254
00:13:15,630 --> 00:13:19,053
The Mars rock, hinting of
life elsewhere, was another.

255
00:13:20,000 --> 00:13:24,730
For America's astronauts were
seeking a new destination.

256
00:13:24,730 --> 00:13:28,360
Any first step would be to
explore Mars with robots.

257
00:13:28,360 --> 00:13:31,720
And leading that effort
at JPL was Donna Shirley,

258
00:13:31,720 --> 00:13:33,933
champion of Pathfinder's rover.

259
00:13:34,881 --> 00:13:36,420
[Faintly]- Make sure
they all fit together.

260
00:13:36,420 --> 00:13:39,130
Something happened, and
this is what happened.

261
00:13:40,210 --> 00:13:42,760
This is Allan Hills 84001.

262
00:13:42,760 --> 00:13:45,610
And it's had a huge impact. Oops.

263
00:13:45,610 --> 00:13:47,672
I don't know why I do that.
There's no orientation.

264
00:13:47,672 --> 00:13:50,590
(all laughing)

265
00:13:50,590 --> 00:13:53,280
And this is what they
think might be a life form,

266
00:13:53,280 --> 00:13:55,110
except it's a couple orders of magnitude

267
00:13:55,110 --> 00:13:57,390
smaller than anything that's
been found on the Earth.

268
00:13:57,390 --> 00:13:59,850
NASA decided, well gee,
we better start looking

269
00:13:59,850 --> 00:14:02,530
at what all this means for
the potential Mars mission.

270
00:14:02,530 --> 00:14:03,363
So there was---

271
00:14:03,363 --> 00:14:05,870
- [Narrator] What NASA wanted
was to send a steady stream

272
00:14:05,870 --> 00:14:08,360
of spacecraft to Mars.

273
00:14:08,360 --> 00:14:10,200
Orbiters, landers,

274
00:14:10,200 --> 00:14:13,600
and even missions to bring
Martian rocks back to Earth.

275
00:14:13,600 --> 00:14:15,440
All to be done cheaply.

276
00:14:15,440 --> 00:14:17,307
- The Mars exploration
program currently has

277
00:14:17,307 --> 00:14:19,480
$150 million a year.

278
00:14:19,480 --> 00:14:21,850
That's about the size of
a major motion picture.

279
00:14:21,850 --> 00:14:24,030
So you can, you know, you can
pay your $8 and go to a movie

280
00:14:24,030 --> 00:14:26,410
or you can go to Mars, whichever you like.

281
00:14:26,410 --> 00:14:28,720
- [Narrator] To cope, Shirley reorganized

282
00:14:28,720 --> 00:14:32,770
and introduced a radical new
way of conducting business.

283
00:14:32,770 --> 00:14:34,630
After building a spacecraft,

284

00:14:34,630 --> 00:14:36,450
teams would hand over the controls

285
00:14:36,450 --> 00:14:40,470
to a single centralized
group called Mars Surveyor

286
00:14:40,470 --> 00:14:43,810
that would fly all of the Mars missions.

287
00:14:43,810 --> 00:14:45,160
- The biggest problem I had

288
00:14:45,160 --> 00:14:48,510
was getting the project
managers to work together,

289
00:14:48,510 --> 00:14:53,070
because the system at JPL,
and almost every place,

290
00:14:53,070 --> 00:14:57,110
is set up so that, if your
project works, you're king.

291
00:14:57,110 --> 00:14:59,870
If your project doesn't
work, you're a goat.

292
00:14:59,870 --> 00:15:02,691
And program? What program?

293
00:15:02,691 --> 00:15:03,930
(dramatic music)

294
00:15:03,930 --> 00:15:05,320
- [Narrator] The program also called

295
00:15:05,320 --> 00:15:08,290

for using industrial partners more often.

296
00:15:08,290 --> 00:15:10,620
Strategy already well underway,

297
00:15:10,620 --> 00:15:14,770
as JPL built Pathfinder,
Lockheed Martin Space Systems

298
00:15:14,770 --> 00:15:16,840
in Denver assembled an orbiter.

299
00:15:16,840 --> 00:15:18,693
Mars Global Surveyor.

300
00:15:20,750 --> 00:15:24,950
- We had a great team
that shared the objective.

301
00:15:24,950 --> 00:15:27,070
And we were going to
make this launch on time

302
00:15:27,070 --> 00:15:29,380
and we were going to
make all the requirements

303
00:15:29,380 --> 00:15:32,180
and we were going to do it
within the cost and schedule.

304
00:15:33,140 --> 00:15:34,313
The team clicked.

305
00:15:35,340 --> 00:15:37,070
We had a good plan.

306
00:15:37,070 --> 00:15:39,193
I think we didn't deviate from the plan.

307
00:15:41,120 --> 00:15:42,630
- [Narrator] The plan for cutting costs

308
00:15:42,630 --> 00:15:45,080
included reducing the
amount of fuel needed

309
00:15:45,080 --> 00:15:47,310
to go into orbit at Mars,

310
00:15:47,310 --> 00:15:50,033
by using a daring technique
called aerobraking.

311
00:15:51,632 --> 00:15:53,250
- And that requires
using the solar arrays,

312
00:15:53,250 --> 00:15:55,750
which are on either
side of the spacecraft,

313
00:15:55,750 --> 00:15:58,530
to essentially drag through
the atmosphere of Mars,

314
00:15:58,530 --> 00:16:01,333
to gradually slow the
orbit of the spacecraft.

315
00:16:02,342 --> 00:16:04,210
(fast tempo music)

316
00:16:04,210 --> 00:16:07,070
- [Narrator] Aerobraking had
been tried only once before

317
00:16:07,070 --> 00:16:10,283

at Venus, where the atmosphere
was more predictable.

318
00:16:11,620 --> 00:16:13,460
And it had been done as an experiment

319
00:16:13,460 --> 00:16:16,410
at the end of a mission,
not the beginning.

320
00:16:16,410 --> 00:16:19,160
(engine roaring)

321
00:16:20,070 --> 00:16:22,350
But these kinds of
decisions were paying off

322
00:16:22,350 --> 00:16:23,903
in money and time.

323
00:16:25,581 --> 00:16:28,150
- You would just, almost
made your head spin

324
00:16:28,150 --> 00:16:30,353
with how rapidly the whole process worked.

325
00:16:32,410 --> 00:16:35,610
- [Narrator] Mars Global
Surveyor met its launch schedule

326
00:16:35,610 --> 00:16:38,837
and not only stayed on
budget, but gave back to NASA

327
00:16:38,837 --> 00:16:40,133
$6 million.

328
00:16:43,740 --> 00:16:44,750

- [Announcer 1] Ten

329
00:16:44,750 --> 00:16:45,810
nine

330
00:16:45,810 --> 00:16:46,810
eight

331
00:16:46,810 --> 00:16:47,850
seven

332
00:16:47,850 --> 00:16:48,910
six

333
00:16:48,910 --> 00:16:49,743
five

334
00:16:49,743 --> 00:16:50,690
four

335
00:16:50,690 --> 00:16:51,700
three

336
00:16:51,700 --> 00:16:52,740
two

337
00:16:52,740 --> 00:16:53,573
one.

338
00:16:53,573 --> 00:16:57,643
We have ignition.
(rocket boosters thundering)

339
00:16:58,696 --> 00:16:59,830
(crowd cheering)

340
00:16:59,830 --> 00:17:01,350
- [Announcer 2] And we have lift off

341
00:17:01,350 --> 00:17:03,540
of NASA's Mars Global Surveyor,

342
00:17:03,540 --> 00:17:06,837
as America begins its journey
back to the red planet.

343
00:17:06,837 --> 00:17:08,725
(rocket boosters roaring)

344
00:17:11,050 --> 00:17:14,800
(rocket boosters separating)

345
00:17:16,581 --> 00:17:17,923
(dramatic music)
(rocket boosters whooshing)

346
00:17:17,923 --> 00:17:19,950
- [Announcer 3] Separation
on all six solids.

347
00:17:19,950 --> 00:17:21,110
- [Announcer 4] Everything is continuing

348
00:17:21,110 --> 00:17:22,410
according to the timeline.

349
00:17:24,010 --> 00:17:25,060
- [Announcer 3] Main engine in.

350
00:17:25,060 --> 00:17:27,658
Vernier chamber pressures. All good.

351
00:17:27,658 --> 00:17:30,938
(rocket engine roaring)

352
00:17:30,938 --> 00:17:32,997

(whooshing)
(inspirational music)

353
00:17:35,564 --> 00:17:37,690
(engine roaring)
And we have ignition.

354
00:17:37,690 --> 00:17:40,706
We have started the second stage engine.

355
00:17:40,706 --> 00:17:44,039
(pop, then rocket engine roaring)

356
00:17:45,692 --> 00:17:48,442
(dramatic music)

357
00:17:52,430 --> 00:17:54,847
We have spin rocket ignition.

358
00:17:58,279 --> 00:18:01,543
(engine blasting)
Third stage ignition.

359
00:18:06,732 --> 00:18:08,994
(whoosh at separation)

360
00:18:10,327 --> 00:18:13,077
(dramatic music)

361
00:18:20,812 --> 00:18:23,562
(servo motors buzzing)

362
00:18:25,617 --> 00:18:26,990
- [Announcer 5] And we have confirmation

363
00:18:26,990 --> 00:18:29,200
that we have spacecraft separation.

364

00:18:29,200 --> 00:18:32,360
Mars Global Surveyor is the
first of nine US-based craft

365
00:18:32,360 --> 00:18:34,710
that will journey to Mars
over the next decade.

366
00:18:43,430 --> 00:18:44,623
- Launch was very good.

367
00:18:45,810 --> 00:18:48,320
Spacecraft came off the launch vehicle

368
00:18:48,320 --> 00:18:52,720
and we noticed that
one of the solar arrays

369
00:18:53,810 --> 00:18:58,060
didn't fold out into its normal position.

370
00:18:58,060 --> 00:19:00,720
- Good afternoon, and welcome
to the Mars Global Surveyor

371
00:19:00,720 --> 00:19:02,500
post-launch press conference.

372
00:19:02,500 --> 00:19:04,940
- About that problem, minor problem

373
00:19:04,940 --> 00:19:06,580
with one of the solar array panels,

374
00:19:06,580 --> 00:19:08,200
what is the worst case scenario?

375
00:19:08,200 --> 00:19:12,010
What happens if it doesn't

get extended further?

376
00:19:12,010 --> 00:19:14,360
What are you going to try to do to fix it?

377
00:19:14,360 --> 00:19:18,900
If you get to Mars with it like
this, do you lose anything?

378
00:19:18,900 --> 00:19:22,303
Do you lose power?
What's the ramifications?

379
00:19:23,220 --> 00:19:26,250
- The fact that we had a
crippled solar array wing

380
00:19:26,250 --> 00:19:27,880
at the very beginning of the mission,

381
00:19:27,880 --> 00:19:30,120
which was absolutely essential

382
00:19:30,120 --> 00:19:32,580
to being able to do the
aerobraking, really upped the stakes

383
00:19:32,580 --> 00:19:34,030
on figuring out what had gone wrong

384
00:19:34,030 --> 00:19:35,380
with the solar array deployment

385
00:19:35,380 --> 00:19:37,280
and trying to find a way to get it fixed.

386
00:19:39,120 --> 00:19:40,850
- [Narrator] Telemetry suggested the array

387
00:19:40,850 --> 00:19:42,873
had not latched into place.

388
00:19:43,830 --> 00:19:45,130
For the entire cruise

389
00:19:45,130 --> 00:19:47,523
the wing would slightly
sway back and forth.

390
00:19:50,700 --> 00:19:53,823
But tests on the ground
pointed to a potential fix.

391
00:19:57,000 --> 00:19:59,390
Once at Mars, it was possible

392
00:19:59,390 --> 00:20:01,030
that the pressure of aerobraking

393
00:20:01,030 --> 00:20:03,680
would provide the added
push the panel needed

394
00:20:03,680 --> 00:20:05,402
to lock into place.

395
00:20:11,973 --> 00:20:14,400
And in early September 1997

396
00:20:14,400 --> 00:20:18,930
after a journey of 300 days
and nearly 500 million miles

397
00:20:18,930 --> 00:20:22,053
Global Surveyor was bearing down on Mars.

398
00:20:24,590 --> 00:20:25,940

For orbit insertion,

399
00:20:25,940 --> 00:20:28,150
as with the cruise phase of the mission,

400
00:20:28,150 --> 00:20:32,010
assignments were split
between Pasadena and Denver.

401
00:20:32,010 --> 00:20:34,720
Lockheed Martin handled
the day to day monitoring

402
00:20:34,720 --> 00:20:36,700
and flying of the spacecraft,

403
00:20:36,700 --> 00:20:39,980
while JPL provided deep
space communications,

404
00:20:39,980 --> 00:20:43,483
navigation expertise
and overall management.

405
00:20:45,190 --> 00:20:47,430
For project manager Glenn Cunningham

406
00:20:47,430 --> 00:20:49,730
the events surrounding orbit insertion

407
00:20:49,730 --> 00:20:52,710
made for an especially anxious time.

408
00:20:52,710 --> 00:20:55,550
Four years before, at just such a moment,

409
00:20:55,550 --> 00:20:59,943
his Mars Observer spacecraft
had vanished without a trace.

410
00:21:01,223 --> 00:21:04,556
(rushing air)

411
00:21:07,449 --> 00:21:08,443
- [Announcer 6] All stations Mars Ops.

412
00:21:08,443 --> 00:21:11,310
At this time, we should
be one way light time

413
00:21:11,310 --> 00:21:12,732
from the burn start.

414
00:21:12,732 --> 00:21:16,185
(roaring)

415
00:21:16,185 --> 00:21:17,935
(engine blasting)

416
00:21:20,917 --> 00:21:22,567
- Can we switch back to the
other part for a minute?

417
00:21:22,567 --> 00:21:24,410
I want to see how far we're going

418
00:21:24,410 --> 00:21:27,372
because we're pretty close
to coming in to occultation.

419
00:21:27,372 --> 00:21:30,205
(tense music)

420
00:21:44,833 --> 00:21:47,003
FA1, this is navigation on Mars Ops.

421
00:21:49,610 --> 00:21:51,620

- [Man 12] Navigation, go ahead.

422
00:21:51,620 --> 00:21:54,100
- Going into the occultation,

423
00:21:54,100 --> 00:21:56,066
I've taken a close look
at the Doppler sequence

424
00:21:56,066 --> 00:21:58,907
and we have a Doppler
signal of minus 50 Hertz.

425
00:21:58,907 --> 00:22:01,657
(engine roaring)

426
00:22:06,660 --> 00:22:09,830
At this time the mission is
more than we have expected,

427
00:22:09,830 --> 00:22:11,520
which is a good indication that the burn

428
00:22:11,520 --> 00:22:13,890
is proceeding very close to nominal.

429
00:22:13,890 --> 00:22:16,523
Of course we won't know
until we see the other side

430
00:22:16,523 --> 00:22:18,114
of coming out of occultation,

431
00:22:18,114 --> 00:22:20,872
but right now it looks like
there's a slight underburn.

432
00:22:20,872 --> 00:22:23,622
(engine roaring)

433
00:22:26,044 --> 00:22:31,044
(roaring stops)
(music)

434
00:22:32,440 --> 00:22:34,280
- We were watching the telemetry

435
00:22:34,280 --> 00:22:36,520
and we had this computer
visualization going along.

436
00:22:36,520 --> 00:22:37,920
So as the telemetry hit the ground

437
00:22:37,920 --> 00:22:39,797
people were calling out, "Main engine on.

438
00:22:39,797 --> 00:22:41,890
"Main engine firing."

439
00:22:41,890 --> 00:22:43,800
And there's always that tense moment,

440
00:22:43,800 --> 00:22:45,696
when you come out from behind the planet.

441
00:22:45,696 --> 00:22:48,196
(tense music)

442
00:22:52,245 --> 00:22:54,032
- [Woman 2] We have a signal on The SSI.

443
00:22:54,032 --> 00:22:56,865
(people cheering)

444
00:23:06,757 --> 00:23:09,129
- [Man 13] For the first time,

we have all four station---

445
00:23:09,129 --> 00:23:10,100
- [Man 14] He's got all four station.

446
00:23:10,100 --> 00:23:13,767
- [Man 12] HC levels
are on neg. 155 to 156.

447
00:23:18,130 --> 00:23:19,927
- Celebratory peanuts here.

448
00:23:20,929 --> 00:23:21,803
All right.

449
00:23:21,803 --> 00:23:23,953
- Glenn, MOI peanuts.
- MOI peanuts. Okay.

450
00:23:24,945 --> 00:23:28,360
(people speaking indistinctly)

451
00:23:28,360 --> 00:23:29,689
- [Woman 3] Thank you.

452
00:23:29,689 --> 00:23:32,447
- [Man 15] Oh, we're dead
on the money on that one.

453
00:23:32,447 --> 00:23:33,280
All other...

454
00:23:34,452 --> 00:23:36,627
attitude control, telemetry
looks pretty good.

455
00:23:36,627 --> 00:23:38,070
(people laughing)

456
00:23:38,070 --> 00:23:39,660
Control of the space craft right now,

457
00:23:39,660 --> 00:23:42,400
[unintelligible] and body rates look good.

458
00:23:42,400 --> 00:23:45,370
So, looks like we had an excellent burn.

459
00:23:45,370 --> 00:23:46,890
- [Man 16] Go ahead, FLM.

460
00:23:46,890 --> 00:23:49,560
- Glenn, we got a healthy
spacecraft in Mars orbit,

461
00:23:49,560 --> 00:23:52,474
and we're go for aerobraking.

462
00:23:52,474 --> 00:23:54,535
- Roger, I copy of that.
Couldn't be better.

463
00:23:54,535 --> 00:23:56,863
Couldn't be better. Thank
you very, very much.

464
00:23:56,863 --> 00:23:58,723
(crowd clapping)

465
00:24:00,340 --> 00:24:01,523
So all well and good.

466
00:24:02,860 --> 00:24:03,839
We thought.

467
00:24:03,839 --> 00:24:06,339
(tense music)

468
00:24:08,490 --> 00:24:11,620
We did a couple of drag passes.

469
00:24:11,620 --> 00:24:14,883
And we noticed that the
panel moved a little bit.

470
00:24:16,210 --> 00:24:19,920
And one day the panel
moved really significantly.

471
00:24:19,920 --> 00:24:21,661
And we got really worried.

472
00:24:21,661 --> 00:24:24,710
(quiet music)

473
00:24:24,710 --> 00:24:25,717
- One of the engineers said,

474
00:24:25,717 --> 00:24:29,007
"As far as the aerodynamics
are concerned on the last pass,

475
00:24:29,007 --> 00:24:30,887
"it went past the point

476
00:24:30,887 --> 00:24:33,530
"where it should have latched into place."

477
00:24:33,530 --> 00:24:35,977
We said, "That's not physically possible

478
00:24:35,977 --> 00:24:38,950
"unless the panel is actually broken."

479
00:24:38,950 --> 00:24:42,210

And he said, "That's what the
aerodynamics are showing."

480
00:24:42,210 --> 00:24:45,227
And I said, "I need a new aerodynamicist."

481
00:24:47,510 --> 00:24:51,090
The panel was physically
bending, not just not latch,

482
00:24:51,090 --> 00:24:54,468
but it was actually out
there flopping in the wind.

483
00:24:55,660 --> 00:24:58,760
- There was a break in
one of the hinge joints.

484
00:24:58,760 --> 00:25:01,760
The risk was that it would
literally snap the spacecraft

485
00:25:01,760 --> 00:25:04,630
solar array off at that damaged point.

486
00:25:04,630 --> 00:25:07,883
So gosh, this could be, you
know, mission catastrophic.

487
00:25:09,940 --> 00:25:11,630
- [Narrator] To protect the spacecraft

488
00:25:11,630 --> 00:25:15,140
it was commanded up out of the atmosphere.

489
00:25:15,140 --> 00:25:18,250
The move bought the engineer's time

490
00:25:18,250 --> 00:25:20,623

but it also created a new problem.

491
00:25:21,950 --> 00:25:24,300
- We knew we were actually very much

492
00:25:24,300 --> 00:25:25,875
racing the clock at that point.

493
00:25:25,875 --> 00:25:27,910
We did have another gotcha.

494
00:25:27,910 --> 00:25:32,010
We realized that if we didn't
get restarted aerobraking,

495
00:25:32,010 --> 00:25:34,870
we would get to a
condition where the orbit

496
00:25:34,870 --> 00:25:39,870
around the planet would leave
us in the shadow of Mars

497
00:25:40,060 --> 00:25:43,000
for more than eight or 10 hours,

498
00:25:43,000 --> 00:25:44,760
when the spacecraft had
really only been designed

499
00:25:44,760 --> 00:25:47,203
to survive about a one
to two hour eclipse.

500
00:25:48,200 --> 00:25:49,730
- [Narrator] And if that were to happen,

501
00:25:49,730 --> 00:25:52,490
the batteries would

eventually cease charging

502
00:25:52,490 --> 00:25:56,543
and slowly, Global Surveyor
would freeze and die.

503
00:25:58,200 --> 00:26:00,000
- Good morning, and
thank you for joining us

504
00:26:00,000 --> 00:26:02,490
at the Jet Propulsion Laboratory.

505
00:26:02,490 --> 00:26:04,480
The Mars Global Surveyor spacecraft

506
00:26:04,480 --> 00:26:08,100
has been an orbit around Mars
for about two months now.

507
00:26:08,100 --> 00:26:09,960
Several members of the
team are here this morning

508
00:26:09,960 --> 00:26:12,150
to give you an update on the mission.

509
00:26:12,150 --> 00:26:17,150
- We believe that we have
identified a secondary failure

510
00:26:17,540 --> 00:26:19,070
in the solar array.

511
00:26:19,070 --> 00:26:24,070
This little model of the panel
shows you the 20 degree kink,

512
00:26:24,570 --> 00:26:29,570

so to speak, between the
yoke and the inboard panel,

513
00:26:29,630 --> 00:26:32,482
where the damper arm was caught.

514
00:26:32,482 --> 00:26:35,950
(suspenseful music)

515
00:26:35,950 --> 00:26:38,650
- [Narrator] The solar panels
were designed to swivel.

516
00:26:40,490 --> 00:26:43,340
Rotating the broken wing
might reinforce the panel

517
00:26:43,340 --> 00:26:46,482
enough to endure the
stress of aerobraking.

518
00:26:46,482 --> 00:26:49,482
(suspenseful music)

519
00:26:51,740 --> 00:26:55,030
But all of the delays had made
shambles of the orbit plots

520
00:26:55,030 --> 00:26:57,600
that had been painstakingly calculated

521
00:26:57,600 --> 00:26:59,800
based on the need of science instruments

522
00:26:59,800 --> 00:27:02,303
to see the Martian surface in daylight.

523
00:27:04,330 --> 00:27:06,040
- To do the science it was designed to do

524
00:27:06,040 --> 00:27:08,290
needed to not only get from the big orbit,

525
00:27:08,290 --> 00:27:11,340
initial capture orbit,
down to the science orbit,

526
00:27:11,340 --> 00:27:13,070
but it needed to do it in
a certain amount of time

527
00:27:13,070 --> 00:27:16,410
so that the lighting
conditions were appropriate

528
00:27:16,410 --> 00:27:18,230
for all the science instruments
that we had on board.

529
00:27:18,230 --> 00:27:19,240
If the lighting wasn't right,

530
00:27:19,240 --> 00:27:21,873
a lot of the science instruments
were not going to work.

531
00:27:23,370 --> 00:27:25,910
- [Narrator] An entirely
new sunlit orbit plan

532
00:27:25,910 --> 00:27:27,923
had to be created on the fly.

533
00:27:29,940 --> 00:27:32,550
Then slowly, the
spacecraft was dropped back

534
00:27:32,550 --> 00:27:34,243

into the Martian atmosphere.

535
00:27:35,830 --> 00:27:38,434
The crippled solar panel held.

536
00:27:38,434 --> 00:27:41,434
(suspenseful music)

537
00:27:46,410 --> 00:27:49,980
In the days that followed
came more encouraging news.

538
00:27:49,980 --> 00:27:51,633
Science discoveries.

539
00:27:53,060 --> 00:27:56,400
There were faint signs of
an ancient magnetic field

540
00:27:56,400 --> 00:27:58,560
and images of geological features

541
00:27:58,560 --> 00:28:01,510
to out-rival some of the
most spectacular places

542
00:28:01,510 --> 00:28:02,913
found on Earth.

543
00:28:06,200 --> 00:28:09,333
But there was a price to pay
in having saved the mission.

544
00:28:13,250 --> 00:28:16,850
Aerobraking was originally
scheduled for four months.

545
00:28:16,850 --> 00:28:19,553
It would now consume a year and a half.

546
00:28:20,710 --> 00:28:24,320
And that meant added strains
on budgets and people

547
00:28:24,320 --> 00:28:28,190
at a time when two more
missions were about to fly.

548
00:28:28,190 --> 00:28:30,923
They too would require urgent attention.

549
00:28:32,650 --> 00:28:36,060
And for every day that passed
on their journey to Mars

550
00:28:36,060 --> 00:28:39,230
the breaking point for
faster, better, cheaper

551
00:28:39,230 --> 00:28:41,978
drew nearer and nearer.

552
00:28:50,665 --> 00:28:53,665
(suspenseful music)

553
00:29:01,750 --> 00:29:04,620
There are many reasons
for the grip Mars has

554
00:29:04,620 --> 00:29:06,283
on the human imagination.

555
00:29:08,320 --> 00:29:10,170
Its mysteries beckon in part

556
00:29:10,170 --> 00:29:12,903
because of what our planets
have shared in common.

557
00:29:14,390 --> 00:29:18,900
In the distant past, Mars
appears to have been much warmer.

558
00:29:18,900 --> 00:29:21,140
A place where water of great quantities

559
00:29:21,140 --> 00:29:22,943
once flowed on the surface.

560
00:29:24,940 --> 00:29:27,313
But where did it go? And why?

561
00:29:28,880 --> 00:29:31,890
Some scientists think the
answers to these questions

562
00:29:31,890 --> 00:29:34,463
might be found in the Martian atmosphere.

563
00:29:35,700 --> 00:29:39,080
- All of the geologic evidence
that we see on the planet

564
00:29:39,080 --> 00:29:41,180
from early data from Mars

565
00:29:41,180 --> 00:29:44,360
suggested that it was once very wet

566
00:29:44,360 --> 00:29:47,620
and therefore apparently warm.

567
00:29:47,620 --> 00:29:51,140
Well, the atmosphere role in this story is

568
00:29:51,140 --> 00:29:53,110

well, where did the atmosphere go?

569
00:29:53,110 --> 00:29:55,900
Why is it so dry?

570
00:29:55,900 --> 00:29:58,000
Why is it so cold?

571
00:29:58,000 --> 00:30:02,040
How did the climate originally
start out as wet and warm?

572
00:30:02,040 --> 00:30:04,720
We couldn't explain that early on.

573
00:30:04,720 --> 00:30:08,160
And we couldn't understand
why the atmosphere changed

574
00:30:08,160 --> 00:30:09,670
so radically.

575
00:30:09,670 --> 00:30:11,770
How had the evolution of the planet

576
00:30:11,770 --> 00:30:13,713
got it to where it is today?

577
00:30:15,767 --> 00:30:16,900
By Dave McKittle---

578
00:30:16,900 --> 00:30:19,680
- [Narrator] Dan McCleese
devoted his science career

579
00:30:19,680 --> 00:30:22,480
to trying to answer these questions.

580

00:30:22,480 --> 00:30:24,210
He worked for more than a decade,

581
00:30:24,210 --> 00:30:26,510
for the chance to fly a science instrument

582
00:30:26,510 --> 00:30:28,500
on the Mars Observer mission.

583
00:30:28,500 --> 00:30:30,430
The spacecraft that was lost

584
00:30:30,430 --> 00:30:33,920
just before reaching Mars in 1993.

585
00:30:33,920 --> 00:30:35,150
- What those tell us---

586
00:30:35,150 --> 00:30:40,150
I knew my career and those of
all of my science colleagues

587
00:30:40,300 --> 00:30:42,403
who, some of whom I had hired

588
00:30:43,290 --> 00:30:46,570
to begin work at JPL on that experiment,

589
00:30:46,570 --> 00:30:50,593
that we were all now looking
at a very uncertain future.

590
00:30:51,700 --> 00:30:53,890
It was going to be every man for himself

591
00:30:53,890 --> 00:30:56,290
trying to get your investigation flown.

592

00:30:56,290 --> 00:30:57,790
And now the question was

593
00:30:57,790 --> 00:30:59,510
who was going to be in the lifeboat

594
00:30:59,510 --> 00:31:02,183
when it pushed off from the wreck?

595
00:31:03,750 --> 00:31:06,170
- [Narrator] McCleese had
to wait five more years

596
00:31:06,170 --> 00:31:09,290
before his life boat arrived.

597
00:31:09,290 --> 00:31:11,210
Mars Climate Orbiter was billed

598
00:31:11,210 --> 00:31:13,973
as the first interplanetary
weather satellite.

599
00:31:15,350 --> 00:31:18,930
McCleese's science instrument,
built to detect water vapor

600
00:31:18,930 --> 00:31:22,830
and carbon dioxide, was the main payload.

601
00:31:22,830 --> 00:31:26,370
It was heavy, required substantial power,

602
00:31:26,370 --> 00:31:28,410
and was highly sensitive to heat

603
00:31:28,410 --> 00:31:30,483
radiating from the spacecraft.

604
00:31:31,470 --> 00:31:33,620
All of these factors
had to be reckoned with

605
00:31:33,620 --> 00:31:36,880
by engineers designing the spacecraft.

606
00:31:36,880 --> 00:31:40,163
The result bore no resemblance
to Mars Global Surveyor.

607
00:31:42,110 --> 00:31:44,980
Climate Orbiter's shape was asymmetrical,

608
00:31:44,980 --> 00:31:47,220
having only a single solar panel,

609
00:31:47,220 --> 00:31:49,913
that was to be flown
mostly off to one side.

610
00:31:50,840 --> 00:31:52,860
It was only one of two missions

611
00:31:52,860 --> 00:31:55,690
that were to be launched in 1998,

612
00:31:55,690 --> 00:31:57,130
the reason why they are sometimes

613
00:31:57,130 --> 00:31:59,973
jointly to referred to as Mars 98.

614
00:32:03,460 --> 00:32:06,960
Mars Polar Lander was a
throwback to the 1970s

615
00:32:06,960 --> 00:32:08,970

Viking missions that used rockets

616
00:32:08,970 --> 00:32:10,863
to reach the Martian surface.

617
00:32:10,863 --> 00:32:13,696
(rocket blasting)

618
00:32:14,980 --> 00:32:17,170
The budgets for the two Viking missions

619
00:32:17,170 --> 00:32:19,793
had been more than a billion dollars.

620
00:32:21,810 --> 00:32:24,760
And even more astonishing
from a budget perspective

621
00:32:24,760 --> 00:32:29,018
was that JPL and industrial
partner Lockheed Martin

622
00:32:29,018 --> 00:32:32,450
had signed up to build and
fly these two spacecraft

623
00:32:32,450 --> 00:32:35,700
for the price of Mars Global Surveyor.

624
00:32:35,700 --> 00:32:37,575
It's commonly believed that this

625
00:32:37,575 --> 00:32:41,333
two-for-the-cost-of-one
idea originated at NASA.

626
00:32:42,970 --> 00:32:45,450
But the agency's then
associate administrator

627
00:32:45,450 --> 00:32:49,880
of space science, Wes
Huntress, calls that folklore.

628
00:32:49,880 --> 00:32:53,633
The original proposal he says
came from Lockheed Martin.

629
00:32:54,640 --> 00:32:57,520
- I was facing a decision about what to do

630
00:32:57,520 --> 00:32:59,910
for that flight opportunity.

631
00:32:59,910 --> 00:33:01,300
Are we going to do another orbiter?

632
00:33:01,300 --> 00:33:02,700
Are we going to do a lander?

633
00:33:04,120 --> 00:33:07,520
The science community was at
odds as to which they wanted.

634
00:33:07,520 --> 00:33:10,110
Some wanted an orbiter,
some wanted a lander.

635
00:33:10,110 --> 00:33:11,107
And at the time I thought,

636
00:33:11,107 --> 00:33:15,047
"Well, I've only got money
to do really one mission

637
00:33:15,047 --> 00:33:18,000
"of the cost of Mars Global Surveyor."

638
00:33:18,000 --> 00:33:21,170
So while worried about what
decision I'm going to make,

639
00:33:21,170 --> 00:33:24,253
Lockheed Martin came in
and said, "We can do two.

640
00:33:25,956 --> 00:33:28,807
"I think we can do a lander
and we can do the orbiter,

641
00:33:28,807 --> 00:33:31,337
"if we take advantage of certain ways

642
00:33:31,337 --> 00:33:33,807
"in which we build our spacecraft
and build them together,

643
00:33:33,807 --> 00:33:35,553
"you know, so we're not building
one spacecraft over here

644
00:33:35,553 --> 00:33:36,557
"and one over here.

645
00:33:36,557 --> 00:33:39,647
"If we could do some
things in construction,

646
00:33:39,647 --> 00:33:43,030
"so that we could keep
the cost down and do two."

647
00:33:43,030 --> 00:33:43,863
Sold.

648
00:33:46,350 --> 00:33:47,890
- [Narrator] Donna Shirley's reaction

649
00:33:47,890 --> 00:33:52,120
was not nearly as
enthusiastic, but JPL signed on

650
00:33:52,120 --> 00:33:55,433
knowing that if it didn't,
some other place would.

651
00:33:56,380 --> 00:33:59,750
- Here's, you can see how
crowded the schedule is.

652
00:33:59,750 --> 00:34:03,130
We are beginning to
understand how hard it is

653
00:34:03,130 --> 00:34:06,150
to turn out production line spacecraft

654
00:34:06,150 --> 00:34:07,470
on this kind of timetable,

655
00:34:07,470 --> 00:34:11,210
especially for tough jobs
like landing on Mars.

656
00:34:11,210 --> 00:34:13,090
- [Narrator] Two missions
for the cost of one

657
00:34:13,090 --> 00:34:17,330
was taking faster, better,
cheaper to an entirely new level,

658
00:34:17,330 --> 00:34:21,830
giving pause to even gung-ho
Pathfinder engineers.

659

00:34:21,830 --> 00:34:25,503
- I remember people bragging early on

660
00:34:26,510 --> 00:34:28,427
that, said, "Yeah, we're going to do two

661
00:34:28,427 --> 00:34:29,570
"for the price of one."

662
00:34:29,570 --> 00:34:34,255
And I thought, "Good God,
is that really doable?"

663
00:34:34,255 --> 00:34:36,672
(soft music)

664
00:34:37,930 --> 00:34:40,670
- [Narrator] John McNamee
was picked as overall manager

665
00:34:40,670 --> 00:34:41,980
of the two missions,

666
00:34:41,980 --> 00:34:44,723
though he had to be talked
into taking the job.

667
00:34:45,640 --> 00:34:48,610
McNamee started out his
career in construction,

668
00:34:48,610 --> 00:34:49,890
but he went back to college

669
00:34:49,890 --> 00:34:52,773
and earned a PhD in aerospace engineering.

670
00:34:53,610 --> 00:34:57,400
Early on at JPL he was

seen as an up and comer.

671
00:34:57,400 --> 00:35:00,420
He had been in charge of
mission design for Pathfinder

672
00:35:00,420 --> 00:35:02,920
and was known for his no-nonsense style

673
00:35:02,920 --> 00:35:04,873
and being a tough negotiator.

674
00:35:06,680 --> 00:35:10,040
- You can't afford to spend
time with hundreds of people

675
00:35:10,040 --> 00:35:12,390
in rooms for hours and
hours, days and days,

676
00:35:12,390 --> 00:35:14,920
trying to figure out what to do.

677
00:35:14,920 --> 00:35:16,550
You take as much data as you have.

678
00:35:16,550 --> 00:35:18,830
You make a decision
quickly and you move on.

679
00:35:18,830 --> 00:35:21,680
And you only revisit a
decision, if, you know,

680
00:35:21,680 --> 00:35:23,780
the preponderance of the evidence says

681
00:35:23,780 --> 00:35:24,930
you really screwed up.

682
00:35:24,930 --> 00:35:25,770
We certainly made someone---

683
00:35:25,770 --> 00:35:27,790
- [Narrator] To have any hopes of success

684
00:35:27,790 --> 00:35:31,150
McNamee was convinced he would
have to run an even leaner

685
00:35:31,150 --> 00:35:34,323
and meaner team than
even Pathfinder had been.

686
00:35:35,180 --> 00:35:38,360
- John McNamee took it to
an even more extreme level.

687
00:35:38,360 --> 00:35:40,280
In the sense that he's, you know,

688
00:35:40,280 --> 00:35:44,653
the JPL fingerprints on Mars
98 were relatively light.

689
00:35:45,490 --> 00:35:47,850
This was a, we're going to
let Lockheed Martin do it

690
00:35:47,850 --> 00:35:49,440
the way they want to do it.

691
00:35:49,440 --> 00:35:53,160
And that itself was a
challenge to the JPL culture,

692
00:35:53,160 --> 00:35:54,260
because like, well, what do you mean?

693
00:35:54,260 --> 00:35:57,107
We're going to not understand
what these guys are doing.

694
00:35:57,107 --> 00:35:58,840
And it's still got a JPL mission,

695
00:35:58,840 --> 00:36:01,220
why don't we have people
overseeing what they're doing?

696
00:36:01,220 --> 00:36:03,280
And John was very adamant about the fact

697
00:36:03,280 --> 00:36:05,400
that he didn't want to do that.

698
00:36:05,400 --> 00:36:06,400
He couldn't afford that,

699
00:36:06,400 --> 00:36:07,940
that the only way to accomplish this

700
00:36:07,940 --> 00:36:10,855
was to let Lockheed do it
the way they wanted to.

701
00:36:10,855 --> 00:36:13,280
(people speaking indistinctly)

702
00:36:13,280 --> 00:36:14,730
- [Narrator] This hands off approach

703
00:36:14,730 --> 00:36:18,830
was not welcomed by a
number of JPL engineers.

704

00:36:18,830 --> 00:36:21,400
Most were accustomed to
peering over the shoulders

705
00:36:21,400 --> 00:36:23,980
of contractors as part
of their responsibility

706
00:36:23,980 --> 00:36:26,440
to assure mission success.

707
00:36:26,440 --> 00:36:29,800
This cultural divide
born during Pathfinder

708
00:36:29,800 --> 00:36:32,313
continued to widen and deepen.

709
00:36:33,410 --> 00:36:35,000
- I don't know whether we were consciously

710
00:36:35,000 --> 00:36:36,340
doing it at that time

711
00:36:36,340 --> 00:36:39,900
but we really were creating
a separate culture.

712
00:36:39,900 --> 00:36:41,770
And there were two cultures.

713
00:36:41,770 --> 00:36:44,430
I can remember walking
around one day, one evening

714
00:36:44,430 --> 00:36:47,501
in building 230, I think it was.

715
00:36:47,501 --> 00:36:51,020

It was after hours and most
of the doors were locked

716
00:36:51,020 --> 00:36:52,610
and I was looking for a paper clip

717
00:36:52,610 --> 00:36:54,160
or a piece of paper or pencil.

718
00:36:54,160 --> 00:36:55,830
And I knocked on one door

719
00:36:55,830 --> 00:36:58,590
and somebody behind the door says, "Yes."

720
00:36:58,590 --> 00:37:01,860
And I said, "I need a
pencil or a paper clip."

721
00:37:01,860 --> 00:37:05,790
And the voice said, "Are you
a Martian?" I said, "No."

722
00:37:05,790 --> 00:37:07,250
And then they opened the door.

723
00:37:07,250 --> 00:37:09,060
So, I mean, there were,

724
00:37:09,060 --> 00:37:12,960
there was a group of people
that were very, very unhappy

725
00:37:12,960 --> 00:37:16,173
that this divergence was taking place.

726
00:37:18,350 --> 00:37:20,270
- [Narrator] No one understood both sides

727
00:37:20,270 --> 00:37:24,063
of JPL's cultural divide
better than John Casani.

728
00:37:24,920 --> 00:37:27,250
He had been in charge of flagship missions

729
00:37:27,250 --> 00:37:30,083
like Voyager, Galileo, and Cassini.

730
00:37:31,040 --> 00:37:33,350
But he was now encouraging
the lab to adapt

731
00:37:33,350 --> 00:37:35,253
to faster, better, cheaper.

732
00:37:36,230 --> 00:37:38,440
He was also serving on review boards

733
00:37:38,440 --> 00:37:41,653
to monitor the progress
of the Mars 98 missions.

734
00:37:43,010 --> 00:37:46,940
Casani saw serious engineering
challenges to be sure,

735
00:37:46,940 --> 00:37:48,763
but no showstoppers.

736
00:37:50,070 --> 00:37:52,990
- I honestly can't say that
I was terribly concerned

737
00:37:52,990 --> 00:37:53,823
about the mission,

738

00:37:53,823 --> 00:37:56,900
but what I didn't have a perspective of

739
00:37:56,900 --> 00:37:58,650
during that period of time

740
00:37:58,650 --> 00:38:01,690
is just how thin we were
in terms of people working

741
00:38:01,690 --> 00:38:02,523
on the project.

742
00:38:02,523 --> 00:38:05,909
Most of the work was being
done at Lockheed Martin.

743
00:38:05,909 --> 00:38:07,280
And so, you know,

744
00:38:07,280 --> 00:38:08,690
let's say you're on a review board

745
00:38:08,690 --> 00:38:10,500
and you sit in the review room.

746
00:38:10,500 --> 00:38:14,363
You don't see what is
actually is going on.

747
00:38:15,489 --> 00:38:17,860
(suspenseful music)

748
00:38:17,860 --> 00:38:20,450
- [Narrator] As for make
a deal and stick with it,

749
00:38:20,450 --> 00:38:23,950
that concept was not proving

to be a two-way street

750
00:38:23,950 --> 00:38:26,970
as NASA began adding on unanticipated,

751
00:38:26,970 --> 00:38:30,723
and from the project's
perspective, unwanted cargo.

752
00:38:31,750 --> 00:38:34,600
For the orbiter, there was
only the addition of a camera.

753
00:38:37,410 --> 00:38:39,380
But for the lander, the requirements creep

754
00:38:39,380 --> 00:38:42,602
became a source of ongoing disagreements.

755
00:38:42,602 --> 00:38:46,100
(legs snapping into place)

756
00:38:46,100 --> 00:38:49,130
First, a descent imager was added.

757
00:38:49,130 --> 00:38:51,690
Then came pressure to
include a science instrument

758
00:38:51,690 --> 00:38:52,850
from Russia.

759
00:38:52,850 --> 00:38:55,200
The gesture meant to encourage cooperation

760
00:38:55,200 --> 00:38:56,853
with a former Cold War foe.

761

00:39:00,100 --> 00:39:02,730
That was followed by
lobbying for a stowaway

762
00:39:02,730 --> 00:39:05,230
inside the Russian instrument,

763
00:39:05,230 --> 00:39:08,980
a microphone to listen
to the sounds of Mars.

764
00:39:12,540 --> 00:39:15,640
The biggest battle was
over two other hitchhikers,

765
00:39:15,640 --> 00:39:18,540
a pair of basketball sized penetrators

766
00:39:18,540 --> 00:39:22,700
that NASA viewed as a new
technology demonstration.

767
00:39:22,700 --> 00:39:25,420
They were to be released just
before the Lander's entry

768
00:39:25,420 --> 00:39:27,560
into the Martian atmosphere.

769
00:39:27,560 --> 00:39:30,460
Then they would free fall
all the way to the surface,

770
00:39:30,460 --> 00:39:34,627
hitting the ground with a
force equal to 60,000Gs.

771
00:39:40,740 --> 00:39:42,600
If still in one piece,

772
00:39:42,600 --> 00:39:45,420
the probes would search
for traces of water ice

773
00:39:45,420 --> 00:39:47,590
and serve as precursors to one day

774
00:39:47,590 --> 00:39:51,423
scattering other miniature
monitors all across Mars.

775
00:39:52,680 --> 00:39:55,500
This experiment, named Deep Space Two,

776
00:39:55,500 --> 00:39:57,893
was also assigned to JPL.

777
00:39:59,540 --> 00:40:02,780
Chosen to lead the effort was Sarah Gavit.

778
00:40:02,780 --> 00:40:05,360
- And electrical aspects of our design.

779
00:40:05,360 --> 00:40:08,320
There are a lot of challenges
in designing a system

780
00:40:08,320 --> 00:40:11,900
that will survive a crash landing.

781
00:40:11,900 --> 00:40:14,300
We started off very early on the mission

782
00:40:14,300 --> 00:40:16,584
with a very aggressive test program.

783
00:40:16,584 --> 00:40:18,917
(exploding)

784
00:40:21,350 --> 00:40:22,780
To truly have tested it,

785
00:40:22,780 --> 00:40:26,860
we probably would have
needed a thousand probes

786
00:40:26,860 --> 00:40:29,540
that you fired in, under a variety

787
00:40:29,540 --> 00:40:30,710
of environmental conditions.

788
00:40:30,710 --> 00:40:33,460
We didn't have the luxury of doing that.

789
00:40:33,460 --> 00:40:36,090
And so we did have to take some shortcuts

790
00:40:36,090 --> 00:40:37,633
in the testing area.

791
00:40:39,580 --> 00:40:41,840
- [Narrator] Deep Space
Two's breakneck schedule

792
00:40:41,840 --> 00:40:44,180
demanded making decisions about risks

793
00:40:44,180 --> 00:40:47,400
that no ordinary mission
would contemplate.

794
00:40:47,400 --> 00:40:51,300
And when this experiment was
elevated to project status

795

00:40:51,300 --> 00:40:54,233
expectations for success were raised, too.

796
00:40:55,340 --> 00:40:59,600
- Sean McNamee did not want
the Deep Space Two probes

797
00:40:59,600 --> 00:41:00,880
on his space craft.

798
00:41:00,880 --> 00:41:02,253
And I don't blame him.

799
00:41:03,320 --> 00:41:06,610
We were just going to
make his mission heavier

800
00:41:06,610 --> 00:41:08,423
and a little bit more complicated.

801
00:41:10,000 --> 00:41:12,780
- [Narrator] McNamee was
unable to keep Deep Space Two

802
00:41:12,780 --> 00:41:15,993
or most of the other add
on payloads off the Lander.

803
00:41:18,500 --> 00:41:19,820
And a year from launch

804
00:41:19,820 --> 00:41:22,530
he saw an even greater threat looming.

805
00:41:22,530 --> 00:41:25,133
This one from inside JPL.

806
00:41:26,800 --> 00:41:29,483
The centralized team that

was to fly the two spacecraft

807
00:41:29,483 --> 00:41:33,293
were still busy finishing
aerobraking for Global Surveyor.

808
00:41:34,887 --> 00:41:36,517
"Where," McNamee asked,

809
00:41:36,517 --> 00:41:39,713
"was a detailed schedule
for the new Mars missions?

810
00:41:42,147 --> 00:41:44,707
"When would staff have the
time to learn to operate

811
00:41:44,707 --> 00:41:46,227
"the two spacecraft?"

812
00:41:47,660 --> 00:41:49,990
As for the suggestion of delaying training

813
00:41:49,990 --> 00:41:53,040
until time of launch,
that McNamee declared,

814
00:41:53,040 --> 00:41:55,773
was a fatally flawed idea.

815
00:41:55,773 --> 00:41:58,190
(soft music)

816
00:41:59,680 --> 00:42:01,290
- And it was just this continual,

817
00:42:01,290 --> 00:42:03,470
what I call the death of a thousand cuts.

818
00:42:03,470 --> 00:42:05,890
And I just realized that really bad things

819
00:42:05,890 --> 00:42:08,753
were gonna happen and I
was watching people suffer.

820
00:42:09,920 --> 00:42:13,710
The program was out of control.
There was no way to fix it.

821
00:42:13,710 --> 00:42:15,200
No one would listen.

822
00:42:15,200 --> 00:42:20,200
I was so concerned about
it, that I actually retired.

823
00:42:21,200 --> 00:42:22,580
I just couldn't stand it.

824
00:42:22,580 --> 00:42:24,020
And people were killing themselves

825
00:42:24,020 --> 00:42:26,400
and they were absolutely
killing themselves

826
00:42:26,400 --> 00:42:27,733
trying to make this work.

827
00:42:29,460 --> 00:42:32,200
And so the day I made
the decision to leave

828
00:42:32,200 --> 00:42:36,310
was pretty much the
nadir of working at JPL,

829
00:42:36,310 --> 00:42:39,720
which is very sad because you
hate to go out on that note.

830
00:42:39,720 --> 00:42:42,883
But we had a great retirement
party. So that worked out.

831
00:42:44,058 --> 00:42:46,497
(crowd clapping)

832
00:42:46,497 --> 00:42:47,720
(camera clicking)

833
00:42:47,720 --> 00:42:49,730
- [Narrator] Besides
official proclamations

834
00:42:49,730 --> 00:42:52,720
of a job well done,
Shirley's retirement party

835
00:42:52,720 --> 00:42:54,230
featured humorous skits

836
00:42:54,230 --> 00:42:57,660
in keeping with the JPL
tradition of its day.

837
00:42:57,660 --> 00:42:59,710
Then as part of letting go

838
00:42:59,710 --> 00:43:03,508
Shirley began passing away
items from her office.

839
00:43:03,508 --> 00:43:07,840
- We can do that. Is Dan
McCleese around? Okay Dan.

840
00:43:07,840 --> 00:43:09,340
Now, Dan asked me for this

841
00:43:09,340 --> 00:43:11,811
and nobody wants to
call Mars more than Dan.

842
00:43:11,811 --> 00:43:14,561
(crowd laughing)

843
00:43:15,700 --> 00:43:17,010
- [Narrator] Shirley's final gift

844
00:43:17,010 --> 00:43:19,910
was a not so subtle dig
at those she believed

845
00:43:19,910 --> 00:43:22,323
still were not heeding her warnings.

846
00:43:22,323 --> 00:43:24,410
(crowd laughing)

847
00:43:24,410 --> 00:43:25,635
- It's a copy of the book

848
00:43:25,635 --> 00:43:27,150
that's only published on the internet.

849
00:43:27,150 --> 00:43:29,050
It's called "Managing Creativity",

850
00:43:29,050 --> 00:43:30,730
and I modified the title

851
00:43:30,730 --> 00:43:33,100
to "Managing Creativity, A

Practical Guide Inventing,

852
00:43:33,100 --> 00:43:34,950
Building, Producing Innovative Products"

853
00:43:34,950 --> 00:43:38,234
or, "A Prophet Is Without
Honor In Her Own Country".

854
00:43:38,234 --> 00:43:42,067
(crowd laughing and clapping)

855
00:43:44,379 --> 00:43:46,262
(suspenseful music)

856
00:43:46,262 --> 00:43:49,929
(men speaking indistinctly)

857
00:43:53,860 --> 00:43:55,040
- [Narrator] Three months later,

858
00:43:55,040 --> 00:43:58,150
Mars Climate Orbiter was
being readied for launch

859
00:43:58,150 --> 00:44:01,830
with Mars Polar Lander
scheduled right behind.

860
00:44:01,830 --> 00:44:05,600
A list of problems continued
all the way onto the pad.

861
00:44:05,600 --> 00:44:08,470
Some software had to be
loaded at the last minute

862
00:44:08,470 --> 00:44:11,120
without being put through

the full rigors of testing.

863
00:44:12,970 --> 00:44:15,710
It was a risk the project
was willing to take

864
00:44:15,710 --> 00:44:20,030
as the alternative was to
delay the mission by two years.

865
00:44:20,030 --> 00:44:21,363
- [Man 17] John, ready to go?

866
00:44:22,654 --> 00:44:24,798
- [Man 18] Please, this way.

867
00:44:24,798 --> 00:44:25,631
Good to go.

868
00:44:25,631 --> 00:44:27,630
See Chief, we've got some good weather.

869
00:44:27,630 --> 00:44:30,020
- [Narrator] A review
board of hardnosed veterans

870
00:44:30,020 --> 00:44:32,470
also delivered the verdict
that the two missions

871
00:44:32,470 --> 00:44:34,370
were ready to fly.

872
00:44:34,370 --> 00:44:38,920
The JPL-Lockheed team had done
what many thought impossible.

873
00:44:38,920 --> 00:44:42,480
They had built two spacecraft

for the price of one

874
00:44:42,480 --> 00:44:46,113
and delivered them on time and on budget.

875
00:44:48,510 --> 00:44:50,130
- For me personally, 15 years ago

876
00:44:50,130 --> 00:44:52,950
I was hammering nails
in a hundred degree heat

877
00:44:52,950 --> 00:44:54,000
on a roof in Texas.

878
00:44:54,000 --> 00:44:56,520
So I am very excited to be
doing what I'm doing right now

879
00:44:56,520 --> 00:44:57,610
as opposed to that.

880
00:44:57,610 --> 00:44:58,850
- Greg Komodi, Aviation Week.

881
00:44:58,850 --> 00:45:01,890
Kind of a broader question
on the lower cost missions.

882
00:45:01,890 --> 00:45:03,260
Are you guys going to maybe go back

883
00:45:03,260 --> 00:45:06,090
and do an operational scrub of any sort

884
00:45:06,090 --> 00:45:08,140
beyond what you would anyway?

885

00:45:08,140 --> 00:45:10,400
- I do not think spending
huge amounts of money

886
00:45:10,400 --> 00:45:12,800
necessarily guarantees success.

887
00:45:12,800 --> 00:45:14,910
And we have examples of that.

888
00:45:14,910 --> 00:45:16,070
And I think the thing to remember

889
00:45:16,070 --> 00:45:18,310
is that the complex
nature of this business

890
00:45:18,310 --> 00:45:20,790
sometimes does come back and
get you with little problems.

891
00:45:20,790 --> 00:45:23,040
And I said this before,

892
00:45:23,040 --> 00:45:26,790
the surprising thing is not
that we have scares or problems,

893
00:45:26,790 --> 00:45:29,683
the surprising thing is
that we have so few of them.

894
00:45:29,683 --> 00:45:31,233
It's a very difficult business.

895
00:45:33,158 --> 00:45:34,787
- [Announcer 7] RTO report.
Ready to go for launch.

896

00:45:34,787 --> 00:45:36,377
- [Female Announcer]
Ready to go for launch.

897
00:45:36,377 --> 00:45:38,400
(rocket boosters blasting)

898
00:45:38,400 --> 00:45:39,233
- [Man 19] And we have lift off

899
00:45:39,233 --> 00:45:41,200
of NASA's Mars Climate Orbiter

900
00:45:41,200 --> 00:45:45,223
as we continue to explore the
mysteries of the red planet.

901
00:45:45,223 --> 00:45:46,442
(rocket boosters blasting)

902
00:45:46,442 --> 00:45:47,710
- [Woman 4] We have ignition.

903
00:45:47,710 --> 00:45:49,820
We have lift off of the Delta Two rocket

904
00:45:49,820 --> 00:45:51,990
carrying Mars Polar Lander

905
00:45:51,990 --> 00:45:54,565
NASA's first visit to the
red planet's southern pole.

906
00:45:54,565 --> 00:45:57,898
(rocket engine roaring)

907
00:45:58,927 --> 00:46:00,540
- [Man 20] View from the second stage

908
00:46:00,540 --> 00:46:03,623
of the Boeing Delta two vehicle.

909
00:46:04,778 --> 00:46:07,170
(people speaking indistinctly)

910
00:46:07,170 --> 00:46:09,470
- Here's the rain cloud,
we're flying through.

911
00:46:11,016 --> 00:46:15,160
(rocket engine roaring)

912
00:46:15,160 --> 00:46:17,993
- [Man 21] Pass through mach
one, coming up on max Q.

913
00:46:17,993 --> 00:46:22,993
(rocket engine roaring)
(dramatic music)

914
00:46:23,090 --> 00:46:25,490
Main engine, both verniers
continue to burn well.

915
00:46:25,490 --> 00:46:26,790
- [Man 22] We expect to see these boosters

916
00:46:26,790 --> 00:46:28,033
burn out in jettison.

917
00:46:30,260 --> 00:46:31,810
We have jettison of the solids.

918
00:46:34,626 --> 00:46:35,640
(rocket engine roaring)

919
00:46:35,640 --> 00:46:37,410

Again, a beautiful view
from the second stage

920
00:46:37,410 --> 00:46:38,493
of the Delta vehicle.

921
00:46:40,772 --> 00:46:42,430
(rocket engine roaring)

922
00:46:42,430 --> 00:46:43,263
And we have main engine cutoff.

923
00:46:43,263 --> 00:46:44,550
- [Man 23] Main engine is cutoff.

924
00:46:46,200 --> 00:46:47,120
- [Man 24] The progress of launch

925
00:46:47,120 --> 00:46:49,576
everything continues to
go right on schedule.

926
00:46:49,576 --> 00:46:52,326
(dramatic music)

927
00:46:53,340 --> 00:46:55,902
No issues or concerns are
being addressed at this time.

928
00:46:55,902 --> 00:46:58,652
(dramatic music)

929
00:47:11,770 --> 00:47:14,187
(soft music)

930
00:47:19,770 --> 00:47:21,380
- [Narrator] Four months after the launch

931

00:47:21,380 --> 00:47:23,960
of the two Mars 98 missions

932
00:47:23,960 --> 00:47:27,610
an elated Ed Stone
presided over JPL's annual

933
00:47:27,610 --> 00:47:29,623
State of the Lab Address.

934
00:47:30,640 --> 00:47:33,610
- Well, it's hard for me to
imagine a more exciting time

935
00:47:33,610 --> 00:47:35,800
than the era we're in right now.

936
00:47:35,800 --> 00:47:38,810
Six launches in six months.

937
00:47:38,810 --> 00:47:41,040
Never before in the laboratory's history.

938
00:47:41,040 --> 00:47:43,023
It is great. It's great.

939
00:47:43,930 --> 00:47:46,920
Well, not only are these
wonderful missions, but---

940
00:47:46,920 --> 00:47:48,050
- [Narrator] For nearly a decade,

941
00:47:48,050 --> 00:47:52,430
Stone had worked tirelessly
to adjust the culture of JPL,

942
00:47:52,430 --> 00:47:55,740
to transform the nature

of the lab's missions

943
00:47:55,740 --> 00:48:00,040
and to fundamentally alter how
the staff performed its work.

944
00:48:00,040 --> 00:48:03,540
And now all of that effort
was coming to a head.

945
00:48:03,540 --> 00:48:06,520
- I've been working at
JPL, on a part time basis

946
00:48:06,520 --> 00:48:09,050
at least, since 1972,
starting with Voyager.

947
00:48:09,050 --> 00:48:10,390
And I can't remember a time

948
00:48:10,390 --> 00:48:11,570
that's more exciting than this one.

949
00:48:11,570 --> 00:48:13,010
I really, literally cannot.

950
00:48:13,010 --> 00:48:15,860
Even though the Voyager
encounters were wonderful,

951
00:48:15,860 --> 00:48:17,220
they were spikes.

952
00:48:17,220 --> 00:48:19,523
What we have now is a continuum.

953
00:48:21,060 --> 00:48:23,840
- [Narrator] Not just two

days after his address,

954
00:48:23,840 --> 00:48:25,470
one of those six missions,

955
00:48:25,470 --> 00:48:29,840
a space telescope built by a
university partner, failed.

956
00:48:29,840 --> 00:48:33,463
An event set in motion when
its cover ejected prematurely.

957
00:48:37,060 --> 00:48:39,160
The two new missions on their way to Mars

958
00:48:39,160 --> 00:48:40,710
were struggling too.

959
00:48:40,710 --> 00:48:42,520
Both were experiencing problems

960
00:48:42,520 --> 00:48:44,570
related to sunlight conditions...

961
00:48:44,570 --> 00:48:47,020
the result of design flaws.

962
00:48:47,020 --> 00:48:49,540
The solutions required
flying the spacecraft

963
00:48:49,540 --> 00:48:52,633
in different orientations
than originally planned.

964
00:48:55,220 --> 00:48:56,140
- Oh my gosh.

965
00:48:56,140 --> 00:48:57,520
It just seemed like there was,

966
00:48:57,520 --> 00:48:58,810
it was another one of those periods

967
00:48:58,810 --> 00:49:01,660
where one thing after another went wrong.

968
00:49:01,660 --> 00:49:03,503
I mean, every day, we struggled.

969
00:49:04,810 --> 00:49:07,660
We ended up essentially putting the MCO

970
00:49:07,660 --> 00:49:09,670
in a semi-comatose state

971
00:49:09,670 --> 00:49:12,150
so we could get through the
launch of Mars Polar Lander

972
00:49:12,150 --> 00:49:13,573
and get it going okay.

973
00:49:14,720 --> 00:49:16,027
And then we said, "Okay,
then we'll come back

974
00:49:16,027 --> 00:49:19,080
"and we'll deal with the
issues that we had on MCO."

975
00:49:19,080 --> 00:49:22,183
Mars Polar Lander had its own
issues shortly after launch.

976
00:49:23,130 --> 00:49:24,750

So we coped with that.

977
00:49:24,750 --> 00:49:26,610
The spring and summer of 1999

978
00:49:26,610 --> 00:49:30,920
was like the most intense
period of my entire life.

979
00:49:30,920 --> 00:49:33,370
And I later realized that
was only the beginning.

980
00:49:34,620 --> 00:49:35,920
- [Narrator] The journey to a planet

981
00:49:35,920 --> 00:49:39,670
is usually considered the
quiet time of a mission.

982
00:49:39,670 --> 00:49:42,340
But that was not the case
for Mars Climate Orbiter

983
00:49:42,340 --> 00:49:43,757
due to its shape.

984
00:49:43,757 --> 00:49:46,174
(soft music)

985
00:49:47,360 --> 00:49:50,010
With the solar panels swung to one side

986
00:49:50,010 --> 00:49:51,860
radiation pressure from the sun

987
00:49:51,860 --> 00:49:54,763
was causing the spacecraft
to slightly rotate.

988
00:49:56,890 --> 00:49:59,140
- It was actually feeling the solar wind

989
00:49:59,140 --> 00:50:00,260
the solar radiation pressure.

990
00:50:00,260 --> 00:50:01,640
And that's kind of blowing it off course,

991
00:50:01,640 --> 00:50:04,100
a little bit like a
sailboat off to the side,

992
00:50:04,100 --> 00:50:05,020
and you have to know that.

993
00:50:05,020 --> 00:50:06,680
But of course, there's
no good way to know that.

994
00:50:06,680 --> 00:50:09,050
You have to guess what the
reflectivity is of the foil

995
00:50:09,050 --> 00:50:10,850
and how much area is shadowed

996
00:50:10,850 --> 00:50:12,603
and exactly what's going on there.

997
00:50:14,850 --> 00:50:16,820
- [Narrator] To correct
for unwanted motion

998
00:50:16,820 --> 00:50:20,648
small gyroscopes called
reaction wheels were spun up.

999
00:50:20,648 --> 00:50:22,710
(wheels buzzing)

1000
00:50:22,710 --> 00:50:25,910
But eventually they
began spinning too fast.

1001
00:50:25,910 --> 00:50:28,830
Then yet another force,
in the form of thrusters,

1002
00:50:28,830 --> 00:50:33,830
were used to de-saturate or
de-spin the reaction wheels.

1003
00:50:36,480 --> 00:50:38,930
- And you have to know how
long did they fire thrusters

1004
00:50:38,930 --> 00:50:40,690
and how much force was applied.

1005
00:50:40,690 --> 00:50:42,950
And a mistake in any of
those means it could be,

1006
00:50:42,950 --> 00:50:44,470
you could be kilometers off course

1007
00:50:44,470 --> 00:50:48,050
because those things build
up over hours, days, weeks,

1008
00:50:48,050 --> 00:50:49,310
and months on the way to Mars.

1009
00:50:49,310 --> 00:50:51,730
And you can actually
get quite far off course

1010
00:50:51,730 --> 00:50:53,880
if you don't know
exactly what's happening.

1011
00:50:55,460 --> 00:50:57,030
- [Narrator] Climate Orbiter's thrusters

1012
00:50:57,030 --> 00:51:00,070
had to be fired every 17 hours.

1013
00:51:00,070 --> 00:51:02,740
An unanticipated chore
that added more pressure

1014
00:51:02,740 --> 00:51:06,383
on a team that had been stripped
down to a skeleton crew.

1015
00:51:07,450 --> 00:51:10,893
Only one full time navigator
was assigned to the mission.

1016
00:51:12,010 --> 00:51:15,020
And during the first four months of crews

1017
00:51:15,020 --> 00:51:18,400
navigation data from the
spacecraft was not even usable

1018
00:51:18,400 --> 00:51:20,163
because of a software error.

1019
00:51:22,200 --> 00:51:24,050
When that problem was fixed

1020
00:51:24,050 --> 00:51:27,453
something seemed slightly
amiss in the predicted plots.

1021
00:51:28,690 --> 00:51:31,010
- We knew there were some
funny things going on

1022
00:51:31,010 --> 00:51:33,110
with the navigation products.

1023
00:51:33,110 --> 00:51:34,920
It was in that gray area between,

1024
00:51:34,920 --> 00:51:37,700
it wasn't bad to the point
of you have to do something

1025
00:51:37,700 --> 00:51:39,880
about this now or the mission's over.

1026
00:51:39,880 --> 00:51:42,260
It wasn't just fine,
and so often, you know,

1027
00:51:42,260 --> 00:51:44,770
when there are one problem after another

1028
00:51:44,770 --> 00:51:46,450
I found at my own role

1029
00:51:46,450 --> 00:51:49,842
you really have to judiciously prioritize.

1030
00:51:49,842 --> 00:51:52,360
(dramatic music)

1031
00:51:52,360 --> 00:51:54,430
- [Narrator] The navigator
and his supervisor

1032

00:51:54,430 --> 00:51:57,460
expressed their puzzlement
in phone calls, emails,

1033
00:51:57,460 --> 00:51:59,493
and even face to face meetings.

1034
00:52:00,390 --> 00:52:03,420
But a formal report was never submitted.

1035
00:52:03,420 --> 00:52:05,650
And the source of the small discrepancies

1036
00:52:05,650 --> 00:52:07,303
was never tracked down.

1037
00:52:08,690 --> 00:52:10,570
- I think we failed to

1038
00:52:12,070 --> 00:52:14,050
properly record it

1039
00:52:14,050 --> 00:52:17,143
as an incident surprise anomaly.

1040
00:52:18,930 --> 00:52:21,890
That was probably the devastating step

1041
00:52:24,270 --> 00:52:25,890
because it was a,

1042
00:52:25,890 --> 00:52:27,840
it was an issue that was recognized.

1043
00:52:27,840 --> 00:52:30,560
I remembered talking about
it in the staff meeting,

1044

00:52:30,560 --> 00:52:34,660
that the trajectory wasn't
performing as expected.

1045
00:52:34,660 --> 00:52:35,910
And I just don't know why

1046
00:52:37,600 --> 00:52:40,267
we never entered it into
the system the right way.

1047
00:52:42,810 --> 00:52:45,030
- [Narrator] Over time,
these navigation worries

1048
00:52:45,030 --> 00:52:48,600
came to be viewed as something
of a theoretical irritant.

1049
00:52:48,600 --> 00:52:51,030
For while the course
plotting of a spacecraft

1050
00:52:51,030 --> 00:52:53,950
can rightly be called rocket science,

1051
00:52:53,950 --> 00:52:57,543
it is surprisingly not an exact science.

1052
00:52:58,600 --> 00:53:00,580
- And of course, you know,
there's no GPS out there.

1053
00:53:00,580 --> 00:53:01,840
There's really no way
to know where you are

1054
00:53:01,840 --> 00:53:05,410
except tracking with the big
deep space network antennas.

1055
00:53:05,410 --> 00:53:07,590
But that's only in the
line between you and me.

1056
00:53:07,590 --> 00:53:10,220
So it's only one component
of the three dimensions

1057
00:53:10,220 --> 00:53:11,880
that the spacecraft is in.

1058
00:53:11,880 --> 00:53:13,770
And so by measuring only one component

1059
00:53:13,770 --> 00:53:15,970
you sort of have to unfold
through understanding

1060
00:53:15,970 --> 00:53:17,890
orbital mechanics and understanding

1061
00:53:17,890 --> 00:53:21,127
what the spacecraft is
doing, exactly where it is.

1062
00:53:21,127 --> 00:53:24,077
And it turns out that's a
pretty complicated process.

1063
00:53:24,077 --> 00:53:25,762
(suspenseful music)

1064
00:53:28,462 --> 00:53:29,600
- So in a sense you're
trying to figure out

1065
00:53:29,600 --> 00:53:31,340
where this thing is in

this cloud out here.

1066
00:53:31,340 --> 00:53:34,120
And all you can do is
know, well it's right here.

1067
00:53:34,120 --> 00:53:36,780
But it could be right
here and going this fast,

1068
00:53:36,780 --> 00:53:38,760
or it could be right
here and going this fast.

1069
00:53:38,760 --> 00:53:42,040
You don't know that this
way, right, that this way,

1070
00:53:42,040 --> 00:53:45,810
you only can do by building up over time.

1071
00:53:45,810 --> 00:53:48,370
Well it was here, and
then we think it was here

1072
00:53:48,370 --> 00:53:51,240
and you begin to eventually
converge in on it.

1073
00:53:51,240 --> 00:53:52,580
And, but that takes months.

1074
00:53:52,580 --> 00:53:53,560
The thing that helps you

1075
00:53:53,560 --> 00:53:55,330
is that it's not just randomly moving.

1076
00:53:55,330 --> 00:53:56,720

It's in orbit around the sun.

1077
00:53:56,720 --> 00:53:59,420
And so it has to be moving
in a predictable way,

1078
00:53:59,420 --> 00:54:00,790
except for the times in which

1079
00:54:00,790 --> 00:54:02,660
something else is pushing on it.

1080
00:54:02,660 --> 00:54:04,320
And the something else
that's pushing on it

1081
00:54:04,320 --> 00:54:06,870
are these little thrusters
that are on the spacecraft.

1082
00:54:06,870 --> 00:54:10,073
And those are things which
are difficult to predict.

1083
00:54:12,140 --> 00:54:14,320
- [Narrator] Two months
before arrival at Mars

1084
00:54:14,320 --> 00:54:16,140
rose another problem.

1085
00:54:16,140 --> 00:54:18,080
During a trajectory course maneuver

1086
00:54:18,080 --> 00:54:21,470
the spacecraft's solar
panels seem to have jammed.

1087
00:54:21,470 --> 00:54:25,283

A problem that if not fixed
would doom the mission.

1088
00:54:27,060 --> 00:54:29,380
- So it was a, you
know, all hands on deck.

1089
00:54:29,380 --> 00:54:32,283
We've got to fix this
problem now, or it's over.

1090
00:54:33,630 --> 00:54:35,110
That was going on at the same time

1091
00:54:35,110 --> 00:54:37,120
the problem that eventually killed us

1092
00:54:37,120 --> 00:54:38,893
was manifesting itself.

1093
00:54:40,480 --> 00:54:42,720
- [Narrator] The solar
panel snag was solved

1094
00:54:42,720 --> 00:54:45,200
but the solution took the
better part of a month

1095
00:54:45,200 --> 00:54:47,663
leaving undone other scheduled work.

1096
00:54:50,090 --> 00:54:52,360
By now, the navigators were deeply worried

1097
00:54:52,360 --> 00:54:54,683
as predictions still weren't converging.

1098
00:54:55,570 --> 00:54:58,400
To address their concerns

the altitude aim point

1099
00:54:58,400 --> 00:55:01,288
was raised to over 200 kilometers.

1100
00:55:01,288 --> 00:55:03,890
(suspenseful music)

1101
00:55:03,890 --> 00:55:06,030
But after the maneuver was performed

1102
00:55:06,030 --> 00:55:09,300
new plot showed the aim
point was 72 kilometers

1103
00:55:09,300 --> 00:55:11,080
lower than expected.

1104
00:55:11,080 --> 00:55:13,222
(suspenseful music)

1105
00:55:15,100 --> 00:55:16,750
With tensions running high

1106
00:55:16,750 --> 00:55:20,140
the navigation team leader
argued for yet another maneuver

1107
00:55:20,140 --> 00:55:22,393
to push the spacecraft even higher.

1108
00:55:24,770 --> 00:55:27,710
- People were used to the navigators,

1109
00:55:27,710 --> 00:55:29,500
basically saying, if
they didn't understand

1110

00:55:29,500 --> 00:55:31,810
where it was super precisely,

1111
00:55:31,810 --> 00:55:32,643
you know, it was like,

1112
00:55:32,643 --> 00:55:33,867
"Well, they always have so much margin.

1113
00:55:33,867 --> 00:55:37,070
"Those guys are, you know,
they never miss anything."

1114
00:55:37,070 --> 00:55:38,897
And when they were trying to communicate

1115
00:55:38,897 --> 00:55:41,107
"No, really, we really don't understand

1116
00:55:41,107 --> 00:55:43,007
"where this trajectory is going.

1117
00:55:43,007 --> 00:55:44,677
"We're seeing things in the data

1118
00:55:44,677 --> 00:55:47,110
"that don't make sense to us."

1119
00:55:47,110 --> 00:55:49,623
The message that was received
was very different, I think,

1120
00:55:49,623 --> 00:55:52,530
than the message that they
were trying to communicate.

1121
00:55:52,530 --> 00:55:54,750
This was another one of
those cases of not knowing

1122
00:55:54,750 --> 00:55:57,793
how close to the edge we were
on this particular mission.

1123
00:55:59,640 --> 00:56:00,860
- [Narrator] Given the concerns

1124
00:56:00,860 --> 00:56:04,100
a small subset of a review
board met by telephone

1125
00:56:04,100 --> 00:56:06,193
to consider an emergency maneuver.

1126
00:56:07,540 --> 00:56:09,433
No navigator was invited.

1127
00:56:10,830 --> 00:56:13,253
The outcome was to press on as planned.

1128
00:56:15,090 --> 00:56:17,630
While the navigation
solutions were worrisome

1129
00:56:17,630 --> 00:56:19,320
they still showed the spacecraft

1130
00:56:19,320 --> 00:56:22,673
having twice the altitude
needed to safely go into orbit.

1131
00:56:23,860 --> 00:56:26,490
Last minute changes, the reasoning went,

1132
00:56:26,490 --> 00:56:28,563
might introduce new dangers.

1133

00:56:30,050 --> 00:56:33,550
Among those on the phone
call was Richard Cook.

1134
00:56:33,550 --> 00:56:36,200
- Oddly, a lot of the senior leadership

1135
00:56:36,200 --> 00:56:39,460
of the development project
and the operations project

1136
00:56:39,460 --> 00:56:41,590
both had navigation backgrounds.

1137
00:56:41,590 --> 00:56:44,010
And so, or all had navigation backgrounds.

1138
00:56:44,010 --> 00:56:46,470
And I think that created this model

1139
00:56:46,470 --> 00:56:48,900
that this is something
that we know how to do.

1140
00:56:48,900 --> 00:56:50,550
And that there was not, you know,

1141
00:56:50,550 --> 00:56:53,300
clearly proper paranoia
is one of the things

1142
00:56:53,300 --> 00:56:56,500
that we believe in very
strongly around here.

1143
00:56:56,500 --> 00:56:58,290
I think that because of that comfort

1144
00:56:58,290 --> 00:57:00,950

with the underlying technical problem

1145
00:57:00,950 --> 00:57:02,860
coming from the management

1146
00:57:02,860 --> 00:57:05,390
there was just not enough paranoia.

1147
00:57:05,390 --> 00:57:07,200
And instead of if anything,
there was the opposite

1148
00:57:07,200 --> 00:57:11,610
which is you guys are too
conservative, you know, you'll be,

1149
00:57:11,610 --> 00:57:15,110
it'll be okay because it's always okay.

1150
00:57:15,110 --> 00:57:17,198
(tense music)

1151
00:57:18,090 --> 00:57:19,710
- [Narrator] Two weeks before the decision

1152
00:57:19,710 --> 00:57:22,290
not to conduct an emergency maneuver

1153
00:57:22,290 --> 00:57:25,253
Climate Orbiter saw this image of Mars.

1154
00:57:27,530 --> 00:57:30,220
It would be the first and only one

1155
00:57:30,220 --> 00:57:31,953
the spacecraft would ever see.

1156
00:57:45,506 --> 00:57:47,320

- [Man 25] Good morning,
this is Mars Climate Orbiter

1157
00:57:47,320 --> 00:57:49,040
in Mission Control of the
Jet Propulsion Laboratory

1158
00:57:49,040 --> 00:57:50,670
in Pasadena, California.

1159
00:57:50,670 --> 00:57:52,410
JPL is an operating division
of the California---

1160
00:57:52,410 --> 00:57:54,450
- [Narrator] JPL's live TV coverage

1161
00:57:54,450 --> 00:57:57,010
of the orbit insertion of Climate Orbiter

1162
00:57:57,010 --> 00:58:01,870
began in the early hours
of September 23rd, 1999.

1163
00:58:01,870 --> 00:58:04,220
Given the hour, there were
only a handful of people

1164
00:58:04,220 --> 00:58:06,040
in the small mission support area

1165
00:58:06,040 --> 00:58:08,630
for what many believed
would be a routine event.

1166
00:58:08,630 --> 00:58:09,940
- [Man 26] Team resides and is watching

1167
00:58:09,940 --> 00:58:11,920

all the telemetry come on in.

1168
00:58:11,920 --> 00:58:13,250
At the Lockheed Martin center,

1169
00:58:13,250 --> 00:58:14,560
they do the actual commanding.

1170
00:58:14,560 --> 00:58:16,110
- [Woman 5] TelePrompter is go.

1171
00:58:17,060 --> 00:58:18,003
- [Man 27] I just want to let you know

1172
00:58:18,003 --> 00:58:19,170
the stations look like they're in lock

1173
00:58:19,170 --> 00:58:23,420
at the appropriate level,
and everything's nominal.

1174
00:58:26,840 --> 00:58:28,690
- [Narrator] In charge of the JPL crew

1175
00:58:28,690 --> 00:58:31,653
was Flight Operations
Manager Sam Thurmond.

1176
00:58:32,550 --> 00:58:34,840
John McNamee was there too.

1177
00:58:34,840 --> 00:58:37,240
He was now working on a different mission,

1178
00:58:37,240 --> 00:58:39,450
but he had continued to be in close touch

1179
00:58:39,450 --> 00:58:41,333

and his opinion still mattered.

1180
00:58:44,020 --> 00:58:48,270
Looking on from just outside
the room was Glenn Cunningham.

1181
00:58:48,270 --> 00:58:51,773
He had recently retired, but
found it hard to stay away.

1182
00:58:54,990 --> 00:58:56,470
Moving into Cunningham's role

1183
00:58:56,470 --> 00:58:58,820
with responsibility for flight operations

1184
00:58:58,820 --> 00:59:01,983
for all of the Mars
missions was Richard Cook.

1185
00:59:03,770 --> 00:59:05,940
- [Woman 6] All systems
continuing to report nominal

1186
00:59:05,940 --> 00:59:07,057
as we head into MOI.

1187
00:59:09,530 --> 00:59:13,400
- The altitude was still,
in the days up to arrival,

1188
00:59:13,400 --> 00:59:17,060
was still hanging around the
150, 160 kilometer range.

1189
00:59:17,060 --> 00:59:18,137
And so everyone was like

1190
00:59:18,137 --> 00:59:21,167

"Yeah, it's going to be lower
than we want but still okay."

1191
00:59:23,240 --> 00:59:26,780
There was one last update of the altitude.

1192
00:59:26,780 --> 00:59:29,740
And that was at about probably
midnight or one o'clock,

1193
00:59:29,740 --> 00:59:31,560
where the data all the
way up to that point

1194
00:59:31,560 --> 00:59:35,390
was used to calculate a new
idea of what the altitude was.

1195
00:59:35,390 --> 00:59:39,133
And it dropped to 110 kilometers,
which was frightening.

1196
00:59:40,740 --> 00:59:43,030
But I think, you know, we
still felt like that was above

1197
00:59:43,030 --> 00:59:44,963
the survival limit of the spacecraft.

1198
00:59:49,396 --> 00:59:50,229
(rocket engine roaring)

1199
00:59:50,229 --> 00:59:53,680
- Systems, FLM.
- FLM systems. Go ahead.

1200
00:59:53,680 --> 00:59:54,780
- [Man 28] Hey, can you ask telecom

1201

00:59:54,780 --> 00:59:56,770
to forward a predicted AGC level

1202
00:59:56,770 --> 00:59:58,840
once we are in the burn attitude?

1203
00:59:58,840 --> 01:00:01,257
- [Woman 7] Will do. Standby.

1204
01:00:08,789 --> 01:00:11,622
(engine blasting)

1205
01:00:17,506 --> 01:00:19,429
- [Woman 8] All stations,
with Mars accord.

1206
01:00:19,429 --> 01:00:21,030
This is APO systems.

1207
01:00:21,030 --> 01:00:23,830
This is time for the commanding
of the onboard sequence.

1208
01:00:24,896 --> 01:00:26,813
- Hey. Yes.
- Yes. Okay.

1209
01:00:30,440 --> 01:00:32,520
- [Woman 9] Then again
would be a loss of signal

1210
01:00:32,520 --> 01:00:36,210
with occultation start at 9:05:41.

1211
01:00:36,210 --> 01:00:37,043
That would be MOI---

1212
01:00:37,043 --> 01:00:39,490
- You could relate almost exactly the time

1213
01:00:39,490 --> 01:00:42,150
at which we lost lock on the signal

1214
01:00:42,150 --> 01:00:43,910
as the spacecraft went behind Mars

1215
01:00:43,910 --> 01:00:48,130
and what altitude the closest
approach was going to be.

1216
01:00:48,130 --> 01:00:50,020
- Okay, station 43 reports

1217
01:00:50,020 --> 01:00:55,020
that they dropped
receiver lock at 09:04:56.

1218
01:00:55,200 --> 01:00:59,813
The last signal seen in
the FFT was at 09:05:02.

1219
01:01:02,620 --> 01:01:04,270
- [Man 29] Roger that. Thank you.

1220
01:01:05,360 --> 01:01:08,237
- We got LOS unusually early

1221
01:01:08,237 --> 01:01:12,930
and I looked to go mark
the spot on that graph

1222
01:01:12,930 --> 01:01:15,781
of where it occurred to
see what the flyby altitude

1223
01:01:15,781 --> 01:01:17,803
would be and it was almost off the page.

1224
01:01:19,338 --> 01:01:22,088
(engine roaring)

1225
01:01:23,750 --> 01:01:25,517
So at that point I remember thinking

1226
01:01:25,517 --> 01:01:28,016
"Uh oh, we really got a problem here."

1227
01:01:28,016 --> 01:01:32,098
(men speaking indistinctly)

1228
01:01:32,098 --> 01:01:34,698
- [Man 30] Yes, sir. Could
you call me into 79134?

1229
01:01:35,970 --> 01:01:36,820
- [Man 31] Roger.

1230
01:01:37,700 --> 01:01:38,890
- [Narrator] The loss of signal

1231
01:01:38,890 --> 01:01:42,490
had occurred 39 seconds
earlier than predicted.

1232
01:01:42,490 --> 01:01:45,650
And that was not good news.

1233
01:01:45,650 --> 01:01:47,000
- See what you guys can do.

1234
01:01:48,688 --> 01:01:49,813
Okay. Thanks Steve.

1235
01:01:52,310 --> 01:01:56,440
- So then we had about, I
think it was about 20 minutes.

1236
01:01:56,440 --> 01:01:58,930
We had to wait out the burn itself

1237
01:01:58,930 --> 01:02:01,283
and then, you know, look to reacquire.

1238
01:02:03,460 --> 01:02:05,860
- [Woman 10] Attitude. This is systems.

1239
01:02:05,860 --> 01:02:09,110
- [Woman 11] Systems attitude.
Random data's complete.

1240
01:02:09,110 --> 01:02:10,770
- [Woman 10] Copy, thank you.

1241
01:02:10,770 --> 01:02:13,190
- [Journalist 1] Joining
us is Dr. Dan McCleese.

1242
01:02:13,190 --> 01:02:14,410
This is a big deal for you here.

1243
01:02:14,410 --> 01:02:16,860
You've got one of the
two science instruments

1244
01:02:16,860 --> 01:02:18,230
on board the spacecraft.

1245
01:02:18,230 --> 01:02:20,620
Yeah, this is very exciting.

1246
01:02:20,620 --> 01:02:21,453
- Yeah, that's right.

1247
01:02:21,453 --> 01:02:23,700

I was on a microphone

1248
01:02:23,700 --> 01:02:27,590
and I was going through
the sequence of events.

1249
01:02:27,590 --> 01:02:30,700
Looking at the clock,
looking at the timeline

1250
01:02:30,700 --> 01:02:34,290
and listening to what the
operations people were saying,

1251
01:02:34,290 --> 01:02:36,130
was happening on the spacecraft.

1252
01:02:36,130 --> 01:02:38,560
- [Woman 12] We're standing
by for exit of occultation.

1253
01:02:38,560 --> 01:02:41,053
Scheduled to be at 9:26:56.

1254
01:02:43,830 --> 01:02:45,270
- Well, we don't even know what a typical

1255
01:02:45,270 --> 01:02:48,263
Martian year is like from
the perspective of weather.

1256
01:02:49,427 --> 01:02:50,850
And as I was talking through,

1257
01:02:50,850 --> 01:02:54,890
near the moment we would
have been in orbit correctly,

1258
01:02:54,890 --> 01:02:57,339

it was clear that
something was very wrong.

1259
01:02:57,339 --> 01:03:00,339
(suspenseful music)

1260
01:03:02,270 --> 01:03:06,150
I didn't know what to say on live TV

1261
01:03:06,150 --> 01:03:08,110
so I just walked away from the microphone.

1262
01:03:08,110 --> 01:03:11,270
I walked into the room where
the telemetry was coming down

1263
01:03:11,270 --> 01:03:13,477
from the spacecraft
and people were saying,

1264
01:03:13,477 --> 01:03:15,827
"It looks like we're going in close.

1265
01:03:15,827 --> 01:03:19,170
"Looks like we're closer
than we thought we would be."

1266
01:03:19,170 --> 01:03:21,407
And I'm saying, "There's an atmosphere.

1267
01:03:21,407 --> 01:03:24,907
"This is not the moon. We
are not going to make it."

1268
01:03:25,750 --> 01:03:28,180
- [Man 32] Okay, waiting
for acquisition of signal.

1269
01:03:28,180 --> 01:03:31,640

Okay. Let's listen and see if we get AOS.

1270
01:03:32,580 --> 01:03:33,413
- And everybody's going

1271
01:03:33,413 --> 01:03:36,577
"Oh, if we just can get
past the entry point

1272
01:03:36,577 --> 01:03:38,560
"we'll see if we come out the other side."

1273
01:03:38,560 --> 01:03:40,600
And I just couldn't believe it.

1274
01:03:40,600 --> 01:03:43,720
I couldn't believe that
people were even imagining

1275
01:03:43,720 --> 01:03:45,171
such a possibility.

1276
01:03:45,171 --> 01:03:47,330
(suspenseful music)

1277
01:03:47,330 --> 01:03:49,720
I knew it was over.

1278
01:03:49,720 --> 01:03:52,843
Twice unlucky? What? This is not possible.

1279
01:03:55,720 --> 01:03:57,103
- And we didn't reacquire.

1280
01:03:57,103 --> 01:03:59,770
I mean, I remember talking
with the so called the ACE,

1281

01:03:59,770 --> 01:04:02,710
the person that talks
directly with the stations,

1282
01:04:02,710 --> 01:04:05,607
he was talking to the
station operators saying,

1283
01:04:05,607 --> 01:04:07,847
"You know, I'm not, are
you seeing anything at all,

1284
01:04:07,847 --> 01:04:09,810
"any sign of the carrier weight?"

1285
01:04:09,810 --> 01:04:11,090
And it wasn't happening.

1286
01:04:11,090 --> 01:04:11,923
And that's something.

1287
01:04:11,923 --> 01:04:13,140
All right, we're going to have to get a,

1288
01:04:13,140 --> 01:04:14,010
you know, off script.

1289
01:04:14,010 --> 01:04:16,270
- I think there are one
of two possibilities.

1290
01:04:16,270 --> 01:04:18,898
It may take a while to
get it torqued back around

1291
01:04:18,898 --> 01:04:21,230
and we'll get a signal out of it.

1292
01:04:21,230 --> 01:04:23,047

- So I remember a voice
in my own head saying

1293
01:04:23,047 --> 01:04:24,217
"Follow your plans."

1294
01:04:25,460 --> 01:04:28,300
The emotional part of it became tolerable

1295
01:04:28,300 --> 01:04:32,030
by having something to do
that had been worked out

1296
01:04:32,030 --> 01:04:33,200
and getting to it.

1297
01:04:33,200 --> 01:04:35,290
- Either way, there are things it will do

1298
01:04:35,290 --> 01:04:38,135
other than just sit there.

1299
01:04:38,135 --> 01:04:38,968
- Okay.

1300
01:04:41,030 --> 01:04:45,620
- And I'm producing this
out of our TV control room.

1301
01:04:45,620 --> 01:04:49,370
And no one's talking on
the comm lines anymore.

1302
01:04:49,370 --> 01:04:50,900
That's gone silent.

1303
01:04:50,900 --> 01:04:53,350
And people are starting to
pick up their telephones

1304
01:04:53,350 --> 01:04:54,790
and communicate.

1305
01:04:54,790 --> 01:04:56,390
It's like, what's going on here?

1306
01:04:58,500 --> 01:05:02,510
Time comes that we're supposed
to reacquire the signal.

1307
01:05:02,510 --> 01:05:03,443
There's no signal.

1308
01:05:04,350 --> 01:05:08,120
So five minutes goes
by. 10 minutes goes by.

1309
01:05:08,120 --> 01:05:11,560
- [Man 32] This is Mars Climate
Orbiter, mission control.

1310
01:05:11,560 --> 01:05:12,900
Now about 14 minutes past the point

1311
01:05:12,900 --> 01:05:15,730
where we would have
expected to receive signals

1312
01:05:15,730 --> 01:05:16,930
from Mars Climate Orbiter

1313
01:05:16,930 --> 01:05:18,713
as it reappeared from behind Mars.

1314
01:05:21,170 --> 01:05:24,330
- David Seidel, who was
doing our commentary,

1315
01:05:24,330 --> 01:05:27,267
gets off mic and calls me and says

1316
01:05:27,267 --> 01:05:28,917
"I don't know what's going on.

1317
01:05:28,917 --> 01:05:31,257
"What is it that I'm supposed to say?"

1318
01:05:32,970 --> 01:05:35,630
Well, I didn't know what was going on.

1319
01:05:35,630 --> 01:05:39,930
So I jumped up and I
ran as fast as I could

1320
01:05:39,930 --> 01:05:44,010
over to the building they
were in, to building 264.

1321
01:05:44,010 --> 01:05:45,597
And as I was running, I was saying,

1322
01:05:45,597 --> 01:05:48,447
"I don't have a contingency plan for this.

1323
01:05:48,447 --> 01:05:51,047
"I don't know what it is I'm going to do

1324
01:05:51,047 --> 01:05:52,757
"when I get up there,

1325
01:05:52,757 --> 01:05:54,377
"but I've got to have a decision made

1326
01:05:54,377 --> 01:05:56,490
"by the time I get off that elevator."

1327
01:05:56,490 --> 01:05:57,323
- [Man 33] Okay.

1328
01:06:01,150 --> 01:06:02,300
Yeah, I don't think we'll be,

1329
01:06:02,300 --> 01:06:04,150
we'll probably not do the live shots.

1330
01:06:05,030 --> 01:06:06,960
- [Blaine] Now hold on. Hold on on that.

1331
01:06:06,960 --> 01:06:10,203
One thing at a time. Okay? Hold on. Okay.

1332
01:06:11,290 --> 01:06:12,930
We'll get Richard from here.

1333
01:06:12,930 --> 01:06:14,680
We need to shoot him with a camera.

1334
01:06:16,550 --> 01:06:21,230
I had to grab Richard Cook out
of the mission support area

1335
01:06:21,230 --> 01:06:23,700
and have him go on live to tell

1336
01:06:23,700 --> 01:06:26,060
whatever it is that we did know.

1337
01:06:26,060 --> 01:06:29,253
We needed to tell that right
then and there to the world.

1338
01:06:30,800 --> 01:06:32,270
This is Mars Climate Orbiter,

1339
01:06:32,270 --> 01:06:34,350
mission control at the
Jet Propulsion Laboratory.

1340
01:06:34,350 --> 01:06:36,300
Joining us now is Richard Cook,

1341
01:06:36,300 --> 01:06:39,620
who's the Mars Surveyor
Operations Project Manager.

1342
01:06:39,620 --> 01:06:41,813
Can you give us a quick
update of what you know?

1343
01:06:41,813 --> 01:06:44,027
- What we're working on
right at the moment is,

1344
01:06:44,027 --> 01:06:49,027
the spacecraft has a number of
autonomous recovery processes

1345
01:06:49,170 --> 01:06:51,700
that it goes through when it has a fault.

1346
01:06:51,700 --> 01:06:53,100
We believe that we are in

1347
01:06:53,100 --> 01:06:55,500
in all likelihood in the
midst of one of those.

1348
01:06:55,500 --> 01:06:58,650
So we're going to be monitoring
it over the next few hours

1349
01:06:58,650 --> 01:07:00,463
to see what happens.

1350
01:07:01,490 --> 01:07:02,780
I think we will,

1351
01:07:02,780 --> 01:07:04,570
obviously we will, as soon
as we find out something,

1352
01:07:04,570 --> 01:07:06,000
we'll let everybody know.

1353
01:07:06,000 --> 01:07:08,160
But at this point we're still,

1354
01:07:08,160 --> 01:07:10,397
still very confident that
we're in orbit at Mars

1355
01:07:10,397 --> 01:07:11,230
and we need to,

1356
01:07:11,230 --> 01:07:13,660
and we're going to see this
spacecraft signal sometime

1357
01:07:13,660 --> 01:07:15,410
in, like I said, the next few hours.

1358
01:07:17,430 --> 01:07:20,530
It was about that same time
when the navigators came in

1359
01:07:20,530 --> 01:07:22,617
and said, "Now we've
got data all the way up

1360
01:07:22,617 --> 01:07:25,830
"until the point at which it
went out of communications."

1361
01:07:25,830 --> 01:07:27,650
When they processed that data

1362
01:07:27,650 --> 01:07:29,970
it dropped to 60 kilometers, right?

1363
01:07:29,970 --> 01:07:32,950
Which is obviously below where
we thought it was survivable.

1364
01:07:32,950 --> 01:07:34,900
And so that's really when it hit the,

1365
01:07:34,900 --> 01:07:36,440
you know, fan so to speak

1366
01:07:36,440 --> 01:07:38,630
and where everybody began to worry

1367
01:07:38,630 --> 01:07:40,963
that we had lost the mission.

1368
01:07:42,510 --> 01:07:45,150
- We have a briefing this
morning to give you an update

1369
01:07:45,150 --> 01:07:47,970
on the status of Mars Climate Orbiter.

1370
01:07:47,970 --> 01:07:48,803
I guess we'll take---

1371
01:07:48,803 --> 01:07:52,170
- [Narrator] A few hours
later, not long after sunrise,

1372
01:07:52,170 --> 01:07:55,270

what had been planned as a
celebratory press conference

1373
01:07:55,270 --> 01:08:00,100
was instead the beginning of
a long search for the guilty.

1374
01:08:00,100 --> 01:08:02,250
- [Robin] Robin Soriano,
with Florida Today.

1375
01:08:02,250 --> 01:08:04,010
Could you tell us who is responsible

1376
01:08:04,010 --> 01:08:06,990
for sending the navigation
commands to the spacecraft?

1377
01:08:06,990 --> 01:08:08,200
- [Journalist 2] You must have a list

1378
01:08:08,200 --> 01:08:10,770
of potential suspects already.

1379
01:08:10,770 --> 01:08:12,470
- [Journalist 3] This isn't a first

1380
01:08:12,470 --> 01:08:15,420
of the smaller, faster,
cheaper, better spacecraft

1381
01:08:15,420 --> 01:08:17,710
that you've had problems with.

1382
01:08:17,710 --> 01:08:19,060
- [Journalist 4] Covered
a lot of JPL missions.

1383
01:08:19,060 --> 01:08:21,840

And I realized you don't
get the real final tracking

1384
01:08:21,840 --> 01:08:22,910
until you get close to the planet.

1385
01:08:22,910 --> 01:08:25,713
But I can't recall an
error this large ever.

1386
01:08:27,350 --> 01:08:30,700
- It was just a terrible,
terrible experience, terrible day.

1387
01:08:30,700 --> 01:08:34,490
And no matter what you say
in that sort of in a moment

1388
01:08:34,490 --> 01:08:36,730
you're going to cause ripples, right?

1389
01:08:36,730 --> 01:08:40,770
I mean, the team is struggling
to stay together in a sense.

1390
01:08:40,770 --> 01:08:42,700
And so any statement about what's,

1391
01:08:42,700 --> 01:08:45,220
you know, what happened other
than we lost the spacecraft,

1392
01:08:45,220 --> 01:08:49,530
you get into that feeling of
the team kind of coming apart.

1393
01:08:49,530 --> 01:08:52,930
And it was just turned into
this incredibly divisive thing

1394
01:08:52,930 --> 01:08:54,940
which is unfortunate obviously.

1395
01:08:54,940 --> 01:08:56,950
- And just to follow up on that last bit

1396
01:08:56,950 --> 01:08:58,000
I wonder if you could just tell us

1397
01:08:58,000 --> 01:09:00,990
literally over the next eight
hours, I mean, literally,

1398
01:09:00,990 --> 01:09:02,660
what are you folks doing?

1399
01:09:02,660 --> 01:09:05,520
- Right now that we have a
fully staffed flight team

1400
01:09:05,520 --> 01:09:07,840
both here and at Lockheed Martin in Denver

1401
01:09:07,840 --> 01:09:09,210
we're going to essentially begin

1402
01:09:09,210 --> 01:09:12,670
to dive into this navigation
issue as soon as possible.

1403
01:09:12,670 --> 01:09:14,783
Probably as soon as we
walk out of this room.

1404
01:09:21,029 --> 01:09:23,446
(soft music)

1405
01:09:27,460 --> 01:09:29,000

- [Narrator] One month before the loss

1406
01:09:29,000 --> 01:09:30,720
of Mars Climate Orbiter

1407
01:09:30,720 --> 01:09:33,860
a JPL-built spacecraft called Cassini

1408
01:09:33,860 --> 01:09:37,940
had skimmed closely past the
earth with pinpoint accuracy

1409
01:09:37,940 --> 01:09:39,393
bound for Saturn.

1410
01:09:41,020 --> 01:09:42,770
Cassini was the most expensive

1411
01:09:42,770 --> 01:09:46,130
and advanced planetary
spacecraft ever built.

1412
01:09:46,130 --> 01:09:50,150
The quintessential Battlestar Galactica.

1413
01:09:50,150 --> 01:09:51,740
- I hate that word:

1414
01:09:51,740 --> 01:09:52,843
Battlestar Galactica

1415
01:09:54,240 --> 01:09:56,253
but I understand where it came from.

1416
01:09:58,800 --> 01:10:01,730
- [Narrator] Tom Gavin
was a veteran JPL engineer

1417

01:10:01,730 --> 01:10:05,100
who considered Cassini as
one of his and the lab's

1418
01:10:05,100 --> 01:10:06,653
proudest achievements.

1419
01:10:08,550 --> 01:10:11,550
In the months preceding
the loss of Climate Orbiter

1420
01:10:11,550 --> 01:10:13,880
he had been asked to look under the hood

1421
01:10:13,880 --> 01:10:18,100
of some of the other faster,
better, cheaper missions.

1422
01:10:18,100 --> 01:10:20,513
What he saw, he didn't like.

1423
01:10:21,850 --> 01:10:24,110
- Well, nearest I could tell
was that all the rule books

1424
01:10:24,110 --> 01:10:25,890
had been thrown out.

1425
01:10:25,890 --> 01:10:27,190
That there were no rules.

1426
01:10:27,190 --> 01:10:29,053
The rules were, there are no rules.

1427
01:10:30,550 --> 01:10:33,030
I think there's a lot in
faster, better, cheaper.

1428
01:10:33,030 --> 01:10:34,400

But it isn't

1429
01:10:34,400 --> 01:10:36,810
it isn't being undisciplined.
And it's okay to take risks.

1430
01:10:36,810 --> 01:10:39,114
But understand what risk
you're taking, okay?

1431
01:10:39,114 --> 01:10:40,290
If you don't understand
what risk you're taking

1432
01:10:40,290 --> 01:10:41,540
then you're uncontrolled.

1433
01:10:43,160 --> 01:10:45,690
I mean the MCO thing
should've never happened.

1434
01:10:45,690 --> 01:10:47,413
There was no excuse.

1435
01:10:49,920 --> 01:10:51,760
I figured this was an easy event.

1436
01:10:51,760 --> 01:10:54,917
And about three o'clock in the
morning, I got a phone call.

1437
01:10:54,917 --> 01:10:55,987
"You better come in."

1438
01:10:57,506 --> 01:11:00,490
And I walked in and I ran
into Cunningham and McNamee.

1439
01:11:00,490 --> 01:11:01,787

And McNamee, I remember McNamee said,

1440
01:11:01,787 --> 01:11:03,847
"We just took a perfectly
operating spacecraft

1441
01:11:03,847 --> 01:11:05,970
"and ran it into Mars."

1442
01:11:05,970 --> 01:11:07,063
And I was shocked.

1443
01:11:08,140 --> 01:11:09,820
How did this happen?

1444
01:11:09,820 --> 01:11:11,616
We know how to do this.

1445
01:11:11,616 --> 01:11:13,670
(soft music)

1446
01:11:13,670 --> 01:11:15,530
- [Narrator] The cause
of the navigation error

1447
01:11:15,530 --> 01:11:18,290
had to be found and quickly.

1448
01:11:18,290 --> 01:11:20,720
Gavin was given that job.

1449
01:11:20,720 --> 01:11:22,540
He assembled a group of experts

1450
01:11:22,540 --> 01:11:26,470
that included the former head
of JPL's navigation section

1451

01:11:26,470 --> 01:11:27,503
Frank Jordan.

1452
01:11:28,940 --> 01:11:31,190
- I had never dreamed that
we were going to lose Orbiter

1453
01:11:31,190 --> 01:11:32,430
to a navigation problem.

1454
01:11:32,430 --> 01:11:34,900
It totally decimated me.

1455
01:11:34,900 --> 01:11:36,187
And Gavin said, "Well, you're the guy

1456
01:11:36,187 --> 01:11:38,137
"that's got to find out what happened."

1457
01:11:40,160 --> 01:11:43,140
- [Narrator] That was
on a Thursday morning.

1458
01:11:43,140 --> 01:11:46,120
By Sunday night, Jordan
believed he had found the answer

1459
01:11:46,120 --> 01:11:49,250
when he compared two columns of numbers.

1460
01:11:49,250 --> 01:11:51,350
The first column from Lockheed Martin,

1461
01:11:51,350 --> 01:11:52,700
showed the amount of force

1462
01:11:52,700 --> 01:11:55,550
exerted by the spacecraft's thrusters.

1463
01:11:55,550 --> 01:11:58,930
The second column was
JPL navigation solutions

1464
01:11:58,930 --> 01:12:00,463
from those numbers.

1465
01:12:03,170 --> 01:12:06,130
- And I looked at these
two rows of numbers

1466
01:12:06,130 --> 01:12:07,343
and it hit me:

1467
01:12:08,750 --> 01:12:11,243
you're all off by about the same ratio.

1468
01:12:13,160 --> 01:12:14,420
And I thought,

1469
01:12:14,420 --> 01:12:16,640
there's something systematic.

1470
01:12:16,640 --> 01:12:17,610
Why should that be?

1471
01:12:17,610 --> 01:12:19,620
And so I computed the ratio

1472
01:12:19,620 --> 01:12:22,910
and it was that the number of JPL

1473
01:12:22,910 --> 01:12:24,873
was four and a half times larger.

1474
01:12:26,600 --> 01:12:28,547
I said, "Oh my God."

1475
01:12:29,880 --> 01:12:31,510
- [Narrator] The 4.5 number

1476
01:12:31,510 --> 01:12:33,710
was precisely the ratio difference

1477
01:12:33,710 --> 01:12:36,490
between the force of thrust
as measured by English

1478
01:12:36,490 --> 01:12:37,963
and metric units.

1479
01:12:39,150 --> 01:12:41,860
For the entire journey,
the navigators had assumed

1480
01:12:41,860 --> 01:12:44,710
the number supplied to
them by Lockheed Martin

1481
01:12:44,710 --> 01:12:47,963
had been in metric units
as had been specified.

1482
01:12:49,400 --> 01:12:53,320
Unknown to them, each time
the thrusters were fired

1483
01:12:53,320 --> 01:12:56,250
the effect had been to push
the spacecraft downward

1484
01:12:56,250 --> 01:13:00,370
four and a half times more
than their calculations.

1485
01:13:00,370 --> 01:13:04,046
The cumulative effect

doomed the spacecraft.

1486
01:13:04,046 --> 01:13:06,796
(dramatic music)

1487
01:13:08,860 --> 01:13:12,450
From morning newspapers
to late night talk shows

1488
01:13:12,450 --> 01:13:15,450
JPL and NASA were ridiculed.

1489
01:13:15,450 --> 01:13:20,063
For the metric confusion mistake
was hardly rocket science.

1490
01:13:21,780 --> 01:13:23,580
- There's a little bit
of human nature here

1491
01:13:23,580 --> 01:13:25,750
because a little bit of

1492
01:13:25,750 --> 01:13:28,017
looking at other people's
misfortunes and thinking,

1493
01:13:28,017 --> 01:13:30,047
"Well there, but for
the grace of God, go I,

1494
01:13:30,047 --> 01:13:31,087
"and look at those smart guys,

1495
01:13:31,087 --> 01:13:32,287
"even they're dummies."

1496
01:13:33,500 --> 01:13:35,600
When it's laid bare, and it comes out

1497
01:13:35,600 --> 01:13:39,100
to something as simple as one
team using the metric system,

1498
01:13:39,100 --> 01:13:41,800
one team using the English system

1499
01:13:41,800 --> 01:13:46,390
and not knowing that there's a
human foible component to it,

1500
01:13:46,390 --> 01:13:47,450
that everybody gets

1501
01:13:47,450 --> 01:13:49,100
'cause we've all made mistakes like that.

1502
01:13:49,100 --> 01:13:51,113
This is just one of those epic mistakes.

1503
01:13:53,610 --> 01:13:55,210
- It was a difficult
time because of course,

1504
01:13:55,210 --> 01:13:57,280
you know, everyone looks
at kind of the, you know,

1505
01:13:57,280 --> 01:13:59,520
the final cause of what happened.

1506
01:13:59,520 --> 01:14:00,950
And that was, you know, the units error

1507
01:14:00,950 --> 01:14:04,110
in this thrusting for the
angular momentum desaturations.

1508
01:14:04,110 --> 01:14:07,333
But of course, you know, that's
the tip of a big iceberg.

1509
01:14:08,550 --> 01:14:11,070
- [Narrator] Mike Watkins
had been named supervisor

1510
01:14:11,070 --> 01:14:14,020
of all of the JPL
navigators only a few months

1511
01:14:14,020 --> 01:14:16,500
before the loss of Climate Orbiter.

1512
01:14:16,500 --> 01:14:18,970
He too was swept into the media storm

1513
01:14:18,970 --> 01:14:21,780
that broke over the measurement mistake.

1514
01:14:21,780 --> 01:14:23,660
- The harder thing to talk about is,

1515
01:14:23,660 --> 01:14:25,360
you know, what led to the design,

1516
01:14:25,360 --> 01:14:26,870
what led to the lack of communication

1517
01:14:26,870 --> 01:14:28,790
and what led to the lack of staffing,

1518
01:14:28,790 --> 01:14:30,560
that didn't uncover that problem

1519
01:14:30,560 --> 01:14:32,920
and work that problem to a solution.

1520
01:14:32,920 --> 01:14:34,250
And I think the disappointing part

1521
01:14:34,250 --> 01:14:36,298
was, of course you
couldn't tell that story.

1522
01:14:36,298 --> 01:14:37,140
You know, you can't tell that story

1523
01:14:37,140 --> 01:14:38,713
in the Tonight Show monologue.

1524
01:14:40,890 --> 01:14:43,200
I personally see the
Climate Orbiter failure

1525
01:14:43,200 --> 01:14:45,330
as a failure of communication.

1526
01:14:45,330 --> 01:14:48,640
A failure to communicate
how the flight system design

1527
01:14:48,640 --> 01:14:50,510
with the more frequent desaturations

1528
01:14:50,510 --> 01:14:52,070
would affect navigation.

1529
01:14:52,070 --> 01:14:53,350
A failure of the navigation team

1530
01:14:53,350 --> 01:14:56,007
to have enough people to
communicate with their peers.

1531

01:14:56,007 --> 01:14:58,490
"Hey, we see something funny.
What do you think about that?"

1532
01:14:58,490 --> 01:14:59,980
And also a communication failure

1533
01:14:59,980 --> 01:15:02,920
between our operations
team and the nav team.

1534
01:15:02,920 --> 01:15:05,510
And I think that lack
of deep communication

1535
01:15:05,510 --> 01:15:09,603
is really the thing we learned
to fix in future missions.

1536
01:15:11,500 --> 01:15:13,140
- Good afternoon. Welcome
to NASA headquarters.

1537
01:15:13,140 --> 01:15:15,350
The subject of today's
briefing is the first report

1538
01:15:15,350 --> 01:15:16,930
of the board investigating the failure

1539
01:15:16,930 --> 01:15:19,190
of NASA's Mars Climate Orbiter mission

1540
01:15:19,190 --> 01:15:21,763
and actions underway at NASA in response.

1541
01:15:23,460 --> 01:15:25,470
- Let me say right at the start

1542

01:15:25,470 --> 01:15:28,210
that we clearly made a serious error.

1543
01:15:28,210 --> 01:15:32,020
Mars Climate Orbiter was
on the wrong trajectory

1544
01:15:32,020 --> 01:15:34,863
and our checks and balances
did not reveal that error.

1545
01:15:35,710 --> 01:15:39,400
- And suddenly that NASA
euphoria that had been building

1546
01:15:39,400 --> 01:15:43,930
all that time, from Pathfinder
to that moment, evaporated.

1547
01:15:43,930 --> 01:15:46,940
- Our report seems to list poor training,

1548
01:15:46,940 --> 01:15:49,760
poor communications, cockiness,

1549
01:15:49,760 --> 01:15:52,000
and a whole bunch of
other not good things.

1550
01:15:52,000 --> 01:15:55,140
- So I know no one person is responsible

1551
01:15:55,140 --> 01:15:58,180
but is there someone who
should take the blame,

1552
01:15:58,180 --> 01:16:00,770
who should be reassigned or fired?

1553

01:16:00,770 --> 01:16:02,350
- [Miles] There was
blood in the water. Okay?

1554
01:16:02,350 --> 01:16:04,250
It was a feeding frenzy.

1555
01:16:04,250 --> 01:16:07,230
The underlying tension
associated with all of this

1556
01:16:07,230 --> 01:16:09,970
somebody described it to me as near panic

1557
01:16:09,970 --> 01:16:13,180
at Jet Propulsion Laboratory
over this whole scenario.

1558
01:16:13,180 --> 01:16:15,430
These were people who really
knew the space business,

1559
01:16:15,430 --> 01:16:17,940
really understood what
faster, better, cheaper meant,

1560
01:16:17,940 --> 01:16:19,527
had deep sources that were saying,

1561
01:16:19,527 --> 01:16:21,387
"This is not good. Pick two.

1562
01:16:21,387 --> 01:16:23,720
"Faster, better, cheaper. Pick two."

1563
01:16:23,720 --> 01:16:26,330
And we knew it. We knew
it was dead in the water.

1564

01:16:26,330 --> 01:16:29,430
- None of us want another mistake

1565
01:16:29,430 --> 01:16:32,200
to go unchecked and unfound.

1566
01:16:32,200 --> 01:16:35,040
One of the most difficult
challenges I had as director

1567
01:16:35,040 --> 01:16:38,620
was the press conference
following the failures.

1568
01:16:38,620 --> 01:16:41,420
And because such press conferences

1569
01:16:41,420 --> 01:16:44,540
tend to be focused on fixing the blame.

1570
01:16:44,540 --> 01:16:46,960
And of course, JPL was
ultimately responsible

1571
01:16:46,960 --> 01:16:47,940
for the mission.

1572
01:16:47,940 --> 01:16:51,690
So in that sense, the
blame was fixed on us.

1573
01:16:51,690 --> 01:16:53,520
But on the way back to the laboratory

1574
01:16:53,520 --> 01:16:54,560
from that press conference

1575
01:16:54,560 --> 01:16:58,210
I realized the most important

thing was to fix the problem

1576
01:16:58,210 --> 01:16:59,710
rather than fixing the blame,

1577
01:16:59,710 --> 01:17:02,780
so that in fact, we could
create a program moving forward.

1578
01:17:02,780 --> 01:17:07,050
And so on the way home,
we worked on a speech,

1579
01:17:07,050 --> 01:17:10,080
which was in fact focused on the way ahead

1580
01:17:10,080 --> 01:17:11,693
rather than on fixing the blame.

1581
01:17:15,240 --> 01:17:18,600
Without a question,
yesterday was the hardest day

1582
01:17:18,600 --> 01:17:20,923
I've experienced in all my years at JPL.

1583
01:17:21,940 --> 01:17:24,480
It was hard because of an old truth.

1584
01:17:24,480 --> 01:17:26,610
The higher the expectation,

1585
01:17:26,610 --> 01:17:28,663
the greater the impact of failure.

1586
01:17:30,110 --> 01:17:33,270
The future will depend on
what we collectively learn

1587
01:17:33,270 --> 01:17:35,533
from the loss of Mars Climate Orbiter.

1588
01:17:36,600 --> 01:17:40,283
Can we learn from our failures
as well as our successes?

1589
01:17:41,130 --> 01:17:45,460
When we fail, do we learn
to fix blame on individuals

1590
01:17:45,460 --> 01:17:48,303
or do we learn to accept
failure as a team?

1591
01:17:49,520 --> 01:17:51,850
Do we learn that the pain we experienced

1592
01:17:51,850 --> 01:17:53,680
in losing a mission is so great

1593
01:17:53,680 --> 01:17:56,320
that we avoid difficult challenges?

1594
01:17:56,320 --> 01:17:58,700
Or do we learn to accept the challenges,

1595
01:17:58,700 --> 01:18:01,030
knowing that either great satisfaction

1596
01:18:01,030 --> 01:18:04,030
or occasional disappointment awaits?

1597
01:18:04,030 --> 01:18:06,770
My choices are to embrace
the tremendous future

1598
01:18:06,770 --> 01:18:08,750

that can be ours.

1599
01:18:08,750 --> 01:18:11,900
But just as our past
successes did not come easily

1600
01:18:11,900 --> 01:18:13,910
neither will the future.

1601
01:18:13,910 --> 01:18:16,170
In the future, success will be defined

1602
01:18:16,170 --> 01:18:19,850
not only by what we do, but how we do it.

1603
01:18:19,850 --> 01:18:22,473
And how we do it starts today.

1604
01:18:27,476 --> 01:18:29,893
(soft music)

1605
01:18:32,770 --> 01:18:34,160
- And then it became very apparent

1606
01:18:34,160 --> 01:18:35,640
that we had to do everything we could

1607
01:18:35,640 --> 01:18:37,623
to try and save the Polar Lander

1608
01:18:37,623 --> 01:18:39,800
because we had just lost the easy one.

1609
01:18:39,800 --> 01:18:41,493
That was the easy one.

1610
01:18:42,674 --> 01:18:44,183
And,

1611
01:18:44,183 --> 01:18:46,433
and then Lander was coming.

1612
01:18:49,420 --> 01:18:51,740
- [Man 33] This team and the spacecraft,

1613
01:18:51,740 --> 01:18:53,270
the spacecraft design

1614
01:18:53,270 --> 01:18:55,570
has been under a great deal of scrutiny.

1615
01:18:55,570 --> 01:18:56,820
The words we're using now,

1616
01:18:56,820 --> 01:18:58,260
is they've turned over all the rocks

1617
01:18:58,260 --> 01:19:00,463
and they're now raking the gravel.

1618
01:19:01,850 --> 01:19:02,683
- [Sarah] We have never been

1619
01:19:02,683 --> 01:19:04,676
to the south pole of Mars before,

1620
01:19:04,676 --> 01:19:06,420
and we're not exactly sure

1621
01:19:06,420 --> 01:19:08,120
what we're going to be going into.

1622
01:19:09,340 --> 01:19:11,310
- [Man 34] This is one of
the most difficult things

1623
01:19:11,310 --> 01:19:13,920
that you can envision
in the space business.

1624
01:19:13,920 --> 01:19:17,970
Requires a very large set of
mechanical activities to occur.

1625
01:19:17,970 --> 01:19:21,600
Technically initiated
separations of the parachute

1626
01:19:21,600 --> 01:19:22,690
and of the heat shield.

1627
01:19:22,690 --> 01:19:26,300
(servos operating)
(engines firing)

1628
01:19:26,300 --> 01:19:30,060
Descent engines have to
fire for about 50 seconds,

1629
01:19:30,060 --> 01:19:33,762
to slow yourself down and
come to rest on the surface.

1630
01:19:33,762 --> 01:19:36,762
(suspenseful music)

1631
01:19:38,466 --> 01:19:41,299
(servos operating)

1632
01:19:44,890 --> 01:19:47,550
- [Narrator] After the cause
for the loss of Climate Orbiter

1633
01:19:47,550 --> 01:19:51,150
was found, Tom Gavin and

NASA led an all out search

1634
01:19:51,150 --> 01:19:54,053
for flaws that might
doom the Polar Lander.

1635
01:19:55,470 --> 01:19:58,630
They had only two months to
dive into the intricate details

1636
01:19:58,630 --> 01:20:02,500
of a spacecraft that had been
built a thousand miles away

1637
01:20:02,500 --> 01:20:06,000
and was now millions
of miles out of reach.

1638
01:20:06,000 --> 01:20:08,440
This frantic scrutiny uncovered a handful

1639
01:20:08,440 --> 01:20:10,913
of potential problems that were addressed.

1640
01:20:11,910 --> 01:20:14,860
There was one issue that had no solution.

1641
01:20:14,860 --> 01:20:17,720
As a cost saving measure
during the entry descent

1642
01:20:17,720 --> 01:20:19,260
and landing sequence

1643
01:20:19,260 --> 01:20:22,560
there would be no
communications from the lander.

1644
01:20:22,560 --> 01:20:24,250

If the mission was lost

1645
01:20:24,250 --> 01:20:26,940
there would be no way of
knowing what had happened

1646
01:20:26,940 --> 01:20:30,103
and little or nothing to
learn for future missions.

1647
01:20:31,410 --> 01:20:34,730
This was another faster,
better, cheaper departure

1648
01:20:34,730 --> 01:20:37,180
from standard practices.

1649
01:20:37,180 --> 01:20:39,140
A point that the mission clearly made

1650
01:20:39,140 --> 01:20:42,133
during reviews at NASA and JPL.

1651
01:20:44,360 --> 01:20:48,280
- Once you begin EDL, there's no RF link.

1652
01:20:48,280 --> 01:20:50,660
It's the way it is. Nothing
can be done with that.

1653
01:20:52,490 --> 01:20:54,530
The laboratory did not understand

1654
01:20:54,530 --> 01:20:56,230
what was going on in that project.

1655
01:20:57,240 --> 01:20:59,380
And it operated in a very isolated mode.

1656
01:20:59,380 --> 01:21:00,580
That was very unhealthy.

1657
01:21:01,596 --> 01:21:04,640
(soft music)

1658
01:21:04,640 --> 01:21:06,170
- [Narrator] No one had greater hopes

1659
01:21:06,170 --> 01:21:08,630
for the success of Mars Polar Lander

1660
01:21:08,630 --> 01:21:13,630
than its young Science Principal
Investigator, David Paige.

1661
01:21:13,820 --> 01:21:15,840
Paige's passion for the red planet

1662
01:21:15,840 --> 01:21:19,360
reached back to college days at Caltech.

1663
01:21:19,360 --> 01:21:22,650
A time when he worked
on the Viking missions.

1664
01:21:22,650 --> 01:21:24,920
- In those days, Viking was old news.

1665
01:21:24,920 --> 01:21:27,310
The data were acquired
during the seventies.

1666
01:21:27,310 --> 01:21:30,750
And I remember I used to
walk down the hallways

1667
01:21:30,750 --> 01:21:33,557

and you know, one sort of
gruff professor would say,

1668
01:21:33,557 --> 01:21:35,477
"Oh, Dave, you're never
going to get anywhere

1669
01:21:35,477 --> 01:21:36,707
"working on Mars.

1670
01:21:36,707 --> 01:21:38,840
"You know, it's just
a bunch of old stuff."

1671
01:21:38,840 --> 01:21:40,817
And you know, "Just don't do that.

1672
01:21:40,817 --> 01:21:42,587
"That's completely boring."

1673
01:21:43,680 --> 01:21:45,530
- [Narrator] But Paige persisted.

1674
01:21:45,530 --> 01:21:48,623
He became especially interested
in the Martian poles.

1675
01:21:49,850 --> 01:21:53,250
A fascination born perhaps
out of his father's adventures

1676
01:21:53,250 --> 01:21:56,790
as a member of Admiral Richard
Bird's second expedition

1677
01:21:56,790 --> 01:22:00,510
to the Antarctic in 1934.

1678
01:22:00,510 --> 01:22:03,790

- You could always argue
that this is the classic case

1679
01:22:03,790 --> 01:22:05,410
of the son following the father

1680
01:22:05,410 --> 01:22:08,790
or at least trying to follow
the father at some level

1681
01:22:08,790 --> 01:22:11,453
exploring the poles of another planet.

1682
01:22:12,670 --> 01:22:14,130
So there could be a
little of that mixed in

1683
01:22:14,130 --> 01:22:16,510
but it certainly wasn't,
you know, conscious.

1684
01:22:16,510 --> 01:22:17,343
Let's put it that way.

1685
01:22:17,343 --> 01:22:19,140
It searches for water under the surface.

1686
01:22:19,140 --> 01:22:21,170
The goal of the mission
is not to find water.

1687
01:22:21,170 --> 01:22:23,453
It won't be considered
a failure if we don't.

1688
01:22:25,100 --> 01:22:26,430
We have good reason to believe

1689
01:22:26,430 --> 01:22:27,810

that there is water below the surface.

1690
01:22:27,810 --> 01:22:29,840
The question is how deep and in what form

1691
01:22:29,840 --> 01:22:32,150
and how abundant it might be.

1692
01:22:32,150 --> 01:22:32,983
Water---

1693
01:22:32,983 --> 01:22:35,300
- [Narrator] Like the
engineers, Paige's science team

1694
01:22:35,300 --> 01:22:39,050
had worked in a feverish
faster, better, cheaper mode,

1695
01:22:39,050 --> 01:22:42,030
only to have the pace
become even more intense

1696
01:22:42,030 --> 01:22:45,082
after the loss of Climate Orbiter.

1697
01:22:45,082 --> 01:22:46,150
(soft music)

1698
01:22:46,150 --> 01:22:48,530
- We had this even
bigger mountain to climb,

1699
01:22:48,530 --> 01:22:51,680
which was to get the Lander together.

1700
01:22:51,680 --> 01:22:55,440
We had, you know, a camera
system, a robotic arm,

1701
01:22:55,440 --> 01:22:56,700
we would dig trenches.

1702
01:22:56,700 --> 01:22:58,940
We would look inside layered terrains.

1703
01:22:58,940 --> 01:23:01,530
And the fact that this orbiter didn't work

1704
01:23:01,530 --> 01:23:04,010
all of a sudden meant that our plans

1705
01:23:04,010 --> 01:23:05,860
for how we were going to operate

1706
01:23:05,860 --> 01:23:07,993
the Lander on the surface of Mars

1707
01:23:07,993 --> 01:23:12,993
in just a couple of months,
had to be radically altered.

1708
01:23:13,290 --> 01:23:15,763
Everybody was under incredible stress.

1709
01:23:17,210 --> 01:23:19,430
- [Narrator] And the Lander
had left the launch pad

1710
01:23:19,430 --> 01:23:22,910
not knowing precisely
where it was to land.

1711
01:23:22,910 --> 01:23:27,350
20 year old Viking images
had identified a general area

1712

01:23:27,350 --> 01:23:29,500
but scientists had been awaiting new

1713
01:23:29,500 --> 01:23:33,193
and far more detailed images
from Mars Global Surveyor.

1714
01:23:35,200 --> 01:23:36,350
- In those days when you looked

1715
01:23:36,350 --> 01:23:39,360
at the south polar layered
terrain with Viking

1716
01:23:39,360 --> 01:23:43,060
you saw this beautiful, smooth area

1717
01:23:43,060 --> 01:23:45,260
that looked like, oh my gosh,
you know, it looks like,

1718
01:23:45,260 --> 01:23:47,270
you know, just, whatever, baby skin.

1719
01:23:47,270 --> 01:23:48,713
You know, there's no,

1720
01:23:49,548 --> 01:23:51,463
there's no hazards here whatsoever.

1721
01:23:53,970 --> 01:23:56,010
- [Narrator] But that
impression was dispelled

1722
01:23:56,010 --> 01:23:58,273
by Global Surveyor's images.

1723
01:23:59,520 --> 01:24:02,380
Although this topographic

map of the landing area

1724
01:24:02,380 --> 01:24:04,280
was intentionally exaggerated

1725
01:24:04,280 --> 01:24:06,460
to highlight height differences,

1726
01:24:06,460 --> 01:24:10,330
it was still a sobering jolt
as landing day approached.

1727
01:24:11,755 --> 01:24:14,505
(dramatic music)

1728
01:24:22,680 --> 01:24:24,430
- [Man 35] We are an
hour and a quarter away

1729
01:24:24,430 --> 01:24:28,045
from arriving on the surface
of Mars with three spacecraft.

1730
01:24:28,045 --> 01:24:31,790
(men speaking indistinctly)

1731
01:24:31,790 --> 01:24:33,540
The soft landing Mars Polar Lander.

1732
01:24:34,700 --> 01:24:37,480
And two experimental [inaudible].

1733
01:24:37,480 --> 01:24:40,430
- [Man 36] Fault Protection
reports all states are nominal.

1734
01:24:41,290 --> 01:24:42,940
We have a good spacecraft.

1735
01:24:42,940 --> 01:24:44,663
We are ready for entry.

1736
01:24:46,640 --> 01:24:48,803
- Spacecraft engineerimg
[unintelligible] on Mars Ops.

1737
01:24:49,680 --> 01:24:52,660
- [Man 37] Yes, I'd like to
report that the pyrotechnic

1738
01:24:52,660 --> 01:24:56,192
device has fired to pressurize
the propulsion system

1739
01:24:56,192 --> 01:24:58,040
for [Unintelligible].

1740
01:24:58,040 --> 01:24:59,341
- [Man 38] Copy.

1741
01:24:59,341 --> 01:25:04,341
(suspenseful music)

1742
01:25:06,085 --> 01:25:09,002
- F1 copy, spacecraft go for entry.

1743
01:25:15,200 --> 01:25:16,390
- You've been sitting in the room here

1744
01:25:16,390 --> 01:25:18,077
for the last hour or so.

1745
01:25:18,077 --> 01:25:20,100
What's your view from the inside?

1746
01:25:20,100 --> 01:25:22,028
- Cautious confidence.

1747
01:25:22,028 --> 01:25:25,000
We think we've done everything we can do.

1748
01:25:25,000 --> 01:25:28,090
It's out of the engineers'
hands at this point in time.

1749
01:25:28,090 --> 01:25:31,030
And every indication
is that the spacecraft

1750
01:25:31,030 --> 01:25:34,510
is performing exactly as intended.

1751
01:25:34,510 --> 01:25:37,000
Everything's nice and
warm and ready to start

1752
01:25:37,000 --> 01:25:38,580
the entry, descent and
landing sequence here

1753
01:25:38,580 --> 01:25:40,626
in just a few short minutes.

1754
01:25:40,626 --> 01:25:43,626
(suspenseful music)

1755
01:25:47,157 --> 01:25:48,870
(men speaking indistinctly)

1756
01:25:48,870 --> 01:25:50,693
- You guys have to eat a lot of peanuts.

1757
01:25:50,693 --> 01:25:53,276
(men laughing)

1758

01:25:55,170 --> 01:25:56,980
- [Man 39] Engineer, attitude
can confirm initialization

1759
01:25:56,980 --> 01:26:00,460
of the absolute slew with
the target entry attitudes.

1760
01:26:00,460 --> 01:26:02,910
- [Man 40] Copy that
attitude. Prepared for slew.

1761
01:26:06,010 --> 01:26:08,510
- [Man 41] F1 copy. Autopilot
initialize for slew.

1762
01:26:10,420 --> 01:26:12,440
- [David] This is a Doppler plot.

1763
01:26:12,440 --> 01:26:14,610
What we're seeing as the
line curves downwards

1764
01:26:14,610 --> 01:26:16,920
is the increase in the
velocity of the spacecraft

1765
01:26:16,920 --> 01:26:18,730
as it approaches Mars.

1766
01:26:18,730 --> 01:26:19,607
The closer it gets to Mars

1767
01:26:19,607 --> 01:26:21,870
the more significant
the gravitational pull

1768
01:26:21,870 --> 01:26:24,413
on the spacecraft and
the greater its speed.

1769
01:26:25,820 --> 01:26:27,840
We're going to lose
this information shortly

1770
01:26:27,840 --> 01:26:29,863
as the spacecraft turns away from earth.

1771
01:26:33,620 --> 01:26:35,480
- [Man 42] And all stations
have tele on Mars Ops.

1772
01:26:35,480 --> 01:26:40,037
We have all stations at 1463 and 15 LCLS.

1773
01:26:40,037 --> 01:26:43,037
(suspenseful music)

1774
01:26:45,360 --> 01:26:47,881
- [Man 43] FLM spacecraft engineer.

1775
01:26:47,881 --> 01:26:49,230
- [Man 44] ZFM.

1776
01:26:49,230 --> 01:26:51,440
- [Man 43] Happy landing, Sam.

1777
01:26:51,440 --> 01:26:54,961
- [Man 44] Copy that lad.
30 minutes or so to go here.

1778
01:26:54,961 --> 01:26:57,400
(men speaking indistinctly)

1779
01:26:57,400 --> 01:26:59,180
- This is a view of the landing site.

1780
01:26:59,180 --> 01:27:01,393

The red ellipse is a target area.

1781
01:27:02,740 --> 01:27:04,890
And in the center of that ellipse

1782
01:27:04,890 --> 01:27:06,820
is where we're headed today.

1783
01:27:06,820 --> 01:27:11,820
They showed me a picture of
this sort of large depression,

1784
01:27:13,540 --> 01:27:16,380
and it reminded me of
Climate Orbiter again,

1785
01:27:16,380 --> 01:27:19,360
that somehow the Lander had
sort of drifted off course

1786
01:27:19,360 --> 01:27:21,620
a little bit compared to
where we wanted to land it.

1787
01:27:21,620 --> 01:27:24,370
And that it was not
going to hit this cliff

1788
01:27:24,370 --> 01:27:26,630
but it seemed like it was awfully close

1789
01:27:26,630 --> 01:27:28,788
to this cliff feature here.

1790
01:27:28,788 --> 01:27:30,890
And I said, "Oh God, you know
what, how did this happen?"

1791
01:27:30,890 --> 01:27:33,470

You know, somebody said some
sort of techno mumbo jumbo

1792
01:27:33,470 --> 01:27:36,040
about, you know,
trajectories and solutions

1793
01:27:36,040 --> 01:27:37,110
and all this kind of stuff.

1794
01:27:37,110 --> 01:27:39,060
And I said, "Okay, you know, whatever."

1795
01:27:40,570 --> 01:27:43,130
But I think that was the real
interesting moment for me

1796
01:27:43,130 --> 01:27:47,930
because it really hit home
sort of how remote Mars is

1797
01:27:47,930 --> 01:27:50,060
from the earth.

1798
01:27:50,060 --> 01:27:51,470
You're just completely on your own.

1799
01:27:51,470 --> 01:27:55,313
Like the concept of like true
exploration really hit home.

1800
01:27:55,313 --> 01:27:57,726
That we were really, really out there.

1801
01:27:57,726 --> 01:27:59,060
(camera clicking)

1802
01:27:59,060 --> 01:28:00,100
- [Man 45] At this time, the Lander

1803
01:28:00,100 --> 01:28:02,240
should be commanding
separation from the back shell

1804
01:28:02,240 --> 01:28:05,640
with the guidance system
initiating a pitch up maneuver.

1805
01:28:05,640 --> 01:28:08,950
Power to send is only about
40 seconds in duration.

1806
01:28:08,950 --> 01:28:11,280
During that time, the
spacecraft will decelerate

1807
01:28:11,280 --> 01:28:14,250
from approximately 75 meters per second

1808
01:28:14,250 --> 01:28:17,617
or 160 miles per hour
down to a soft landing,

1809
01:28:17,617 --> 01:28:19,823
in just over five miles per hour.

1810
01:28:22,178 --> 01:28:25,953
- [Man 46] Systems, we expect
to touch down at 20:14:45.

1811
01:28:27,030 --> 01:28:27,863
- [Man 47] Copy that.

1812
01:28:27,863 --> 01:28:29,440
Hey Billy, are we past that mark systems?

1813
01:28:29,440 --> 01:28:31,230
- [Man 46] Affirmative.

1814
01:28:31,230 --> 01:28:32,063
- [Man 47] Copy that.

1815
01:28:32,063 --> 01:28:32,896
- [David] At this point the Lander

1816
01:28:32,896 --> 01:28:34,270
should be sitting resting safely

1817
01:28:34,270 --> 01:28:37,090
on the surface for the
nominal flight path.

1818
01:28:37,090 --> 01:28:40,390
Again, storing RT data
in critical entry descent

1819
01:28:40,390 --> 01:28:43,290
landing engineering telemetry
in its nonvolatile memory.

1820
01:28:44,530 --> 01:28:45,757
- [Narrator] Just minutes after the time

1821
01:28:45,757 --> 01:28:47,640
of the scheduled touchdown

1822
01:28:47,640 --> 01:28:51,420
into the mission support
area walked, unannounced,

1823
01:28:51,420 --> 01:28:54,300
NASA Administrator Dan Goldin.

1824
01:28:54,300 --> 01:28:57,880
He was followed by JPL Director Ed Stone

1825

01:28:57,880 --> 01:29:01,270
and Caltech president David Baltimore.

1826
01:29:01,270 --> 01:29:03,290
And on the telephone from Washington

1827
01:29:03,290 --> 01:29:08,033
was vice president Al Gore
waiting to congratulate the team.

1828
01:29:09,450 --> 01:29:11,980
- In this particular
instance it was almost like

1829
01:29:11,980 --> 01:29:14,300
you hear stories about animals or cats,

1830
01:29:14,300 --> 01:29:16,360
you know, that are pregnant
cats that want to go off

1831
01:29:16,360 --> 01:29:17,630
in a corner and hide somewhere

1832
01:29:17,630 --> 01:29:19,220
before they give birth. Right?

1833
01:29:19,220 --> 01:29:21,310
This was definitely one of
those cases, where it was like,

1834
01:29:21,310 --> 01:29:24,020
can we just get all of
the press out of here

1835
01:29:24,020 --> 01:29:25,930
and get all of the dignitaries out of here

1836
01:29:25,930 --> 01:29:28,550

and let us do what we
need to do, you know,

1837
01:29:28,550 --> 01:29:31,420
in dignity by yourselves
and we'll call you.

1838
01:29:31,420 --> 01:29:32,253
You know, get out of the,

1839
01:29:32,253 --> 01:29:34,800
get the dad out of the delivery room, go,

1840
01:29:34,800 --> 01:29:36,690
go to the bar across the street.

1841
01:29:36,690 --> 01:29:38,710
And once the delivery's done

1842
01:29:38,710 --> 01:29:41,450
one way or the other we'll
call you when this is over.

1843
01:29:41,450 --> 01:29:44,190
(men speaking indistinctly)

1844
01:29:44,190 --> 01:29:47,030
- We were showing him the
pictures of the landing site

1845
01:29:47,030 --> 01:29:48,153
and he looked and said, "That's,

1846
01:29:48,153 --> 01:29:50,510
"are you sure this is a safe spot?

1847
01:29:50,510 --> 01:29:54,440
You know, all of a sudden,
(laughing)

1848
01:29:54,440 --> 01:29:57,700
you could see this, you
know, twinge of doubt,

1849
01:29:57,700 --> 01:30:00,320
sort of roll over the man's face

1850
01:30:00,320 --> 01:30:02,970
as he started, you
know, sort of looking at

1851
01:30:02,970 --> 01:30:05,060
what we were actually going to do here,

1852
01:30:05,060 --> 01:30:08,290
which was to, you know, come
blazing through the atmosphere,

1853
01:30:08,290 --> 01:30:09,540
open up these parachutes,

1854
01:30:09,540 --> 01:30:11,170
put on the thrusters and try to land

1855
01:30:11,170 --> 01:30:14,683
this three legged Lander, you
know, in this terrain here.

1856
01:30:15,580 --> 01:30:16,871
- [Man 48] All stations [Unintelligible].

1857
01:30:16,871 --> 01:30:17,704
We're still looking.

1858
01:30:17,704 --> 01:30:18,610
[Inaudible]

1859

01:30:28,333 --> 01:30:30,340
- [Narrator] Half past high noon

1860
01:30:30,340 --> 01:30:33,980
was the first opportunity
to hear from the lander

1861
01:30:33,980 --> 01:30:36,381
but there was only silence.

1862
01:30:36,381 --> 01:30:39,381
(suspenseful music)

1863
01:30:45,325 --> 01:30:47,833
(camera clicking)

1864
01:31:05,260 --> 01:31:08,593
- [Man 49] First AD, we are at 21:23:26.

1865
01:31:14,005 --> 01:31:17,803
Telemetry looking for... [Inaudible]

1866
01:31:22,980 --> 01:31:26,483
- Imagine standing next to Dan Goldin.

1867
01:31:27,540 --> 01:31:29,680
And then Goldin's
assistant's got the telephone

1868
01:31:29,680 --> 01:31:32,653
tied in to Gore, to report the success.

1869
01:31:33,552 --> 01:31:34,702
And, um...

1870
01:31:35,800 --> 01:31:37,193
that's bad news.

1871

01:31:38,136 --> 01:31:38,969
Bad day.

1872
01:31:40,979 --> 01:31:45,979
(man speaking indistinctly)

1873
01:31:55,283 --> 01:31:58,950
(men speaking indistinctly)

1874
01:32:04,435 --> 01:32:07,435
(suspenseful music)

1875
01:32:08,480 --> 01:32:10,080
- We did not hear.

1876
01:32:10,080 --> 01:32:12,660
But we had a plan for what would
happen when we didn't hear.

1877
01:32:12,660 --> 01:32:13,760
We have a plan

1878
01:32:13,760 --> 01:32:17,220
of additional communications
opportunities today.

1879
01:32:17,220 --> 01:32:19,290
That playbook, you know,

1880
01:32:19,290 --> 01:32:22,400
I think it reflects our normal model

1881
01:32:22,400 --> 01:32:23,960
which is, well, it's a problem,

1882
01:32:23,960 --> 01:32:25,380
but this thing will, you know,

1883

01:32:25,380 --> 01:32:27,690
this is what could have
caused it and that'll be okay

1884
01:32:27,690 --> 01:32:30,340
because there'll be another opportunity.

1885
01:32:30,340 --> 01:32:32,150
- What are the possibilities realistically

1886
01:32:32,150 --> 01:32:35,770
that something catastrophic
has happened to the spacecraft?

1887
01:32:35,770 --> 01:32:37,210
- I think we have a long way to go

1888
01:32:37,210 --> 01:32:39,420
before we're going to be of any concern.

1889
01:32:39,420 --> 01:32:42,080
- Can you think of a single scenario

1890
01:32:42,080 --> 01:32:45,840
that would account for the
failure of communication

1891
01:32:45,840 --> 01:32:49,163
with both the probes and the Lander.

1892
01:32:50,460 --> 01:32:53,220
- Not separating. The
cruise stage not separating.

1893
01:32:53,220 --> 01:32:55,900
And so we played through the playbook,

1894
01:32:55,900 --> 01:32:58,060
which stretched for days.

1895
01:32:58,060 --> 01:33:02,840
- And, we will continue to
look for the probes once a day

1896
01:33:02,840 --> 01:33:04,970
all the way out through sol nine.

1897
01:33:04,970 --> 01:33:06,050
But to be honest with you,

1898
01:33:06,050 --> 01:33:07,930
the chances of hearing from them

1899
01:33:07,930 --> 01:33:11,730
will be greatly decreased
by tomorrow morning.

1900
01:33:11,730 --> 01:33:15,100
It was a very bad time period

1901
01:33:15,100 --> 01:33:19,640
for those of us who had given so much

1902
01:33:19,640 --> 01:33:22,670
and invested so much in a mission.

1903
01:33:22,670 --> 01:33:25,540
You get very attached to the spacecraft.

1904
01:33:25,540 --> 01:33:26,420
And when you lose one

1905
01:33:26,420 --> 01:33:29,653
it's like losing a best friend
and it's very difficult.

1906
01:33:31,100 --> 01:33:32,480

- [Journalist 5] How confident are you

1907
01:33:32,480 --> 01:33:35,210
that the probe is intact on the surface?

1908
01:33:35,210 --> 01:33:37,807
- You know, I think that
that's the big question.

1909
01:33:37,807 --> 01:33:39,400
- And it begs the question again

1910
01:33:39,400 --> 01:33:43,144
whether we're trying to do
these too fast and too cheap.

1911
01:33:43,144 --> 01:33:44,760
And that is something
that we hear quite often

1912
01:33:44,760 --> 01:33:47,090
from people around here.

1913
01:33:47,090 --> 01:33:47,923
What do you say?

1914
01:33:49,290 --> 01:33:51,960
- Frankly, are you not
clutching at straws?

1915
01:33:51,960 --> 01:33:54,260
- We haven't exhausted
all the possibilities.

1916
01:33:54,260 --> 01:33:56,370
I do think that the
lesson I learned from that

1917
01:33:56,370 --> 01:33:58,470

is that they either go really well

1918
01:33:58,470 --> 01:33:59,900
or they really don't go well.

1919
01:33:59,900 --> 01:34:03,670
There's not really a in
between that's very likely.

1920
01:34:03,670 --> 01:34:05,660
We're pretty much reaching the point

1921
01:34:05,660 --> 01:34:08,900
where we've used up our
final silver bullets.

1922
01:34:08,900 --> 01:34:11,010
You can still continue to try to find it

1923
01:34:11,010 --> 01:34:13,410
but to get yourself in that mindset

1924
01:34:13,410 --> 01:34:15,700
which you got to accept it, is better,

1925
01:34:15,700 --> 01:34:16,670
better for everyone

1926
01:34:16,670 --> 01:34:18,950
than sort of slowly
ripping the band-aid off,

1927
01:34:18,950 --> 01:34:20,003
which is what we did.

1928
01:34:22,152 --> 01:34:23,073
- JFM, go ahead.

1929

01:34:24,500 --> 01:34:26,940
- [Man 50] JFM, I'm sorry
to report that all we have

1930
01:34:26,940 --> 01:34:29,250
is HKTM at this point.

1931
01:34:29,250 --> 01:34:32,723
It seemed to have been a
nominal no-contact MR pass.

1932
01:34:34,610 --> 01:34:35,443
- Copy that Mark.

1933
01:34:35,443 --> 01:34:36,440
Thanks for that.

1934
01:34:36,440 --> 01:34:38,240
Thanks for hanging in there with us.

1935
01:34:42,144 --> 01:34:45,060
(soft music)

1936
01:34:45,060 --> 01:34:47,130
- [Narrator] The loss of Mars Polar Lander

1937
01:34:47,130 --> 01:34:49,130
was first believed to have been caused

1938
01:34:49,130 --> 01:34:52,670
by a premature shutdown
of the descent engines.

1939
01:34:52,670 --> 01:34:57,220
If true, the Lander after safely
traveling 200 million miles

1940
01:34:57,220 --> 01:35:00,883
was lost in the last

200 feet of its journey.

1941
01:35:02,070 --> 01:35:05,550
But no crash site has
ever been seen from orbit.

1942
01:35:05,550 --> 01:35:07,910
Subsequent research
points to the likelihood

1943
01:35:07,910 --> 01:35:10,833
that the Lander in its
cruise stage never separated.

1944
01:35:11,670 --> 01:35:16,203
But Mars Polar Lander remains
a mystery still to be solved.

1945
01:35:17,910 --> 01:35:21,840
- We just went too far
in trying to skinny down

1946
01:35:21,840 --> 01:35:25,700
and reduce the number of eyes,
the number people involved.

1947
01:35:25,700 --> 01:35:27,450
It was just too fragile.

1948
01:35:27,450 --> 01:35:28,700
It almost worked.

1949
01:35:28,700 --> 01:35:30,490
In fact, it probably could have worked.

1950
01:35:30,490 --> 01:35:33,090
But that is not the right answer.

1951
01:35:33,090 --> 01:35:35,670

The right answer is to
find the right balance

1952
01:35:35,670 --> 01:35:38,810
of checks and balances and safety net.

1953
01:35:38,810 --> 01:35:41,900
So that in fact, you don't expose teams

1954
01:35:41,900 --> 01:35:43,340
to these sorts of situations

1955
01:35:43,340 --> 01:35:45,490
which are really
devastating for the teams.

1956
01:35:46,530 --> 01:35:48,560
The eyes of the world are always upon us

1957
01:35:48,560 --> 01:35:50,460
when we go to the red planet.

1958
01:35:50,460 --> 01:35:52,120
When we succeed---

1959
01:35:52,120 --> 01:35:54,290
- [Narrator] One week
after the failed landing

1960
01:35:54,290 --> 01:35:57,750
Ed Stone, once again, addressed the lab.

1961
01:35:57,750 --> 01:36:00,940
While acknowledging another painful loss,

1962
01:36:00,940 --> 01:36:04,070
his message was really about the future.

1963

01:36:04,070 --> 01:36:06,350
- The last week has been very difficult

1964
01:36:06,350 --> 01:36:08,870
and the attention is far from over.

1965
01:36:08,870 --> 01:36:12,050
But scrutiny and criticism
can be good things.

1966
01:36:12,050 --> 01:36:14,000
At times we will be uncomfortable

1967
01:36:14,000 --> 01:36:15,930
with some of what is said about us.

1968
01:36:15,930 --> 01:36:17,430
But at the end of the day

1969
01:36:17,430 --> 01:36:19,180
we will learn from what has happened

1970
01:36:19,180 --> 01:36:21,763
and JPL will be a better
place for all of it.

1971
01:36:22,970 --> 01:36:24,900
I was reminded of this earlier this week,

1972
01:36:24,900 --> 01:36:27,110
when Homer Hickam, the
author of "Rocket Boys",

1973
01:36:27,110 --> 01:36:30,217
some of you may know the
book by the movie title,

1974
01:36:30,217 --> 01:36:32,970
"October Sky." And he suggested

1975
01:36:32,970 --> 01:36:35,733
that I turn to chapter 19 of his book.

1976
01:36:36,820 --> 01:36:40,400
A lot has happened to you,
probably more than I know.

1977
01:36:40,400 --> 01:36:43,850
But I'm telling you, if you
stop working on your rockets now

1978
01:36:43,850 --> 01:36:46,210
you will regret it the rest of your life.

1979
01:36:46,210 --> 01:36:48,570
You've got to put all
your hurt and anger aside

1980
01:36:48,570 --> 01:36:50,580
so that you can do your job.

1981
01:36:50,580 --> 01:36:53,850
Your job, sonny, is to build your rockets.

1982
01:36:53,850 --> 01:36:56,050
You've got to give it
everything you've got.

1983
01:36:57,170 --> 01:36:59,460
You all are Homer Hickams.

1984
01:36:59,460 --> 01:37:02,890
A lot has happened to you,
probably more than I know.

1985
01:37:02,890 --> 01:37:06,230
But if you stop working on
your rockets, on your projects,

1986
01:37:06,230 --> 01:37:09,200
you too will regret it
the rest of your life.

1987
01:37:09,200 --> 01:37:12,210
You have to put all your
hurt, your anger aside,

1988
01:37:12,210 --> 01:37:13,920
so you can do your job.

1989
01:37:13,920 --> 01:37:16,180
Because your job is to build the rocket.

1990
01:37:16,180 --> 01:37:18,590
Your rocket is going to open the doors

1991
01:37:18,590 --> 01:37:20,990
to space exploration in the 21st century.

1992
01:37:20,990 --> 01:37:22,483
Thank you.

1993
01:37:22,483 --> 01:37:25,483
(audience clapping)

1994
01:37:45,958 --> 01:37:48,375
(soft music)

1995
01:37:53,080 --> 01:37:54,590
- [Facilitator] All
members' opening statements

1996
01:37:54,590 --> 01:37:57,350
will be placed into the
record at this point.

1997

01:37:57,350 --> 01:38:00,060
Will you all please stand
and raise your right hand?

1998
01:38:00,060 --> 01:38:01,330
- We just went too far.

1999
01:38:01,330 --> 01:38:03,176
We pushed those boundaries too far

2000
01:38:03,176 --> 01:38:04,310
and we've cut,

2001
01:38:04,310 --> 01:38:07,810
we cut back too far on
what history has taught us,

2002
01:38:07,810 --> 01:38:11,750
to be sound management and
sound engineering principles.

2003
01:38:11,750 --> 01:38:14,060
I think the project felt
that what they were doing

2004
01:38:14,060 --> 01:38:16,457
was reasonable and that it's good work

2005
01:38:16,457 --> 01:38:18,310
and it would work and
it could have worked.

2006
01:38:18,310 --> 01:38:21,623
And it would've worked
if nobody made a mistake.

2007
01:38:22,730 --> 01:38:25,580
But that's the big if, you know,
and that's what people are.

2008
01:38:25,580 --> 01:38:26,680
They're mistake makers.

2009
01:38:26,680 --> 01:38:30,483
And you have to have a system
that's tolerant to a mistake.

2010
01:38:31,530 --> 01:38:34,450
Which means you have to
have checks and balances.

2011
01:38:34,450 --> 01:38:36,090
- We find a NASA headquarters,

2012
01:38:36,090 --> 01:38:38,480
Jet Propulsion Laboratory's interface,

2013
01:38:38,480 --> 01:38:43,290
that was ineffective in resolving
issues and managing risk.

2014
01:38:43,290 --> 01:38:44,281
We find a Lockheed---

2015
01:38:44,281 --> 01:38:47,550
I think that JPL had two responsibilities.

2016
01:38:47,550 --> 01:38:50,840
They had the responsibility
to follow our direction,

2017
01:38:50,840 --> 01:38:55,550
but they also had the responsibility
to go back and to say,

2018
01:38:55,550 --> 01:38:57,210
you know, that it wasn't,

2019

01:38:57,210 --> 01:38:59,500
that the direction was not executable.

2020
01:38:59,500 --> 01:39:03,100
And we identified organizational changes

2021
01:39:03,100 --> 01:39:05,697
that we thought were appropriate at JPL

2022
01:39:05,697 --> 01:39:07,140
and at NASA headquarters

2023
01:39:07,140 --> 01:39:09,950
to assure the success of
the program in the future.

2024
01:39:09,950 --> 01:39:12,230
- I was excoriated,

2025
01:39:12,230 --> 01:39:14,410
in the hearings in the Congress.

2026
01:39:14,410 --> 01:39:15,483
It was ugly.

2027
01:39:16,380 --> 01:39:20,090
- I don't object to
losses from taking risks.

2028
01:39:20,090 --> 01:39:21,590
That's what it's all about.

2029
01:39:21,590 --> 01:39:24,880
I definitely object to
losses due to mistakes,

2030
01:39:24,880 --> 01:39:28,720
especially what I unmercifully
will call, stupid mistakes.

2031
01:39:28,720 --> 01:39:30,260
- I'll answer the question.

2032
01:39:30,260 --> 01:39:34,630
I feel a certain level of
hostility in this interaction.

2033
01:39:34,630 --> 01:39:36,460
- [Senator Vern] Well,
you're a good politician.

2034
01:39:36,460 --> 01:39:38,350
I'm trying to get to the point yet--

2035
01:39:38,350 --> 01:39:41,020
- But those two missions to Mars

2036
01:39:42,690 --> 01:39:45,160
will always be on my back.

2037
01:39:45,160 --> 01:39:46,053
I don't care.

2038
01:39:46,980 --> 01:39:50,340
- We wanted to push the limits
to see how far we can go.

2039
01:39:50,340 --> 01:39:52,040
He was not thrilled with what he heard,

2040
01:39:52,040 --> 01:39:54,320
I guess, would be a way to describe it.

2041
01:39:54,320 --> 01:39:56,853
I mean, he didn't say
anything about you're wrong.

2042

01:39:58,150 --> 01:40:00,120
You know, it's a problem.

2043
01:40:00,120 --> 01:40:01,610
But he was, you know,

2044
01:40:01,610 --> 01:40:04,160
he was having difficulty as I would have,

2045
01:40:04,160 --> 01:40:07,730
you know, internalizing
the whole activity.

2046
01:40:07,730 --> 01:40:09,960
- You don't win popularity contests

2047
01:40:09,960 --> 01:40:11,633
when you're changing bureaucracy.

2048
01:40:12,570 --> 01:40:16,070
- As a NASA administrator,
I had to take the heat.

2049
01:40:16,070 --> 01:40:19,030
I was worried we were going
to lose the Jet Propulsion Lab

2050
01:40:19,030 --> 01:40:21,630
due to this gnashing of teeth.

2051
01:40:21,630 --> 01:40:25,210
And there were people at NASA headquarters

2052
01:40:25,210 --> 01:40:26,913
who love retribution.

2053
01:40:28,640 --> 01:40:30,400
- It had to go down hard.

2054
01:40:30,400 --> 01:40:32,150
I think it would have gone
down hard with anybody,

2055
01:40:32,150 --> 01:40:34,920
because it was a pretty
hard hitting report.

2056
01:40:34,920 --> 01:40:38,164
And it really said that, you
know, we were on a course

2057
01:40:38,164 --> 01:40:39,970
that

2058
01:40:40,890 --> 01:40:42,773
was destructive for NASA.

2059
01:40:44,030 --> 01:40:46,450
- So if there is no further
business before the committee,

2060
01:40:46,450 --> 01:40:48,620
the Committee on Science stands adjourned.

2061
01:40:48,620 --> 01:40:51,287
(gavel banging)

2062
01:40:52,276 --> 01:40:55,609
(footsteps approaching)

2063
01:40:56,530 --> 01:40:59,410
- I pushed too hard.

2064
01:40:59,410 --> 01:41:03,970
And in doing so, stretched
the system too thin.

2065

01:41:03,970 --> 01:41:06,633
It wasn't intentional.
It wasn't malicious.

2066
01:41:07,730 --> 01:41:09,540
I believed in the vision.

2067
01:41:09,540 --> 01:41:13,743
But it may have made
some failure inevitable.

2068
01:41:14,660 --> 01:41:18,180
I have no qualms about pushing them.

2069
01:41:18,180 --> 01:41:20,500
Albeit, they should have
pushed back a little bit,

2070
01:41:20,500 --> 01:41:22,110
but it's okay.

2071
01:41:22,110 --> 01:41:24,840
I wanted to demonstrate to the world

2072
01:41:24,840 --> 01:41:29,820
that we could do things much
better than anyone else.

2073
01:41:29,820 --> 01:41:30,893
And you delivered.

2074
01:41:32,720 --> 01:41:35,630
What we did is we reduced
the price of the mission

2075
01:41:36,620 --> 01:41:40,690
from, in excess of billions,

2076
01:41:40,690 --> 01:41:42,123

to a few hundred million.

2077
01:41:43,070 --> 01:41:47,590
We knew we could have errors
and it occurred. So what?

2078
01:41:47,590 --> 01:41:48,853
So what?

2079
01:41:50,600 --> 01:41:54,010
I salute the team's conviction and courage

2080
01:41:54,010 --> 01:41:59,010
and make no mistake, they
need not apologize to anyone.

2081
01:41:59,790 --> 01:42:02,150
They did not fail alone.

2082
01:42:02,150 --> 01:42:07,150
As the head of NASA, I
accept the responsibility.

2083
01:42:07,450 --> 01:42:11,693
You can't have stunning
science without failure.

2084
01:42:12,690 --> 01:42:15,770
And I have no regrets

2085
01:42:15,770 --> 01:42:17,140
about that mission.

2086
01:42:17,140 --> 01:42:18,753
Zero. None.

2087
01:42:23,495 --> 01:42:25,912
(soft music)

2088
01:42:29,260 --> 01:42:32,670
- [Narrator] The Mars 98
failures were a setback

2089
01:42:32,670 --> 01:42:34,640
and a new beginning.

2090
01:42:34,640 --> 01:42:39,000
Rather than retrenching, NASA's
Mars program was reinvented

2091
01:42:39,000 --> 01:42:41,163
and given greater financial support.

2092
01:42:44,310 --> 01:42:46,350
In years to come, technical twins

2093
01:42:46,350 --> 01:42:48,823
of Mars Polar Lander would fly.

2094
01:42:50,140 --> 01:42:53,110
The Climate Orbiter mission
was immediately reflown,

2095
01:42:53,110 --> 01:42:55,440
as Mars Odyssey 2001.

2096
01:42:55,440 --> 01:42:57,840
- [Man 51] We have
basically, eight receivers

2097
01:42:57,840 --> 01:43:00,688
in lock right now and
the spacecraft all...

2098
01:43:00,688 --> 01:43:03,271
(men clapping)

2099

01:43:05,010 --> 01:43:06,980
- [Narrator] Dan McCleese'
science instrument

2100
01:43:06,980 --> 01:43:08,840
on his third attempt,

2101
01:43:08,840 --> 01:43:11,633
finally made it safely to the red planet.

2102
01:43:13,510 --> 01:43:16,700
Getting Mars Odyssey underway
was a fitting capstone

2103
01:43:16,700 --> 01:43:19,713
for Ed Stone's tenure as JPL director.

2104
01:43:20,650 --> 01:43:23,610
And before departing he
signed onto a bold plan,

2105
01:43:23,610 --> 01:43:26,873
to send an entirely new
kind of Rover to Mars.

2106
01:43:28,890 --> 01:43:31,060
Dan Goldin liked the idea so much

2107
01:43:31,060 --> 01:43:33,540
that he ordered up two of them.

2108
01:43:33,540 --> 01:43:36,213
It was one of his last major decisions.

2109
01:43:37,068 --> 01:43:40,120
(soft music)

2110
01:43:40,120 --> 01:43:44,460
As 2001 was also Goldin's

final year at NASA.

2111
01:43:44,460 --> 01:43:48,400
The era of faster, better,
cheaper came to an end.

2112
01:43:48,400 --> 01:43:52,293
But there would also be far
fewer Battlestar Galacticas.

2113
01:43:54,290 --> 01:43:58,070
And while one era was ending,
another was beginning.

2114
01:43:58,070 --> 01:44:02,030
For JPL and its new
Director, Charles Elachi,

2115
01:44:02,030 --> 01:44:04,170
the arrival of the 21st century

2116
01:44:04,170 --> 01:44:07,533
would be the opening of a
renaissance of space exploration.

2117
01:44:09,080 --> 01:44:12,190
And several of those involved in Mars 98

2118
01:44:12,190 --> 01:44:15,463
would join the ranks of the
laboratory's upper management.

2119
01:44:16,370 --> 01:44:17,900
One of them was Tom Gavin,

2120
01:44:17,900 --> 01:44:20,700
who would put in place
flight rules and practices

2121

01:44:20,700 --> 01:44:24,090
that all missions were required to follow.

2122
01:44:24,090 --> 01:44:27,660
Spacecrafts became more
expensive as a result,

2123
01:44:27,660 --> 01:44:29,133
but more of them worked.

2124
01:44:32,210 --> 01:44:35,250
The year 2001 also marked the completion

2125
01:44:35,250 --> 01:44:38,690
of Mars Global Surveyor's primary mission.

2126
01:44:38,690 --> 01:44:41,040
The mapping orbiter
would continue to operate

2127
01:44:41,040 --> 01:44:44,030
for five more years, collecting more data

2128
01:44:44,030 --> 01:44:46,713
than all previous Mars missions combined.

2129
01:44:47,790 --> 01:44:52,150
But Global Surveyor
ceased operating in 2006.

2130
01:44:52,150 --> 01:44:55,410
Its demise brought on by an
error made during an update

2131
01:44:55,410 --> 01:44:58,523
to the spacecraft's
complex computer system.

2132
01:45:01,120 --> 01:45:03,960

It was another reminder that humans are

2133
01:45:03,960 --> 01:45:06,490
and will always be

2134
01:45:06,490 --> 01:45:08,599
mistake makers.