
USTREAM LIVE

1
00:00:06,789 --> 00:00:04,630
i made it i am in roswell new mexico

2
00:00:09,430 --> 00:00:06,799
beth is going to be so happy

3
00:00:17,910 --> 00:00:09,440
i won wonder where she is

4
00:00:21,990 --> 00:00:20,230
hey beth hey marty where are you i'm

5
00:00:23,910 --> 00:00:22,000
getting ready for the show

6
00:00:25,429 --> 00:00:23,920
i'm in roswell new mexico you know the

7
00:00:26,790 --> 00:00:25,439
show's all about landing on other

8
00:00:29,349 --> 00:00:26,800
planets

9
00:00:31,269 --> 00:00:29,359
here in roswell new mexico the show

10
00:00:33,430 --> 00:00:31,279
isn't about aliens landing on this

11
00:00:36,150 --> 00:00:33,440
planet it's about us landing on other

12
00:00:38,310 --> 00:00:36,160
planets and why it's so hard well let me

13
00:00:40,549 --> 00:00:38,320

tell you it is really flat here i mean

14
00:00:42,790 --> 00:00:40,559
it would be easy to land something if

15
00:00:46,470 --> 00:00:42,800
you know what i mean that was a weather

16
00:00:49,190 --> 00:00:46,480
balloon 70 years ago oh it wasn't a ufo

17
00:00:51,670 --> 00:00:49,200
with little green men no now can you get

18
00:00:53,350 --> 00:00:51,680
back here so we can start the show yeah

19
00:00:56,229 --> 00:00:53,360
it's going to take me some time

20
00:00:58,630 --> 00:00:56,239
i better be soon because

21
00:01:28,469 --> 00:00:58,640
this is stem 30.

22
00:01:28,479 --> 00:01:49,030
this is 7 30.

23
00:01:53,350 --> 00:01:51,109
hi i'm marty and i'm beth and we are

24
00:01:56,069 --> 00:01:53,360
coming to you live from the stephen f

25
00:01:57,910 --> 00:01:56,079
udvar-hazy center in chantilly virginia

26
00:02:01,429 --> 00:01:57,920
we're standing in front of space shuttle

27
00:02:03,910 --> 00:02:01,439
discovery this thing spent 365 days in

28
00:02:08,070 --> 00:02:03,920
space over the course of 39 missions it

29
00:02:09,830 --> 00:02:08,080
flew over 148 million miles now today's

30
00:02:11,190 --> 00:02:09,840
show's about landing on other planets

31
00:02:13,190 --> 00:02:11,200
and there's some big misconceptions

32
00:02:15,510 --> 00:02:13,200
about the space shuttle they were never

33
00:02:18,070 --> 00:02:15,520
built to land on other planets in fact

34
00:02:20,309 --> 00:02:18,080
the only planet that this ever landed on

35
00:02:22,150 --> 00:02:20,319
was here on earth the space shuttle flew

36
00:02:24,550 --> 00:02:22,160
in low earth orbit which basically means

37
00:02:26,550 --> 00:02:24,560
it circled the earth and i'm guessing

38
00:02:28,390 --> 00:02:26,560

that our friends from jefferson academy

39
00:02:30,150 --> 00:02:28,400
already know that they're here today

40
00:02:32,869 --> 00:02:30,160
they've got some really great questions

41
00:02:35,350 --> 00:02:32,879
that they're ready to ask our expert now

42
00:02:36,470 --> 00:02:35,360
if you're watching us on television or

43
00:02:38,949 --> 00:02:36,480
online

44
00:02:41,110 --> 00:02:38,959
remember you can participate too in our

45
00:02:42,470 --> 00:02:41,120
discussion you can submit a question in

46
00:02:45,030 --> 00:02:42,480
the little box to the right on your

47
00:02:47,270 --> 00:02:45,040
screen we may take it live here on the

48
00:02:49,430 --> 00:02:47,280
air or if not we do have an expert

49
00:02:51,589 --> 00:02:49,440
standing by to answer it landing on

50
00:02:53,350 --> 00:02:51,599
other planets is hard and some of our

51
00:02:55,350 --> 00:02:53,360
friends from jefferson academy are

52
00:02:57,830 --> 00:02:55,360
trying their hand today at creating

53
00:03:00,949 --> 00:02:57,840
simulated martian landers and what their

54
00:03:03,190 --> 00:03:00,959
job today is to do is to take an egg

55
00:03:05,430 --> 00:03:03,200
stranaut and try to get it to land

56
00:03:07,149 --> 00:03:05,440
safely here on the floor and let me tell

57
00:03:10,229 --> 00:03:07,159
you they have been working

58
00:03:13,190 --> 00:03:10,239
extremely hard on this challenge i

59
00:03:14,949 --> 00:03:13,200
cannot wait to see how they do

60
00:03:17,190 --> 00:03:14,959
you know make me say it yeah otherwise

61
00:03:19,830 --> 00:03:17,200
i'm gonna egg you on

62
00:03:21,750 --> 00:03:19,840
okay no more yolks

63
00:03:23,670 --> 00:03:21,760

now marty you actually spent some time

64
00:03:25,589 --> 00:03:23,680
in roswell new mexico but you were not

65
00:03:27,190 --> 00:03:25,599
looking for aliens i was not robert

66
00:03:28,789 --> 00:03:27,200
goddard spent a lot of time in roswell

67
00:03:30,789 --> 00:03:28,799
new mexico building and launching

68
00:03:33,030 --> 00:03:30,799
rockets and i got an opportunity to go

69
00:03:35,430 --> 00:03:33,040
to the roswell museum and art center

70
00:03:37,910 --> 00:03:35,440
where they have recreated his lab with a

71
00:03:41,110 --> 00:03:37,920
lot of the original equipment it is

72
00:03:43,750 --> 00:03:41,120
almost exactly like it was back then

73
00:03:45,910 --> 00:03:43,760
i'm sure you were very excited

74
00:03:48,630 --> 00:03:45,920
now robert goddard is known as the

75
00:03:50,550 --> 00:03:48,640
father of modern rocketry he was

76
00:03:54,149 --> 00:03:50,560
credited as being the first person to

77
00:03:56,550 --> 00:03:54,159
use liquid of fuel in a rocket so

78
00:03:58,789 --> 00:03:56,560
let's go check it out

79
00:04:00,309 --> 00:03:58,799
i'm now joined by bill ciders docent and

80
00:04:01,990 --> 00:04:00,319
member of the board of trustees at the

81
00:04:03,670 --> 00:04:02,000
roswell museum and art center bill

82
00:04:05,190 --> 00:04:03,680
thanks for so much for talking with us

83
00:04:07,350 --> 00:04:05,200
you're welcome now we are in a

84
00:04:09,990 --> 00:04:07,360
recreation of robert goddard's lab tell

85
00:04:13,030 --> 00:04:10,000
us a little bit about robert goddard

86
00:04:15,429 --> 00:04:13,040
robert goddard is a very unusual man

87
00:04:18,789 --> 00:04:15,439
born in 1882

88
00:04:21,830 --> 00:04:18,799

so he came of age in at the turn of the

89
00:04:24,790 --> 00:04:21,840
century he wrote the definitive papers

90
00:04:28,710 --> 00:04:24,800
on rockets and rocket launching in the

91
00:04:31,350 --> 00:04:28,720
teens 1914 1916. he did the technology

92
00:04:34,310 --> 00:04:31,360
the science work and as you see around

93
00:04:36,469 --> 00:04:34,320
us here he he applied the technology to

94
00:04:39,590 --> 00:04:36,479
the problems in rockets

95
00:04:42,150 --> 00:04:39,600
he was an engineer i mean he designed

96
00:04:43,830 --> 00:04:42,160
this this rocket sitting here was a

97
00:04:46,390 --> 00:04:43,840
rocket that was built by him and his

98
00:04:48,790 --> 00:04:46,400
staff you couldn't buy anything he did

99
00:04:50,310 --> 00:04:48,800
the whole thing he was an engineer a

100
00:04:53,110 --> 00:04:50,320
technologist

101
00:04:56,710 --> 00:04:53,120
and a scientist that's

102
00:04:58,629 --> 00:04:56,720
that's a nice acronym s-t-e-m

103
00:05:01,830 --> 00:04:58,639
now why did robert goddard choose

104
00:05:04,629 --> 00:05:01,840
roswell because of a friend

105
00:05:05,590 --> 00:05:04,639
he had a friend charles lindbergh

106
00:05:07,350 --> 00:05:05,600
and

107
00:05:09,189 --> 00:05:07,360
they used to get together on a regular

108
00:05:10,469 --> 00:05:09,199
basis they would get out on goddard's

109
00:05:12,710 --> 00:05:10,479
back porch

110
00:05:14,230 --> 00:05:12,720
and talk over what was going on i can

111
00:05:16,710 --> 00:05:14,240
only imagine what those conversations

112
00:05:19,029 --> 00:05:16,720
were like well one of them occurred when

113
00:05:21,749 --> 00:05:19,039

goddard had had an explosion with these

114
00:05:23,189 --> 00:05:21,759
rockets in massachusetts so they packed

115
00:05:26,150 --> 00:05:23,199
all of this stuff up all of the

116
00:05:28,710 --> 00:05:26,160
equipment put it on a train shipped it

117
00:05:30,629 --> 00:05:28,720
out to roswell new mexico and started

118
00:05:33,110 --> 00:05:30,639
launching rockets from here and launched

119
00:05:34,870 --> 00:05:33,120
rockets he set up a test stand not more

120
00:05:37,029 --> 00:05:34,880
than about three miles from where we are

121
00:05:38,950 --> 00:05:37,039
right here tested all of his rocket

122
00:05:42,469 --> 00:05:38,960
designs and engine designs through the

123
00:05:44,629 --> 00:05:42,479
1930s and they went to a branch and they

124
00:05:45,510 --> 00:05:44,639
launched the rockets out there

125
00:05:47,270 --> 00:05:45,520
and

126
00:05:49,270 --> 00:05:47,280
that really was a precursor for all of

127
00:05:51,189 --> 00:05:49,280
the rockets that we have today right

128
00:05:53,350 --> 00:05:51,199
when he started working with rockets the

129
00:05:54,950 --> 00:05:53,360
the old rockets that have been around

130
00:05:57,350 --> 00:05:54,960
you know the skyrockets we see at the

131
00:05:59,909 --> 00:05:57,360
fourth of july they have an efficiency

132
00:06:01,909 --> 00:05:59,919
of about six percent six percent of the

133
00:06:03,830 --> 00:06:01,919
energy generated goes into kinetic

134
00:06:06,550 --> 00:06:03,840
energy to make it go

135
00:06:09,189 --> 00:06:06,560
goddard after a few years of research

136
00:06:11,029 --> 00:06:09,199
had improved that to

137
00:06:12,790 --> 00:06:11,039
60 percent

138
00:06:15,909 --> 00:06:12,800

every rocket that goes up today is a

139
00:06:20,070 --> 00:06:17,990
wow from this angle you really get an

140
00:06:21,830 --> 00:06:20,080
idea of the scale and just how immense

141
00:06:24,150 --> 00:06:21,840
the space shuttle is

142
00:06:25,830 --> 00:06:24,160
now today i'm joined by dr ian clark the

143
00:06:28,070 --> 00:06:25,840
principal investigator for the low

144
00:06:31,029 --> 00:06:28,080
density supersonic decelerator

145
00:06:32,550 --> 00:06:31,039
decelerators at uh nasa's jet propulsion

146
00:06:34,150 --> 00:06:32,560
laboratory thank you so much for joining

147
00:06:35,510 --> 00:06:34,160
us today thanks for having me it's

148
00:06:36,550 --> 00:06:35,520
awesome to be here that title is a

149
00:06:38,790 --> 00:06:36,560
mouthful

150
00:06:40,230 --> 00:06:38,800
it's a lot of syllables now we've been

151
00:06:41,670 --> 00:06:40,240
landing on mars for a long time and

152
00:06:43,350 --> 00:06:41,680
we've done a lot of different ways can

153
00:06:46,070 --> 00:06:43,360
you kind of talk us through that sure

154
00:06:47,749 --> 00:06:46,080
let me first talk about how landing on

155
00:06:50,070 --> 00:06:47,759
mars is so incredibly difficult and why

156
00:06:51,990 --> 00:06:50,080
it's difficult uh let's use curiosity a

157
00:06:53,749 --> 00:06:52,000
recent example we landed curiosity rover

158
00:06:55,189 --> 00:06:53,759
on the surface of mars a few years ago

159
00:06:57,350 --> 00:06:55,199
when it started at the top of the

160
00:06:59,430 --> 00:06:57,360
atmosphere it was going 13 and a half

161
00:07:01,029 --> 00:06:59,440
thousand miles an hour it had an

162
00:07:02,469 --> 00:07:01,039
enormous amount of energy in it

163
00:07:05,029 --> 00:07:02,479

generally in the form of kinetic energy

164
00:07:06,790 --> 00:07:05,039
energy of moving bodies uh

165
00:07:09,510 --> 00:07:06,800
its combination of kinetic energy and

166
00:07:11,270 --> 00:07:09,520
potential energy was 60 billion joules

167
00:07:14,309 --> 00:07:11,280
which is enough energy to power a

168
00:07:16,790 --> 00:07:14,319
standard light bulb about 35 years or a

169
00:07:18,950 --> 00:07:16,800
an entire house for a year and a half

170
00:07:21,029 --> 00:07:18,960
but curiosity had to take all of that

171
00:07:22,629 --> 00:07:21,039
energy and get rid of it

172
00:07:24,950 --> 00:07:22,639
in seven minutes and it had to do it

173
00:07:26,870 --> 00:07:24,960
safely without damaging the spacecraft

174
00:07:28,710 --> 00:07:26,880
so we've been doing this for for 40

175
00:07:30,150 --> 00:07:28,720
years going back to when we first landed

176
00:07:31,909 --> 00:07:30,160
on the surface of mars with the twin

177
00:07:33,350 --> 00:07:31,919
viking landers

178
00:07:35,110 --> 00:07:33,360
and the techniques have been similar but

179
00:07:37,589 --> 00:07:35,120
we've made improvements viking back in

180
00:07:39,670 --> 00:07:37,599
1976 started the top of the atmosphere

181
00:07:41,670 --> 00:07:39,680
with an enormous aeroshell and it was

182
00:07:44,309 --> 00:07:41,680
shaped to create a lot of atmospheric

183
00:07:46,710 --> 00:07:44,319
drag to help slow from 13 000 miles an

184
00:07:48,710 --> 00:07:46,720
hour down to about a thousand miles an

185
00:07:50,629 --> 00:07:48,720
hour but that's all the the deceleration

186
00:07:53,589 --> 00:07:50,639
that aeroshell could could provide but

187
00:07:55,189 --> 00:07:53,599
it still removed 99.5 percent of the

188
00:07:56,710 --> 00:07:55,199

initial energy they're still half

189
00:07:58,550 --> 00:07:56,720
percent left and you're going a thousand

190
00:08:00,390 --> 00:07:58,560
miles an hour so what did it do it had

191
00:08:03,189 --> 00:08:00,400
to slam on the emergency brake and it

192
00:08:05,189 --> 00:08:03,199
deployed a large 65-foot diameter

193
00:08:07,110 --> 00:08:05,199
parachute at twice the speed of sound

194
00:08:08,950 --> 00:08:07,120
that parachute helped slow viking down

195
00:08:11,230 --> 00:08:08,960
from a thousand miles an hour to about

196
00:08:13,909 --> 00:08:11,240
200 miles an hour so it's gotten rid of

197
00:08:16,309 --> 00:08:13,919
99.98 of all of that initial energy but

198
00:08:18,070 --> 00:08:16,319
it still has that 0.02 percent left and

199
00:08:19,430 --> 00:08:18,080
it's going 200 miles an hour which is

200
00:08:21,909 --> 00:08:19,440
still pretty fast right not very

201
00:08:23,350 --> 00:08:21,919
comfortable landing so viking then had

202
00:08:25,430 --> 00:08:23,360
to turn on its rocket engines and it

203
00:08:28,070 --> 00:08:25,440
used rocket engines to slow it from 200

204
00:08:30,230 --> 00:08:28,080
miles an hour to zero miles an hour and

205
00:08:31,110 --> 00:08:30,240
put it safely on the surface where it

206
00:08:32,469 --> 00:08:31,120
landed

207
00:08:34,070 --> 00:08:32,479
since viking we've made some

208
00:08:35,829 --> 00:08:34,080
improvements we've got materials now

209
00:08:37,190 --> 00:08:35,839
that are more capable of withstanding

210
00:08:38,550 --> 00:08:37,200
the heating environment that you have

211
00:08:40,790 --> 00:08:38,560
the extreme heating environment when you

212
00:08:43,269 --> 00:08:40,800
enter an atmosphere like mars

213
00:08:44,710 --> 00:08:43,279

we've got techniques for flying these

214
00:08:46,790 --> 00:08:44,720
very blunt objects through the

215
00:08:49,030 --> 00:08:46,800
atmosphere to improve our landing

216
00:08:50,790 --> 00:08:49,040
capability and be able to slow down

217
00:08:52,470 --> 00:08:50,800
higher in the atmosphere we've also

218
00:08:53,910 --> 00:08:52,480
improved on our landing systems we've

219
00:08:55,910 --> 00:08:53,920
gone from using just basic rocket

220
00:08:57,829 --> 00:08:55,920
engines like what viking did to new

221
00:08:59,590 --> 00:08:57,839
innovative techniques like using airbags

222
00:09:02,550 --> 00:08:59,600
like the giant airbags behind me that

223
00:09:05,910 --> 00:09:02,560
were used uh or tested to help land the

224
00:09:07,509 --> 00:09:05,920
the spirit and opportunity rovers uh and

225
00:09:10,310 --> 00:09:07,519
more recently we used the sky crane

226
00:09:12,550 --> 00:09:10,320
system on curiosity this spider-like

227
00:09:14,550 --> 00:09:12,560
contraption to slow the rover down and

228
00:09:16,310 --> 00:09:14,560
gently put it on the surface

229
00:09:18,790 --> 00:09:16,320
where it is today doing amazing science

230
00:09:20,630 --> 00:09:18,800
for us that doesn't sound very easy oh

231
00:09:22,630 --> 00:09:20,640
it's tremendously difficult so many

232
00:09:24,310 --> 00:09:22,640
things have to happen just right and in

233
00:09:27,030 --> 00:09:24,320
a very short amount of time

234
00:09:29,110 --> 00:09:27,040
wow um now engineering for landing a

235
00:09:31,190 --> 00:09:29,120
robot or a rover on mars is one thing

236
00:09:32,870 --> 00:09:31,200
but designing something for humans to

237
00:09:34,790 --> 00:09:32,880
come back seems like it's even more

238
00:09:36,150 --> 00:09:34,800

challenging oh it's i mean when you talk

239
00:09:37,590 --> 00:09:36,160
about the scales and the energies

240
00:09:39,670 --> 00:09:37,600
associated with that yes they can be

241
00:09:41,190 --> 00:09:39,680
orders of magnitude more difficult wow

242
00:09:42,870 --> 00:09:41,200
now astronauts came back on the space

243
00:09:44,150 --> 00:09:42,880
shuttle that you see behind us but the

244
00:09:46,150 --> 00:09:44,160
astronauts that come back from the

245
00:09:48,070 --> 00:09:46,160
international space station today come

246
00:09:49,910 --> 00:09:48,080
back on in a capsule called the soyuz

247
00:09:51,350 --> 00:09:49,920
and it lands a little bit differently

248
00:09:52,949 --> 00:09:51,360
beth had an opportunity to talk to a

249
00:09:55,269 --> 00:09:52,959
couple of astronauts that actually

250
00:09:57,350 --> 00:09:55,279
landed in a soyuz check this out

251
00:09:59,350 --> 00:09:57,360
i'm here with paolo nespoli who is an

252
00:10:01,509 --> 00:09:59,360
italian astronaut with the european

253
00:10:03,750 --> 00:10:01,519
space agency thank you so much for

254
00:10:05,430 --> 00:10:03,760
coming and talking to us today at stem

255
00:10:08,069 --> 00:10:05,440
30. thank you for inviting me here it's

256
00:10:10,790 --> 00:10:08,079
a pleasure now you flew both on the

257
00:10:12,470 --> 00:10:10,800
shuttle and on the soyuz yes can you

258
00:10:15,590 --> 00:10:12,480
explain the difference between the two

259
00:10:17,829 --> 00:10:15,600
spacecraft the re-entry is totally

260
00:10:20,230 --> 00:10:17,839
completely different the soyuz re-enters

261
00:10:22,310 --> 00:10:20,240
with the parachute it's pretty much

262
00:10:24,949 --> 00:10:22,320
fairly rough i would say usually

263
00:10:27,670 --> 00:10:24,959

summarizes say that it's a sequence of

264
00:10:30,949 --> 00:10:27,680
catastrophic events that happen in rapid

265
00:10:33,030 --> 00:10:30,959
succession until you eventually

266
00:10:35,990 --> 00:10:33,040
go to the last part which is the soft

267
00:10:38,550 --> 00:10:36,000
landing which is equivalent to a car

268
00:10:40,069 --> 00:10:38,560
crash between a truck and a car and you

269
00:10:42,150 --> 00:10:40,079
know you are in the car not in the truck

270
00:10:44,790 --> 00:10:42,160
and and and then you are on earth like

271
00:10:46,870 --> 00:10:44,800
whoa that was a that was pretty good uh

272
00:10:48,630 --> 00:10:46,880
entry

273
00:10:50,470 --> 00:10:48,640
now we are joined by tim copper thank

274
00:10:52,870 --> 00:10:50,480
you so much for being here today it's my

275
00:10:56,230 --> 00:10:52,880
pleasure you were on the space shuttle

276
00:10:59,190 --> 00:10:56,240
and the soyuz right you want to tell us

277
00:11:00,550 --> 00:10:59,200
how landing in those two were you know

278
00:11:02,310 --> 00:11:00,560
landing actually is the biggest

279
00:11:04,150 --> 00:11:02,320
difference when you land with a space

280
00:11:05,910 --> 00:11:04,160
shuttle it lands on a runway and it's

281
00:11:08,150 --> 00:11:05,920
very similar to an airplane but when you

282
00:11:10,069 --> 00:11:08,160
come home on a soyuz it lands underneath

283
00:11:11,750 --> 00:11:10,079
a parachute when you come down you get

284
00:11:14,069 --> 00:11:11,760
thrown around quite a bit and then

285
00:11:16,470 --> 00:11:14,079
before landing some jets fire to soften

286
00:11:18,389 --> 00:11:16,480
the blow but it is a very firm hit on

287
00:11:20,630 --> 00:11:18,399
the ground

288
00:11:22,230 --> 00:11:20,640

how do you think future missions to mars

289
00:11:23,990 --> 00:11:22,240
there's no water down there there's no

290
00:11:25,670 --> 00:11:24,000
runway how are we going to land on that

291
00:11:27,590 --> 00:11:25,680
planet you know we're going to have to

292
00:11:29,110 --> 00:11:27,600
be very careful right we need to figure

293
00:11:31,190 --> 00:11:29,120
out the right way to get the crew down

294
00:11:33,269 --> 00:11:31,200
safely in all likelihood it'll be

295
00:11:34,630 --> 00:11:33,279
something similar to what some companies

296
00:11:36,710 --> 00:11:34,640
are doing now we have some sort of

297
00:11:38,470 --> 00:11:36,720
thrust allows us to land softer and

298
00:11:40,949 --> 00:11:38,480
that's one viable way to get down on the

299
00:11:42,230 --> 00:11:40,959
planet what about the big airbags do you

300
00:11:43,509 --> 00:11:42,240
think you guys would want to take a

301
00:11:45,269 --> 00:11:43,519
tumble down you know i think that's

302
00:11:46,630 --> 00:11:45,279
probably not a great idea you know one

303
00:11:47,910 --> 00:11:46,640
of the reasons it's not a great idea is

304
00:11:49,110 --> 00:11:47,920
because it's going to take us a long

305
00:11:51,269 --> 00:11:49,120
time to get to mars and we'll be

306
00:11:52,870 --> 00:11:51,279
de-conditioned and so you really don't

307
00:11:54,550 --> 00:11:52,880
want to perturb your body any more than

308
00:11:55,910 --> 00:11:54,560
you have to so you really want a smooth

309
00:11:57,750 --> 00:11:55,920
landing that would be perfect yeah if we

310
00:12:02,150 --> 00:11:57,760
can do that that would be great thank

311
00:12:06,150 --> 00:12:03,949
these guys look like they're doing an

312
00:12:07,430 --> 00:12:06,160
exceptional job ian do you have any

313
00:12:09,350 --> 00:12:07,440

advice for them as they build their

314
00:12:11,509 --> 00:12:09,360
landers uh it looks like they're doing

315
00:12:13,509 --> 00:12:11,519
great work uh you know one of the tricks

316
00:12:15,110 --> 00:12:13,519
that we've learned uh it's so easy to

317
00:12:16,710 --> 00:12:15,120
think about all the things that could go

318
00:12:18,710 --> 00:12:16,720
wrong and have to try to make sure that

319
00:12:20,310 --> 00:12:18,720
they don't happen a lot of times it's

320
00:12:21,910 --> 00:12:20,320
better and easier to think about all the

321
00:12:23,350 --> 00:12:21,920
things that have to happen just right

322
00:12:24,629 --> 00:12:23,360
and make sure that those do happen the

323
00:12:26,069 --> 00:12:24,639
way they need to happen awesome well

324
00:12:27,190 --> 00:12:26,079
they've got a little bit of extra time

325
00:12:29,430 --> 00:12:27,200
to work on that and while they're

326
00:12:32,389 --> 00:12:29,440
working tell us about the low density

327
00:12:33,990 --> 00:12:32,399
supersonic decelerators so ldsd or the

328
00:12:35,910 --> 00:12:34,000
low density supersonic accelerators is a

329
00:12:37,990 --> 00:12:35,920
project aimed at developing

330
00:12:40,150 --> 00:12:38,000
new technologies for future mars

331
00:12:42,870 --> 00:12:40,160
missions when we landed curiosity a few

332
00:12:45,110 --> 00:12:42,880
years ago it's a one-ton rover the size

333
00:12:46,389 --> 00:12:45,120
of a car and it was just a tremendous

334
00:12:47,990 --> 00:12:46,399
engineering undertaking it was the

335
00:12:49,829 --> 00:12:48,000
largest most massive thing we had ever

336
00:12:51,670 --> 00:12:49,839
landed on another planet and in the

337
00:12:53,430 --> 00:12:51,680
process of developing the system to land

338
00:12:55,590 --> 00:12:53,440

it we started realizing that if we

339
00:12:58,069 --> 00:12:55,600
wanted to land bigger payloads and we do

340
00:13:00,069 --> 00:12:58,079
uh you know thinking about the horizon

341
00:13:01,670 --> 00:13:00,079
the just breadth of exciting science

342
00:13:03,430 --> 00:13:01,680
missions we want to be able to return

343
00:13:04,550 --> 00:13:03,440
samples from mars and bring them back to

344
00:13:06,710 --> 00:13:04,560
earth so we can study them in more

345
00:13:09,110 --> 00:13:06,720
detail and of course recently the

346
00:13:11,350 --> 00:13:09,120
president reiterated our commitment to

347
00:13:13,670 --> 00:13:11,360
putting humans on the surface of mars so

348
00:13:15,829 --> 00:13:13,680
to do that we needed new technologies

349
00:13:17,590 --> 00:13:15,839
new capabilities to land those very very

350
00:13:19,750 --> 00:13:17,600
massive payloads on the surface of mars

351
00:13:21,030 --> 00:13:19,760
curiosity was a ton in order to put

352
00:13:22,230 --> 00:13:21,040
humans on the surface of mars you're

353
00:13:24,870 --> 00:13:22,240
gonna have to figure out to go from one

354
00:13:26,389 --> 00:13:24,880
ton to two tons to five to tens of tons

355
00:13:28,230 --> 00:13:26,399
uh maybe even a hundred tons on the

356
00:13:29,829 --> 00:13:28,240
surface of mars

357
00:13:31,910 --> 00:13:29,839
so

358
00:13:33,829 --> 00:13:31,920
what exactly does the decelerator do

359
00:13:35,430 --> 00:13:33,839
it's it's not a parachute well it's a

360
00:13:36,790 --> 00:13:35,440
combination of parachutes right when we

361
00:13:39,030 --> 00:13:36,800
have to land on mars we have to pull out

362
00:13:40,710 --> 00:13:39,040
all the stops literally uh we have

363
00:13:42,150 --> 00:13:40,720

inflatable drag devices that are

364
00:13:43,910 --> 00:13:42,160
deployed in a fraction of a second and

365
00:13:46,470 --> 00:13:43,920
grow the size of the aeroshell to make

366
00:13:49,189 --> 00:13:46,480
it bigger to allow it to create more

367
00:13:50,710 --> 00:13:49,199
drag to slow it down in the atmosphere

368
00:13:52,629 --> 00:13:50,720
but we also have to couple those with

369
00:13:54,389 --> 00:13:52,639
other technologies like parachutes so

370
00:13:56,230 --> 00:13:54,399
we've been developing a parachute an

371
00:13:57,829 --> 00:13:56,240
enormous 100 foot diameter parachute

372
00:13:59,590 --> 00:13:57,839
that would generate two and a half times

373
00:14:02,069 --> 00:13:59,600
the drag of any parachute used

374
00:14:03,910 --> 00:14:02,079
previously and has to be able to survive

375
00:14:06,310 --> 00:14:03,920
at twice the speed of sound basically

376
00:14:07,670 --> 00:14:06,320
how do you take 200 pounds of nylon and

377
00:14:09,829 --> 00:14:07,680
kevlar and get it to inflate

378
00:14:11,670 --> 00:14:09,839
successfully in a 2 000 mile an hour

379
00:14:14,230 --> 00:14:11,680
wind and i'm guessing all those tests

380
00:14:16,069 --> 00:14:14,240
went perfectly the first time oh never

381
00:14:17,670 --> 00:14:16,079
you know one of the reasons why we do

382
00:14:19,030 --> 00:14:17,680
the tests is to see what happens or if

383
00:14:20,150 --> 00:14:19,040
we knew the answers ahead of time we

384
00:14:22,230 --> 00:14:20,160
probably wouldn't need to do the test to

385
00:14:24,150 --> 00:14:22,240
begin with uh but we do the tasks to

386
00:14:25,829 --> 00:14:24,160
learn and to see new things and we had a

387
00:14:27,430 --> 00:14:25,839
tremendous amount of that awesome you

388
00:14:28,470 --> 00:14:27,440

ready to take some questions absolutely

389
00:14:30,069 --> 00:14:28,480
all right let's start with an online

390
00:14:31,670 --> 00:14:30,079
question

391
00:14:33,910 --> 00:14:31,680
what kinds of materials are used to

392
00:14:35,990 --> 00:14:33,920
build the supersonic parachutes ah great

393
00:14:38,150 --> 00:14:36,000
question uh most of the materials are

394
00:14:40,230 --> 00:14:38,160
relatively common materials things like

395
00:14:41,910 --> 00:14:40,240
nylon or polyester

396
00:14:43,750 --> 00:14:41,920
same kind of nylon that maybe your

397
00:14:45,590 --> 00:14:43,760
camping tint is made out of

398
00:14:46,949 --> 00:14:45,600
but we couple those very lightweight and

399
00:14:48,389 --> 00:14:46,959
relatively strong materials with

400
00:14:50,629 --> 00:14:48,399
significantly stronger materials like

401
00:14:52,470 --> 00:14:50,639
kevlar same kind of kevlar that we use

402
00:14:54,310 --> 00:14:52,480
to build bulletproof vests out of for

403
00:14:57,030 --> 00:14:54,320
example okay all right let's go to an

404
00:14:59,030 --> 00:14:57,040
audience question okay

405
00:15:01,110 --> 00:14:59,040
how did a spacecraft slow down when

406
00:15:02,389 --> 00:15:01,120
landing on the planet how do spacecraft

407
00:15:05,509 --> 00:15:02,399
slow down when they land on other

408
00:15:07,670 --> 00:15:05,519
planets a variety of techniques

409
00:15:09,350 --> 00:15:07,680
the dominant mechanism is we use drag if

410
00:15:10,949 --> 00:15:09,360
there's an atmosphere to work with we

411
00:15:13,910 --> 00:15:10,959
try to use that atmosphere to create

412
00:15:15,670 --> 00:15:13,920
drag to help slow us down so viking for

413
00:15:17,430 --> 00:15:15,680

example had to go from 10 000 miles an

414
00:15:19,189 --> 00:15:17,440
hour down to a thousand miles an hour

415
00:15:21,189 --> 00:15:19,199
predominantly using drag and then from a

416
00:15:24,069 --> 00:15:21,199
thousand miles an hour to 200 miles an

417
00:15:25,590 --> 00:15:24,079
hour again using drag from a parachute

418
00:15:28,069 --> 00:15:25,600
and then ultimately we had to take that

419
00:15:29,590 --> 00:15:28,079
last little bit out using rocket fuel

420
00:15:31,269 --> 00:15:29,600
what's the difference between the the

421
00:15:33,670 --> 00:15:31,279
two atmospheres here on earth and on

422
00:15:34,949 --> 00:15:33,680
mars great question uh here on earth the

423
00:15:37,269 --> 00:15:34,959
atmosphere though it doesn't seem like

424
00:15:39,430 --> 00:15:37,279
it to us is really thick uh it's this

425
00:15:41,269 --> 00:15:39,440
nice thick soup which means that to

426
00:15:42,870 --> 00:15:41,279
generate drag it's relatively easy i

427
00:15:45,189 --> 00:15:42,880
don't have to have something

428
00:15:46,870 --> 00:15:45,199
too too large but at mars the atmosphere

429
00:15:49,269 --> 00:15:46,880
is extremely thin it's about one percent

430
00:15:50,949 --> 00:15:49,279
the thickness of earth's atmosphere so

431
00:15:52,870 --> 00:15:50,959
things need to be ten times bigger at

432
00:15:54,710 --> 00:15:52,880
mars than they would be at earth

433
00:15:57,030 --> 00:15:54,720
the viking air shell for example was

434
00:15:58,949 --> 00:15:57,040
about 10 feet in diameter the curiosity

435
00:16:00,710 --> 00:15:58,959
aeroshell was 15 feet in diameter and

436
00:16:03,110 --> 00:16:00,720
the parachute for curiosity was 70 feet

437
00:16:05,990 --> 00:16:03,120
in diameter just enormous devices wow

438
00:16:07,910 --> 00:16:06,000

all right let's go to an online question

439
00:16:09,749 --> 00:16:07,920
how long does it take to build a mars

440
00:16:11,350 --> 00:16:09,759
rover ah

441
00:16:13,829 --> 00:16:11,360
years you know the the design of the

442
00:16:15,829 --> 00:16:13,839
mars rovers uh can take years and years

443
00:16:17,590 --> 00:16:15,839
and then actually fabricating putting

444
00:16:19,110 --> 00:16:17,600
all the pieces together and then testing

445
00:16:21,030 --> 00:16:19,120
the rover making sure it's gonna do the

446
00:16:23,990 --> 00:16:21,040
job that it needs to do uh may take

447
00:16:25,590 --> 00:16:24,000
years as well so for example it's 2016

448
00:16:28,470 --> 00:16:25,600
we've been working for a few years now

449
00:16:30,870 --> 00:16:28,480
on a mars 2020 rover uh that will launch

450
00:16:32,790 --> 00:16:30,880
in surprise 2020.

451
00:16:35,509 --> 00:16:32,800
well recently there was an announcement

452
00:16:37,670 --> 00:16:35,519
an announcement by spacex about sending

453
00:16:40,389 --> 00:16:37,680
humans to mars in the future check this

454
00:16:44,629 --> 00:16:42,230
spacex is a major innovator in the

455
00:16:46,710 --> 00:16:44,639
commercial space industry they currently

456
00:16:48,470 --> 00:16:46,720
partner with nasa to provide resupply

457
00:16:50,710 --> 00:16:48,480
missions to the international space

458
00:16:53,030 --> 00:16:50,720
station they have achieved a major

459
00:16:55,030 --> 00:16:53,040
milestone in rocketry they have

460
00:16:57,590 --> 00:16:55,040
successfully landed a rocket vertically

461
00:16:59,509 --> 00:16:57,600
which allows for rapid reuse

462
00:17:02,069 --> 00:16:59,519
this makes human space flight much much

463
00:17:04,150 --> 00:17:02,079

cheaper and much more efficient

464
00:17:05,829 --> 00:17:04,160
elon musk their founder has a vision for

465
00:17:07,270 --> 00:17:05,839
colonizing mars

466
00:17:09,429 --> 00:17:07,280
they want to create a rocket type

467
00:17:12,150 --> 00:17:09,439
spaceship that can accommodate a hundred

468
00:17:14,390 --> 00:17:12,160
passengers that will travel to mars in

469
00:17:16,150 --> 00:17:14,400
as little as three months

470
00:17:18,390 --> 00:17:16,160
once there the rocket will land

471
00:17:21,270 --> 00:17:18,400
vertically which allows humans to leave

472
00:17:22,870 --> 00:17:21,280
mars if they ever need to

473
00:17:24,630 --> 00:17:22,880
they hope to achieve this in your

474
00:17:29,270 --> 00:17:24,640
lifetime

475
00:17:34,710 --> 00:17:31,830
okay so ian are you ready to test some

476
00:17:35,590 --> 00:17:34,720
of these contraptions i'm excited

477
00:17:37,190 --> 00:17:35,600
okay

478
00:17:38,950 --> 00:17:37,200
don't start

479
00:17:41,190 --> 00:17:38,960
you'll get marty started all right do

480
00:17:45,270 --> 00:17:41,200
you guys want to tell us uh what was

481
00:17:50,230 --> 00:17:47,590
our thought process and developmentness

482
00:17:52,549 --> 00:17:50,240
was we wanted this to be a parachute but

483
00:17:58,830 --> 00:17:52,559
it came out different and we have enough

484
00:18:03,029 --> 00:18:01,029
okay the um

485
00:18:04,230 --> 00:18:03,039
bubble wrap so that it will fall

486
00:18:06,230 --> 00:18:04,240
securely

487
00:18:08,549 --> 00:18:06,240
so it won't break

488
00:18:12,789 --> 00:18:08,559

but i try to do something real quick all

489
00:18:16,470 --> 00:18:14,549
all right okay here we go oh my gosh all

490
00:18:18,310 --> 00:18:16,480
right let's let's see how this goes is

491
00:18:19,430 --> 00:18:18,320
there a kitchen sink on this

492
00:18:21,110 --> 00:18:19,440
all right

493
00:18:22,470 --> 00:18:21,120
you guys ready

494
00:18:23,350 --> 00:18:22,480
in three

495
00:18:24,789 --> 00:18:23,360
two

496
00:18:25,909 --> 00:18:24,799
one

497
00:18:29,830 --> 00:18:25,919
oh

498
00:18:34,950 --> 00:18:32,150
i don't know where the egg is right here

499
00:18:38,710 --> 00:18:35,830
i'm gonna

500
00:18:48,390 --> 00:18:38,720
crack it i know just

501
00:18:51,750 --> 00:18:49,270
well

502
00:18:53,590 --> 00:18:51,760
so basically i mean the the eggs started

503
00:18:55,430 --> 00:18:53,600
with a lot of potential energy way up

504
00:18:57,270 --> 00:18:55,440
high right and all that potential energy

505
00:18:59,270 --> 00:18:57,280
got converted to kinetic energy and that

506
00:19:01,430 --> 00:18:59,280
kinetic energy had to be absorbed by

507
00:19:03,990 --> 00:19:01,440
something possibly the egg and here they

508
00:19:07,350 --> 00:19:04,000
have all kinds of bubble wrap bubble

509
00:19:16,070 --> 00:19:07,360
wrap and cotton balls and

510
00:19:19,510 --> 00:19:17,270
so a lot of different things to help

511
00:19:21,029 --> 00:19:19,520
absorb that energy okay so it doesn't go

512
00:19:27,190 --> 00:19:21,039
to the egg all right so you guys good

513
00:19:32,150 --> 00:19:29,909

i think they're challenging you okay

514
00:19:35,029 --> 00:19:32,160
where's the egginess

515
00:19:37,029 --> 00:19:35,039
okay all right why don't you tell us

516
00:19:39,750 --> 00:19:37,039
what your thought process was i thought

517
00:19:42,549 --> 00:19:39,760
process was to make something that would

518
00:19:45,029 --> 00:19:42,559
cushion the blow so it wouldn't crack

519
00:19:46,710 --> 00:19:45,039
okay and what have you used here a lot

520
00:19:50,310 --> 00:19:46,720
of stuff there's a lot of fluff balls

521
00:19:52,470 --> 00:19:50,320
and we use like these um coffee coffee

522
00:19:54,789 --> 00:19:52,480
grinders or something filters filters to

523
00:19:56,310 --> 00:19:54,799
make it like a parachute

524
00:19:57,990 --> 00:19:56,320
okay well let's see if this parachute

525
00:19:58,950 --> 00:19:58,000
works okay

526
00:20:02,630 --> 00:19:58,960
let's

527
00:20:02,640 --> 00:20:07,510
okay

528
00:20:10,630 --> 00:20:09,350
this would not be good this tangled what

529
00:20:11,669 --> 00:20:10,640
did he no

530
00:20:13,350 --> 00:20:11,679
all right

531
00:20:15,110 --> 00:20:13,360
okay

532
00:20:16,390 --> 00:20:15,120
all right you guys ready

533
00:20:18,390 --> 00:20:16,400
yep

534
00:20:21,909 --> 00:20:18,400
okay

535
00:20:26,149 --> 00:20:24,390
all right let's see

536
00:20:27,029 --> 00:20:26,159
all right in three

537
00:20:28,710 --> 00:20:27,039
two

538
00:20:30,070 --> 00:20:28,720

one

539
00:20:32,830 --> 00:20:30,080
oh

540
00:20:37,430 --> 00:20:36,310
quiet i didn't hear anything break okay

541
00:20:46,310 --> 00:20:37,440
okay

542
00:20:53,110 --> 00:20:48,789
yeah i'm gonna break it before i'm

543
00:20:57,270 --> 00:20:55,190
i think it's intact yeah it looks pretty

544
00:20:58,310 --> 00:20:57,280
good wow

545
00:20:59,990 --> 00:20:58,320
yeah

546
00:21:02,149 --> 00:21:00,000
and again this

547
00:21:03,350 --> 00:21:02,159
they've got like springs down here yeah

548
00:21:04,789 --> 00:21:03,360
i don't know that the parachutes really

549
00:21:07,350 --> 00:21:04,799
slowed it down as much as you would hope

550
00:21:09,110 --> 00:21:07,360
but you got i like the the little pipe

551
00:21:11,510 --> 00:21:09,120
cleaner springs that you had to help

552
00:21:12,950 --> 00:21:11,520
absorb some of the energy as well

553
00:21:14,230 --> 00:21:12,960
good job guys

554
00:21:21,510 --> 00:21:14,240
all right

555
00:21:27,510 --> 00:21:23,510
okay gentlemen

556
00:21:30,870 --> 00:21:28,549
okay

557
00:21:33,029 --> 00:21:30,880
we thought that we could make it look

558
00:21:34,070 --> 00:21:33,039
like a rocket and have springs right

559
00:21:35,430 --> 00:21:34,080
here

560
00:21:37,590 --> 00:21:35,440
so like

561
00:21:39,510 --> 00:21:37,600
it wouldn't have that much as a fall so

562
00:21:40,630 --> 00:21:39,520
it wouldn't like break

563
00:21:42,149 --> 00:21:40,640

and

564
00:21:45,590 --> 00:21:42,159
we could have a parachute so i could

565
00:21:46,630 --> 00:21:45,600
like sail down like kind of gently

566
00:21:49,029 --> 00:21:46,640
like because if we didn't have a

567
00:21:50,549 --> 00:21:49,039
parachute it would just like splat okay

568
00:21:51,830 --> 00:21:50,559
well let's see how well their parachute

569
00:21:53,909 --> 00:21:51,840
works yeah

570
00:21:57,430 --> 00:21:53,919
yep let's see

571
00:21:57,440 --> 00:22:01,590
you ready okay you ready

572
00:22:05,029 --> 00:22:03,590
all right here we go

573
00:22:06,070 --> 00:22:05,039
in three

574
00:22:16,470 --> 00:22:06,080
two

575
00:22:22,149 --> 00:22:20,789
well we got one scrambler here i i don't

576
00:22:23,830 --> 00:22:22,159
okay now

577
00:22:26,710 --> 00:22:23,840
ian sometimes these things don't work

578
00:22:27,909 --> 00:22:26,720
out nope not every time but i mean the

579
00:22:30,149 --> 00:22:27,919
only failure is when you don't learn

580
00:22:32,230 --> 00:22:30,159
from your mistakes right and so what do

581
00:22:35,190 --> 00:22:32,240
you guys think you do next time to make

582
00:22:38,070 --> 00:22:35,200
this work a little bit better

583
00:22:40,390 --> 00:22:38,080
put it go ahead and speak into that

584
00:22:41,350 --> 00:22:40,400
put a little more protection on it yeah

585
00:22:43,830 --> 00:22:41,360
that's

586
00:22:46,310 --> 00:22:43,840
it's probably not a bad idea but good

587
00:22:48,310 --> 00:22:46,320
try i mean you did try the parachute

588
00:22:50,950 --> 00:22:48,320

um all right

589
00:22:52,950 --> 00:22:50,960
overall excellent job excellent job

590
00:22:54,390 --> 00:22:52,960
gentlemen okay i'm gonna hold on to this

591
00:22:57,830 --> 00:22:54,400
because we're gonna get rid of this are

592
00:23:01,590 --> 00:22:57,840
you ready for some questions sure okay

593
00:23:04,549 --> 00:23:01,600
so let's take an online question

594
00:23:06,830 --> 00:23:04,559
how do engineers come up with the idea

595
00:23:09,190 --> 00:23:06,840
of the structure of a

596
00:23:10,870 --> 00:23:09,200
spacecraft they got to be very creative

597
00:23:12,950 --> 00:23:10,880
but a lot of times the structure and the

598
00:23:15,029 --> 00:23:12,960
shape of the spacecraft is really driven

599
00:23:17,190 --> 00:23:15,039
by what the spacecraft has to do some

600
00:23:19,350 --> 00:23:17,200
particular job so for example the space

601
00:23:21,110 --> 00:23:19,360
shuttle right that was a spacecraft that

602
00:23:22,870 --> 00:23:21,120
needed to generate lift so we could fly

603
00:23:25,190 --> 00:23:22,880
like an airplane

604
00:23:27,669 --> 00:23:25,200
so the shape needed to be something like

605
00:23:29,029 --> 00:23:27,679
an airplane needed to have wings

606
00:23:30,710 --> 00:23:29,039
those wings needed to have a particular

607
00:23:31,990 --> 00:23:30,720
geometry so the airplane could fly very

608
00:23:33,990 --> 00:23:32,000
fast so the space shuttle could enter

609
00:23:35,750 --> 00:23:34,000
the atmosphere very fast it also had to

610
00:23:37,590 --> 00:23:35,760
have control surfaces that allowed it to

611
00:23:38,549 --> 00:23:37,600
maneuver through the atmosphere because

612
00:23:40,470 --> 00:23:38,559
when the space shuttle enters the

613
00:23:42,390 --> 00:23:40,480

atmosphere it inserts at a very high

614
00:23:44,070 --> 00:23:42,400
angle relative to the wind and it's so

615
00:23:46,549 --> 00:23:44,080
it can use that nice smooth flat

616
00:23:48,390 --> 00:23:46,559
enormous underbelly to help create drag

617
00:23:50,390 --> 00:23:48,400
to slow it down okay we've got one in

618
00:23:53,029 --> 00:23:50,400
the audience

619
00:23:54,789 --> 00:23:53,039
where was the first airbag tested where

620
00:23:56,950 --> 00:23:54,799
was the first airbag tested like

621
00:23:58,789 --> 00:23:56,960
goodness guys oh well so the airbags

622
00:24:01,029 --> 00:23:58,799
that we used for the mars landers the

623
00:24:02,950 --> 00:24:01,039
first ones uh were for the mars

624
00:24:04,950 --> 00:24:02,960
pathfinder mission in the early mid

625
00:24:07,669 --> 00:24:04,960
1990s uh

626
00:24:09,269 --> 00:24:07,679
we did some tests of those out at jpl

627
00:24:12,230 --> 00:24:09,279
out at the the company that built those

628
00:24:14,390 --> 00:24:12,240
airbags ilc dover uh and also out at uh

629
00:24:16,950 --> 00:24:14,400
plum brook station a giant vacuum

630
00:24:18,390 --> 00:24:16,960
chamber that nasa has in ohio they

631
00:24:19,830 --> 00:24:18,400
worked out pretty well they did

632
00:24:21,269 --> 00:24:19,840
incredibly well

633
00:24:23,029 --> 00:24:21,279
all right we have another audience

634
00:24:24,310 --> 00:24:23,039
question

635
00:24:28,549 --> 00:24:24,320
about how

636
00:24:31,190 --> 00:24:28,559
spacecraft how long does it take to

637
00:24:33,350 --> 00:24:31,200
build a spacecraft uh it depends on the

638
00:24:34,870 --> 00:24:33,360

size of the spacecraft right the space

639
00:24:37,350 --> 00:24:34,880
shuttle was being designed and developed

640
00:24:39,590 --> 00:24:37,360
as beginning back in the late 1960s and

641
00:24:41,190 --> 00:24:39,600
designed for the uh the entire decade of

642
00:24:44,149 --> 00:24:41,200
the 1970s and we didn't actually get to

643
00:24:45,909 --> 00:24:44,159
send it into space until 1981. uh some

644
00:24:48,310 --> 00:24:45,919
of the spacecraft that we send to mars

645
00:24:50,789 --> 00:24:48,320
may take five to ten years to design

646
00:24:52,390 --> 00:24:50,799
build test and ultimately send to mars

647
00:24:53,909 --> 00:24:52,400
so it depends on what the job is it

648
00:24:57,269 --> 00:24:53,919
depends on the job it depends on how big

649
00:24:58,830 --> 00:24:57,279
the spacecraft is uh yeah yeah okay

650
00:25:00,470 --> 00:24:58,840
let's take an online

651
00:25:02,870 --> 00:25:00,480
question uh

652
00:25:05,190 --> 00:25:02,880
do you ever use more than one parachute

653
00:25:06,870 --> 00:25:05,200
at a time absolutely sometimes you need

654
00:25:08,870 --> 00:25:06,880
to create so much drag that the

655
00:25:10,630 --> 00:25:08,880
parachute to create it would just be too

656
00:25:12,870 --> 00:25:10,640
big to manage right

657
00:25:15,110 --> 00:25:12,880
uh the apollo spacecraft for example

658
00:25:16,149 --> 00:25:15,120
that returned humans from the moon that

659
00:25:17,510 --> 00:25:16,159
used

660
00:25:19,350 --> 00:25:17,520
a combination of parachutes but the main

661
00:25:21,029 --> 00:25:19,360
parachutes it had three enormous

662
00:25:23,029 --> 00:25:21,039
parachutes that were in a giant uh

663
00:25:24,870 --> 00:25:23,039

cluster to help bring that spacecraft to

664
00:25:27,590 --> 00:25:24,880
the right slow enough conditions before

665
00:25:29,190 --> 00:25:27,600
it could land in the ocean okay now next

666
00:25:31,350 --> 00:25:29,200
month we will actually we've been

667
00:25:33,029 --> 00:25:31,360
talking about the space shuttle we will

668
00:25:34,789 --> 00:25:33,039
have an astronaut who actually flew on

669
00:25:37,110 --> 00:25:34,799
the space shuttle very cool you send

670
00:25:38,230 --> 00:25:37,120
experiments out she was actually an

671
00:25:39,110 --> 00:25:38,240
experiment

672
00:25:41,590 --> 00:25:39,120
herself

673
00:25:43,510 --> 00:25:41,600
human guinea pigs human guinea pigs so

674
00:25:46,870 --> 00:25:43,520
why don't we check this out

675
00:25:51,269 --> 00:25:49,269
this is mercury friendship seven this is

676
00:25:53,350 --> 00:25:51,279
the capsule that john glenn flew to

677
00:25:55,909 --> 00:25:53,360
become the first american astronaut to

678
00:25:58,390 --> 00:25:55,919
orbit the earth now inside this capsule

679
00:26:00,789 --> 00:25:58,400
there are these little tiny eye charts

680
00:26:02,710 --> 00:26:00,799
why eye charts well doctors at the time

681
00:26:04,549 --> 00:26:02,720
didn't know how microgravity was going

682
00:26:06,710 --> 00:26:04,559
to affect the body and they thought john

683
00:26:08,310 --> 00:26:06,720
glenn's eyes might get out of shape

684
00:26:10,310 --> 00:26:08,320
affecting his vision and he couldn't be

685
00:26:12,230 --> 00:26:10,320
able to see the control panel so they

686
00:26:13,750 --> 00:26:12,240
tested his eyes during the flight have

687
00:26:16,390 --> 00:26:13,760
you ever wondered what kind of

688
00:26:18,149 --> 00:26:16,400

experiments astronauts run in space

689
00:26:23,590 --> 00:26:18,159
if you have be sure to check out the

690
00:26:28,310 --> 00:26:25,990
i think my big takeaway from that is how

691
00:26:29,830 --> 00:26:28,320
important failure actually is absolutely

692
00:26:31,269 --> 00:26:29,840
you got to be able to learn from failure

693
00:26:33,269 --> 00:26:31,279
be able to learn from the mistakes and

694
00:26:34,789 --> 00:26:33,279
take that knowledge and make corrections

695
00:26:36,310 --> 00:26:34,799
and come up with a better overall system

696
00:26:37,750 --> 00:26:36,320
at the end awesome ian thank you so much

697
00:26:39,510 --> 00:26:37,760
for joining us today thanks for having

698
00:26:41,350 --> 00:26:39,520
me it's been great i'd also like to

699
00:26:44,230 --> 00:26:41,360
thank our sponsor nasa for sponsoring

700
00:26:45,830 --> 00:26:44,240
this show as well as bill airy from ilc

701
00:26:47,669 --> 00:26:45,840
dover for bringing the giant mars

702
00:26:49,510 --> 00:26:47,679
airbags along we're going to leave you

703
00:26:51,669 --> 00:26:49,520
today with the sights of roswell new

704
00:26:53,830 --> 00:26:51,679
mexico and goddard's lab as well as the

705
00:26:56,149 --> 00:26:53,840
rants ranch where he launched from and

706
00:26:58,549 --> 00:26:56,159
then stick around after the credits for

707
00:27:00,870 --> 00:26:58,559
an extended interview with bill ciders