
Mission Control Center
CATO

1
00:00:05,670 --> 00:00:04,309
good morning welcome to mission control

2
00:00:07,510 --> 00:00:05,680
houston we're here inside the space

3
00:00:09,190 --> 00:00:07,520
station flight control room i'm brandi

4
00:00:11,190 --> 00:00:09,200
dean i work in public affairs here at

5
00:00:13,509 --> 00:00:11,200
nasa and i've got here with me stan love

6
00:00:15,030 --> 00:00:13,519
one of our astronauts he's been to the

7
00:00:16,870 --> 00:00:15,040
international space station onboard a

8
00:00:18,070 --> 00:00:16,880
space shuttle and now is working on a

9
00:00:19,990 --> 00:00:18,080
lot of um

10
00:00:21,590 --> 00:00:20,000
kind of future planning activities for

11
00:00:23,830 --> 00:00:21,600
what's next for nasa so stan why don't

12
00:00:25,990 --> 00:00:23,840
you tell us a little bit about yourself

13
00:00:28,630 --> 00:00:26,000

sure my name is dan love i joined nasa

14
00:00:30,390 --> 00:00:28,640
in 1998 as an astronaut before that my

15
00:00:32,870 --> 00:00:30,400
background was in

16
00:00:35,990 --> 00:00:32,880
physics astronomy planetary science and

17
00:00:40,389 --> 00:00:37,830
since then i've been done a bunch of

18
00:00:42,069 --> 00:00:40,399
jobs here at nasa including working as a

19
00:00:43,270 --> 00:00:42,079
capcom here in mission control and in

20
00:00:44,950 --> 00:00:43,280
our other control centers here at

21
00:00:46,310 --> 00:00:44,960
johnson space center it's been about

22
00:00:48,470 --> 00:00:46,320
eight years doing that so i'm used to

23
00:00:51,189 --> 00:00:48,480
sitting at another console in this room

24
00:00:52,069 --> 00:00:51,199
and capcom's are the the people here on

25
00:00:53,670 --> 00:00:52,079
the ground who get to talk to the

26
00:00:55,670 --> 00:00:53,680
astronauts when they're in space yeah so

27
00:00:57,590 --> 00:00:55,680
when you hear a voice saying you know uh

28
00:00:59,510 --> 00:00:57,600
iss houston such and such that's the

29
00:01:01,990 --> 00:00:59,520
capcom speaking

30
00:01:03,750 --> 00:01:02,000
so i also flew in space on space shuttle

31
00:01:05,910 --> 00:01:03,760
mission sts-122

32
00:01:06,789 --> 00:01:05,920
that was in 2008 i did a couple space

33
00:01:08,789 --> 00:01:06,799
walks

34
00:01:10,789 --> 00:01:08,799
um worked the robotic arm on the shuttle

35
00:01:13,190 --> 00:01:10,799
and on the station and my crewmates and

36
00:01:14,789 --> 00:01:13,200
i installed the columbus laboratory

37
00:01:16,469 --> 00:01:14,799
module onto the space station which is

38
00:01:19,350 --> 00:01:16,479

still there today right on the front

39
00:01:20,870 --> 00:01:19,360
where it's easy to see

40
00:01:22,149 --> 00:01:20,880
and i'm with you here today i'll be

41
00:01:24,070 --> 00:01:22,159
happy to answer your questions about

42
00:01:25,270 --> 00:01:24,080
space travel

43
00:01:29,510 --> 00:01:25,280
so if you're ready we can go ahead and

44
00:01:33,350 --> 00:01:30,550
okay

45
00:01:35,350 --> 00:01:33,360
what effects uh wait what do astronauts

46
00:01:38,069 --> 00:01:35,360
do in space to negate the effects of

47
00:01:40,950 --> 00:01:38,079
microgravity

48
00:01:42,710 --> 00:01:40,960
okay um what do astronauts do to try to

49
00:01:44,310 --> 00:01:42,720
mitigate the effects of microgravity

50
00:01:46,630 --> 00:01:44,320
quite a lot actually they spend at least

51
00:01:47,590 --> 00:01:46,640
two and a half hours every single day in

52
00:01:50,789 --> 00:01:47,600
space

53
00:01:52,789 --> 00:01:50,799
um doing mostly physical exercise to

54
00:01:53,749 --> 00:01:52,799
help counteract the effects of gravity

55
00:01:55,670 --> 00:01:53,759
of course

56
00:01:57,990 --> 00:01:55,680
your body is like anything else that's

57
00:01:59,270 --> 00:01:58,000
precious uh use it or lose it so when

58
00:02:00,950 --> 00:01:59,280
you get up into space and you get out of

59
00:02:02,149 --> 00:02:00,960
the effects of gravity you don't have to

60
00:02:03,910 --> 00:02:02,159
carry your body weight up and down

61
00:02:05,429 --> 00:02:03,920
stairs and things like that your muscles

62
00:02:09,749 --> 00:02:05,439
get real weak

63
00:02:11,270 --> 00:02:09,759

bunch other things happen

64
00:02:13,270 --> 00:02:11,280
in order to keep your muscles and bones

65
00:02:15,350 --> 00:02:13,280
strong then you have to do a lot of

66
00:02:16,869 --> 00:02:15,360
exercise to

67
00:02:19,030 --> 00:02:16,879
try to

68
00:02:20,710 --> 00:02:19,040
make your body work as hard in space as

69
00:02:21,990 --> 00:02:20,720
it has to every day on earth you don't

70
00:02:23,990 --> 00:02:22,000
even realize how much work you're doing

71
00:02:26,070 --> 00:02:24,000
just standing up and moving around so

72
00:02:27,830 --> 00:02:26,080
the astronauts will be

73
00:02:28,949 --> 00:02:27,840
doing the equivalent of lifting weights

74
00:02:30,309 --> 00:02:28,959
of course you can lift a lot of weight

75
00:02:32,229 --> 00:02:30,319
on the space station it's not much of a

76
00:02:33,750 --> 00:02:32,239
workout because there's no gravity

77
00:02:35,910 --> 00:02:33,760
so instead they've got a weight lifting

78
00:02:37,830 --> 00:02:35,920
machine that instead of pushing a big

79
00:02:39,830 --> 00:02:37,840
weight you're pushing against a cylinder

80
00:02:41,350 --> 00:02:39,840
of compressed air

81
00:02:42,229 --> 00:02:41,360
they also have a treadmill for running

82
00:02:43,990 --> 00:02:42,239
of course you don't stay on the

83
00:02:45,270 --> 00:02:44,000
treadmill and weightlessness so you have

84
00:02:46,550 --> 00:02:45,280
to have a bunch of bungees to hold you

85
00:02:47,509 --> 00:02:46,560
down make you feel like you're running

86
00:02:52,390 --> 00:02:47,519
on a

87
00:02:53,750 --> 00:02:52,400
and again they're hard scheduled for

88
00:02:55,430 --> 00:02:53,760

that two and a half hours every day to

89
00:02:56,949 --> 00:02:55,440
try to keep them in good shape

90
00:02:58,229 --> 00:02:56,959
in the early history of the space

91
00:02:59,670 --> 00:02:58,239
program

92
00:03:01,750 --> 00:02:59,680
especially the russians who were doing

93
00:03:02,830 --> 00:03:01,760
long duration space flights before the

94
00:03:05,190 --> 00:03:02,840
united states

95
00:03:06,710 --> 00:03:05,200
was crew members who didn't exercise

96
00:03:08,710 --> 00:03:06,720
came back and were in pretty poor

97
00:03:10,390 --> 00:03:08,720
physical shape it took them a long time

98
00:03:11,750 --> 00:03:10,400
a lot of rehab on the ground to get back

99
00:03:12,790 --> 00:03:11,760
their their strength and their bone

100
00:03:13,990 --> 00:03:12,800
density

101
00:03:15,270 --> 00:03:14,000
but we're finding that our crews are

102
00:03:16,830 --> 00:03:15,280
coming back from station in pretty good

103
00:03:19,350 --> 00:03:16,840
shape because they're doing their

104
00:03:20,550 --> 00:03:19,360
exercises and actually if you're really

105
00:03:21,990 --> 00:03:20,560
interested in that you can find out more

106
00:03:23,670 --> 00:03:22,000
about some of the workouts that

107
00:03:25,830 --> 00:03:23,680
astronauts here on the ground and also

108
00:03:27,830 --> 00:03:25,840
in space do at with our train leg and

109
00:03:29,350 --> 00:03:27,840
astronaut program

110
00:03:30,869 --> 00:03:29,360
mike hopkins who just launched the space

111
00:03:32,149 --> 00:03:30,879
station yesterday has been real involved

112
00:03:33,509 --> 00:03:32,159
with that and he's been sending down

113
00:03:35,110 --> 00:03:33,519

some tips and

114
00:03:36,710 --> 00:03:35,120
we have some suggested workouts for you

115
00:03:39,509 --> 00:03:36,720
and you can find out more about that on

116
00:03:41,589 --> 00:03:39,519
facebook at facebook.com

117
00:03:42,869 --> 00:03:41,599
train astronaut you can see that

118
00:03:44,149 --> 00:03:42,879
address on the bottom of your screen

119
00:03:46,550 --> 00:03:44,159
there

120
00:03:49,190 --> 00:03:46,560
next question

121
00:03:51,830 --> 00:03:49,200
um what materials like on the outside of

122
00:03:54,470 --> 00:03:51,840
the space station are used i'd like to

123
00:03:55,830 --> 00:03:54,480
keep it i guess safe and are there

124
00:03:58,149 --> 00:03:55,840
better materials that you could have

125
00:03:59,990 --> 00:03:58,159
been you can use that you simply can't

126
00:04:00,949 --> 00:04:00,000
get up there right now or you or it

127
00:04:03,990 --> 00:04:00,959
can't be

128
00:04:09,190 --> 00:04:06,789
okay um the outside of the space station

129
00:04:10,789 --> 00:04:09,200
to keep it safe you said uh the main

130
00:04:12,550 --> 00:04:10,799
threat to the space station and the

131
00:04:14,470 --> 00:04:12,560
crews living on board

132
00:04:16,069 --> 00:04:14,480
is orbital debris

133
00:04:17,909 --> 00:04:16,079
you'll hear us sometimes at nasa use the

134
00:04:20,870 --> 00:04:17,919
phrase mmod which stands for

135
00:04:22,710 --> 00:04:20,880
micrometeorites and orbital debris but

136
00:04:25,270 --> 00:04:22,720
up where the station orbits there is

137
00:04:27,030 --> 00:04:25,280
actually not very much micro meteorite

138
00:04:29,189 --> 00:04:27,040

it's almost all orbital debris that is

139
00:04:30,710 --> 00:04:29,199
stuff that we have put up there either

140
00:04:32,550 --> 00:04:30,720
accidentally or on purpose it's orbiting

141
00:04:34,870 --> 00:04:32,560
around the earth at enormous speeds much

142
00:04:35,670 --> 00:04:34,880
much faster than a rifle bullet

143
00:04:38,310 --> 00:04:35,680
so

144
00:04:40,790 --> 00:04:38,320
to keep the station safe it has what's

145
00:04:43,189 --> 00:04:40,800
called a debris shield so instead of

146
00:04:44,469 --> 00:04:43,199
just having your hull of your space

147
00:04:46,550 --> 00:04:44,479
station which is a single wall of

148
00:04:47,590 --> 00:04:46,560
aluminum out there facing the orbital

149
00:04:49,189 --> 00:04:47,600
debris where if something hits it it

150
00:04:51,749 --> 00:04:49,199
could punch a hole in it

151
00:04:53,830 --> 00:04:51,759
we put a second wall around the whole

152
00:04:56,390 --> 00:04:53,840
space station and

153
00:04:58,310 --> 00:04:56,400
stood out from the inner wall by a few

154
00:04:59,670 --> 00:04:58,320
inches to maybe a foot

155
00:05:01,430 --> 00:04:59,680
and what that does is when a piece of

156
00:05:03,590 --> 00:05:01,440
orthodory comes in it's coming in so

157
00:05:05,189 --> 00:05:03,600
fast that it hits anything even

158
00:05:06,150 --> 00:05:05,199
something as thin as a sheet of tissue

159
00:05:07,670 --> 00:05:06,160
paper

160
00:05:09,990 --> 00:05:07,680
that projectile is just going to break

161
00:05:11,590 --> 00:05:10,000
up into a spray of molten droplets and

162
00:05:14,070 --> 00:05:11,600
little tiny fragments

163
00:05:15,590 --> 00:05:14,080

and then that stuff spreads out over the

164
00:05:16,950 --> 00:05:15,600
intervening gap between the debris

165
00:05:18,230 --> 00:05:16,960
shield and the main hall of space

166
00:05:19,510 --> 00:05:18,240
station so that when it hits the main

167
00:05:20,950 --> 00:05:19,520
hull it's all spread out and doesn't

168
00:05:22,550 --> 00:05:20,960
punch a hole in it

169
00:05:24,790 --> 00:05:22,560
so that's how you protect against really

170
00:05:26,310 --> 00:05:24,800
high speed stuff so it doesn't really

171
00:05:28,390 --> 00:05:26,320
matter what the material is you know you

172
00:05:30,790 --> 00:05:28,400
can make strong armor or something like

173
00:05:32,150 --> 00:05:30,800
that and at the speeds of collision that

174
00:05:33,510 --> 00:05:32,160
we're talking about it really makes very

175
00:05:34,790 --> 00:05:33,520
little difference the important thing is

176
00:05:36,550 --> 00:05:34,800
to have that

177
00:05:38,469 --> 00:05:36,560
shield can be very thin doesn't matter

178
00:05:40,870 --> 00:05:38,479
what it's made out of stood off from

179
00:05:42,310 --> 00:05:40,880
your main pressure hall

180
00:05:44,230 --> 00:05:42,320
the actual material that we use for all

181
00:05:45,749 --> 00:05:44,240
of that is aluminum that's what

182
00:05:48,550 --> 00:05:45,759
aerospace engineers the folks who go to

183
00:05:50,550 --> 00:05:48,560
work here at nasa were trained to use

184
00:05:52,550 --> 00:05:50,560
when they were in college studying to be

185
00:05:53,990 --> 00:05:52,560
aerospace engineers aluminum is what

186
00:05:55,749 --> 00:05:54,000
we're used to it works pretty well it's

187
00:05:57,590 --> 00:05:55,759
also really light which is important

188
00:06:00,390 --> 00:05:57,600

because everything has to be launched on

189
00:06:01,749 --> 00:06:00,400
a rocket and we can just barely shave

190
00:06:03,749 --> 00:06:01,759
down the masses of all the stuff we

191
00:06:05,430 --> 00:06:03,759
throw into space enough so that it will

192
00:06:07,029 --> 00:06:05,440
actually the rocket can actually lift it

193
00:06:09,270 --> 00:06:07,039
up into orbit

194
00:06:10,950 --> 00:06:09,280
so aluminum is a good choice i don't

195
00:06:12,710 --> 00:06:10,960
think we have anything waiting in the

196
00:06:14,629 --> 00:06:12,720
wings that's like a super armor that

197
00:06:16,870 --> 00:06:14,639
would be better

198
00:06:19,189 --> 00:06:16,880
slowly composite materials you may have

199
00:06:22,150 --> 00:06:19,199
heard of which are made out of

200
00:06:23,430 --> 00:06:22,160
fibers of carbon and epoxy glue

201
00:06:25,350 --> 00:06:23,440
are working their way into aerospace

202
00:06:27,189 --> 00:06:25,360
that stuff is uh stronger than aluminum

203
00:06:30,230 --> 00:06:27,199
and a little lighter i don't know how it

204
00:06:31,909 --> 00:06:30,240
behaves in micrometeorite impact

205
00:06:33,430 --> 00:06:31,919
the physics of micro meteorite not high

206
00:06:35,189 --> 00:06:33,440
speed impacts they're a little bit weird

207
00:06:37,270 --> 00:06:35,199
and things that you might expect to be

208
00:06:39,110 --> 00:06:37,280
super strong like kevlar

209
00:06:41,270 --> 00:06:39,120
kevlar is great for a bulletproof vest

210
00:06:43,270 --> 00:06:41,280
it's lousy for orbital debris

211
00:06:44,309 --> 00:06:43,280
just depending on the physics of the

212
00:06:45,270 --> 00:06:44,319
material

213
00:06:46,870 --> 00:06:45,280

so i don't think we have anything

214
00:06:49,270 --> 00:06:46,880
waiting in the wings to replace aluminum

215
00:06:52,390 --> 00:06:49,280
it's a good choice

216
00:06:52,400 --> 00:06:57,350
um how do you guys sleep at night

217
00:07:00,230 --> 00:06:58,950
how do you sleep at night uh pretty much

218
00:07:01,510 --> 00:07:00,240
the same you do on earth maybe your

219
00:07:03,189 --> 00:07:01,520
first couple nights in space you're a

220
00:07:06,469 --> 00:07:03,199
little uh excited about where you are so

221
00:07:08,230 --> 00:07:06,479
you may not sleep real well um but

222
00:07:10,309 --> 00:07:08,240
at night you can just go to sleep

223
00:07:12,150 --> 00:07:10,319
wherever you are and it's really really

224
00:07:13,749 --> 00:07:12,160
comfortable because there's no gravity

225
00:07:15,909 --> 00:07:13,759
pulling you onto the bed but if you just

226
00:07:18,150 --> 00:07:15,919
go go to sleep floating around the cabin

227
00:07:20,309 --> 00:07:18,160
you will wake up on the ventilation

228
00:07:22,070 --> 00:07:20,319
inlet grill because the air currents in

229
00:07:23,990 --> 00:07:22,080
the cabin will very slowly pull you over

230
00:07:25,270 --> 00:07:24,000
to the ventilation duct so if you don't

231
00:07:26,870 --> 00:07:25,280
want to wake up with all your cremates

232
00:07:29,110 --> 00:07:26,880
on the ventilation duct you have to do

233
00:07:31,029 --> 00:07:29,120
something to kind of restrain yourself

234
00:07:32,950 --> 00:07:31,039
so there are sleeping bags

235
00:07:33,830 --> 00:07:32,960
which you can strap to the wall

236
00:07:35,430 --> 00:07:33,840
and

237
00:07:37,029 --> 00:07:35,440
you just climb into your sleeping bag

238
00:07:38,070 --> 00:07:37,039

you can has a little elastic straps to

239
00:07:40,230 --> 00:07:38,080
hold you in

240
00:07:41,350 --> 00:07:40,240
and hang out and go to sleep so it takes

241
00:07:43,670 --> 00:07:41,360
a little getting used to the first

242
00:07:45,510 --> 00:07:43,680
couple nights some people miss having a

243
00:07:46,309 --> 00:07:45,520
force pulling them into the bed

244
00:07:47,909 --> 00:07:46,319
um

245
00:07:50,390 --> 00:07:47,919
i know a person who when they're in

246
00:07:52,550 --> 00:07:50,400
space uh sleeps sort of sandwiched in

247
00:07:53,909 --> 00:07:52,560
between two big huge heavy cargo bags

248
00:07:55,670 --> 00:07:53,919
because it gives them that extra feeling

249
00:07:56,869 --> 00:07:55,680
of security but once you get used to it

250
00:08:00,629 --> 00:07:56,879
it's the most comfortable night's sleep

251
00:08:00,639 --> 00:08:11,110
next question

252
00:08:16,790 --> 00:08:13,749
what are the requirements um in terms of

253
00:08:19,430 --> 00:08:16,800
education and merit to become um an

254
00:08:21,110 --> 00:08:19,440
astronaut that might be featured um on a

255
00:08:22,150 --> 00:08:21,120
mission to the international space

256
00:08:24,710 --> 00:08:22,160
station

257
00:08:27,430 --> 00:08:24,720
okay to be an astronaut you have to have

258
00:08:29,430 --> 00:08:27,440
at least a bachelor's degree in a

259
00:08:32,230 --> 00:08:29,440
technical field like physics or

260
00:08:34,149 --> 00:08:32,240
engineering or something like that

261
00:08:37,589 --> 00:08:34,159
you can also enter the astronaut core as

262
00:08:38,949 --> 00:08:37,599
a teacher or as a military test pilot

263
00:08:40,310 --> 00:08:38,959

but everybody has to have at least that

264
00:08:42,310 --> 00:08:40,320
bachelor's degree plus some work

265
00:08:44,149 --> 00:08:42,320
experience or else

266
00:08:45,910 --> 00:08:44,159
advanced degrees

267
00:08:46,870 --> 00:08:45,920
beyond that it's you have to be very

268
00:08:49,750 --> 00:08:46,880
healthy

269
00:08:51,509 --> 00:08:49,760
you have to be pretty fit um the

270
00:08:54,710 --> 00:08:51,519
rigors of working in a spacesuit on a

271
00:08:56,230 --> 00:08:54,720
spacewalk are pretty intense and if

272
00:08:58,550 --> 00:08:56,240
you're not in good shape you're not

273
00:09:00,230 --> 00:08:58,560
going to be able to do well at that

274
00:09:03,030 --> 00:09:00,240
so those are the basics and then the

275
00:09:05,030 --> 00:09:03,040
hard part is there's 5000 other people

276
00:09:06,470 --> 00:09:05,040
just like you want to go do this and you

277
00:09:07,990 --> 00:09:06,480
have to be

278
00:09:09,670 --> 00:09:08,000
lucky enough to come out on top in the

279
00:09:11,910 --> 00:09:09,680
selection process but the basics are

280
00:09:14,470 --> 00:09:11,920
very simple they're also on the web

281
00:09:16,070 --> 00:09:14,480
uh if you look on nasa's website you can

282
00:09:17,910 --> 00:09:16,080
download the job application it tells

283
00:09:20,070 --> 00:09:17,920
you exactly what you need you can find

284
00:09:30,870 --> 00:09:20,080
that at nasa.gov astronaut if you want

285
00:09:34,710 --> 00:09:33,350
what is being researched on the space

286
00:09:36,870 --> 00:09:34,720
station

287
00:09:38,389 --> 00:09:36,880
i heard something about like

288
00:09:41,350 --> 00:09:38,399

bio um

289
00:09:42,949 --> 00:09:41,360
biomechanics and microbiology and such

290
00:09:45,590 --> 00:09:42,959
and

291
00:09:47,750 --> 00:09:45,600
surface tension for liquids what all is

292
00:09:49,670 --> 00:09:47,760
being researched there

293
00:09:52,070 --> 00:09:49,680
i certainly cannot answer that question

294
00:09:54,470 --> 00:09:52,080
there are dozens of investigations going

295
00:09:56,630 --> 00:09:54,480
on on the space station all the time

296
00:09:58,630 --> 00:09:56,640
and you listed the main ones the main

297
00:10:00,470 --> 00:09:58,640
classes combustion

298
00:10:02,470 --> 00:10:00,480
the way flames work

299
00:10:03,590 --> 00:10:02,480
in one gravity is very different from

300
00:10:06,470 --> 00:10:03,600
how they work in zero gravity we're

301
00:10:08,550 --> 00:10:06,480
trying to understand how flames work

302
00:10:10,630 --> 00:10:08,560
we're doing work on biology we're also

303
00:10:11,509 --> 00:10:10,640
doing a lot of work on human health so

304
00:10:13,030 --> 00:10:11,519
that

305
00:10:14,470 --> 00:10:13,040
we can send people

306
00:10:17,269 --> 00:10:14,480
say all the way to mars and back and

307
00:10:19,030 --> 00:10:17,279
keep them healthy in space but i

308
00:10:23,750 --> 00:10:19,040
i'm sorry i don't have a full list for

309
00:10:23,760 --> 00:10:30,790
next question

310
00:10:35,509 --> 00:10:33,509
uh what is the average cost for a

311
00:10:38,230 --> 00:10:35,519
mission to save the international space

312
00:10:41,190 --> 00:10:40,150
i don't know and neither does anybody

313
00:10:43,590 --> 00:10:41,200

else

314
00:10:45,509 --> 00:10:43,600
um right now we're paying about 60

315
00:10:47,829 --> 00:10:45,519
million dollars per seat

316
00:10:50,150 --> 00:10:47,839
for a seat on the soyuz but the

317
00:10:51,990 --> 00:10:50,160
accounting for how rockets are funded

318
00:10:54,150 --> 00:10:52,000
and how much they cost and which money

319
00:10:58,949 --> 00:10:54,160
comes out of which pot is so obscure

320
00:11:03,190 --> 00:11:01,509
cost for an unmanned rocket launch 50 to

321
00:11:05,190 --> 00:11:03,200
75 million dollars

322
00:11:06,870 --> 00:11:05,200
uh soyuz if you multiply that seat cost

323
00:11:09,509 --> 00:11:06,880
times the three crew that ends up at

324
00:11:10,949 --> 00:11:09,519
about 200 million dollars um of course

325
00:11:12,230 --> 00:11:10,959
rockets that carry people are more

326
00:11:13,829 --> 00:11:12,240
expensive than rockets that carry

327
00:11:15,910 --> 00:11:13,839
satellites because the ones that carry

328
00:11:18,069 --> 00:11:15,920
people have to have extra safety systems

329
00:11:19,590 --> 00:11:18,079
which cost money and more people

330
00:11:21,190 --> 00:11:19,600
examining all their parts and making

331
00:11:22,870 --> 00:11:21,200
sure that they're really really ready to

332
00:11:25,030 --> 00:11:22,880
fly because you really don't want an

333
00:11:26,790 --> 00:11:25,040
accident with people on board but sort

334
00:11:28,790 --> 00:11:26,800
of hundreds of millions of dollars per

335
00:11:30,310 --> 00:11:28,800
launch or tens to hundreds of millions

336
00:11:33,670 --> 00:11:30,320
of dollars is kind of the ballpark for

337
00:11:33,680 --> 00:11:41,110
next question

338
00:11:46,310 --> 00:11:43,670

you mentioned ensuring that uh

339
00:11:48,310 --> 00:11:46,320
astronauts were exceptionally healthy

340
00:11:50,949 --> 00:11:48,320
uh how do you ensure that no

341
00:11:53,829 --> 00:11:50,959
particularly uh nasty viruses or

342
00:11:56,710 --> 00:11:53,839
bacteria end up on the on the space

343
00:11:58,069 --> 00:11:56,720
shuttle infecting anyone same way we've

344
00:12:00,310 --> 00:11:58,079
done for hundreds of years you

345
00:12:02,069 --> 00:12:00,320
quarantine everybody before they go

346
00:12:03,269 --> 00:12:02,079
so before a crew launches to the space

347
00:12:05,509 --> 00:12:03,279
station

348
00:12:08,150 --> 00:12:05,519
they will enter quarantine and they will

349
00:12:11,110 --> 00:12:08,160
spend a week to 10 days without

350
00:12:12,550 --> 00:12:11,120
contacting basically anyone else the few

351
00:12:14,629 --> 00:12:12,560
people that they are in contact with

352
00:12:16,949 --> 00:12:14,639
either have to wear pollen masks

353
00:12:18,949 --> 00:12:16,959
or have to get examined by a doctor and

354
00:12:20,470 --> 00:12:18,959
make sure that they're healthy

355
00:12:22,550 --> 00:12:20,480
and we've been doing that in the space

356
00:12:24,470 --> 00:12:22,560
program both the u.s space program the

357
00:12:27,190 --> 00:12:24,480
russian space programs for decades

358
00:12:29,430 --> 00:12:27,200
and it works most of the time

359
00:12:31,750 --> 00:12:29,440
we did get the flu on space station one

360
00:12:33,670 --> 00:12:31,760
time a few years ago and the crew got

361
00:12:35,350 --> 00:12:33,680
sick and felt lousy for a couple days

362
00:12:36,550 --> 00:12:35,360
just like happens when you get the flu

363
00:12:38,069 --> 00:12:36,560

and then they got better just like

364
00:12:40,069 --> 00:12:38,079
happens when you get the flu but we work

365
00:12:41,910 --> 00:12:40,079
hard to try to

366
00:12:43,509 --> 00:12:41,920
keep the crews in quarantine and

367
00:12:45,590 --> 00:12:43,519
isolated from germs so that we don't get

368
00:12:46,790 --> 00:12:45,600
any bugs on the space station because we

369
00:12:48,230 --> 00:12:46,800
want our folks up there to be able to

370
00:12:52,069 --> 00:12:48,240
work and we don't want them stuck in bed

371
00:12:52,079 --> 00:12:55,990
next question

372
00:12:59,190 --> 00:12:57,350
and once again just a reminder

373
00:13:01,509 --> 00:12:59,200
definitely speak up so they can hear you

374
00:13:03,590 --> 00:13:01,519
uh clearly in mission control and go

375
00:13:05,430 --> 00:13:03,600
ahead with your next question

376
00:13:08,310 --> 00:13:05,440
how do the astronauts cope with the

377
00:13:14,870 --> 00:13:08,320
speed used to project him in outer space

378
00:13:19,590 --> 00:13:16,550
how do astronauts cope with the speed

379
00:13:20,949 --> 00:13:19,600
used to project them in the outer space

380
00:13:23,190 --> 00:13:20,959
i don't know how do you cope with the

381
00:13:24,710 --> 00:13:23,200
speed you need to ride in an airplane

382
00:13:26,069 --> 00:13:24,720
seems pretty okay you know it's five

383
00:13:27,269 --> 00:13:26,079
you're going 500 miles an hour but you

384
00:13:30,389 --> 00:13:27,279
don't feel it feel that inside the

385
00:13:32,470 --> 00:13:30,399
aircraft same thing in a rocket your

386
00:13:33,509 --> 00:13:32,480
environment travels along with you and

387
00:13:35,509 --> 00:13:33,519
there is

388
00:13:36,629 --> 00:13:35,519

little sense of the speed you're going

389
00:13:39,350 --> 00:13:36,639
at

390
00:13:40,870 --> 00:13:39,360
except during launch

391
00:13:43,030 --> 00:13:40,880
during launch when all those rockets are

392
00:13:44,710 --> 00:13:43,040
firing and you can hear the howling of

393
00:13:46,870 --> 00:13:44,720
the wind outside the capsule when you're

394
00:13:48,389 --> 00:13:46,880
still at low altitude and

395
00:13:51,030 --> 00:13:48,399
you're not up in vacuum yet you can hear

396
00:13:52,310 --> 00:13:51,040
that there is a sense of speed

397
00:13:54,629 --> 00:13:52,320
um

398
00:13:56,069 --> 00:13:54,639
and the way you cope with that is uh and

399
00:13:57,910 --> 00:13:56,079
especially the acceleration that the

400
00:13:59,509 --> 00:13:57,920
rocket produces which isn't that great

401
00:14:00,550 --> 00:13:59,519
um if you watch a lot of movies you see

402
00:14:02,389 --> 00:14:00,560
people getting you know world and

403
00:14:03,990 --> 00:14:02,399
centrifuges and things like that

404
00:14:05,750 --> 00:14:04,000
the acceleration you feel right in the

405
00:14:07,350 --> 00:14:05,760
soyuz the space station tops out about

406
00:14:09,030 --> 00:14:07,360
four and a half g's which is enough to

407
00:14:10,550 --> 00:14:09,040
make you notice you got to pay attention

408
00:14:12,389 --> 00:14:10,560
to your breathing but you're lying on

409
00:14:13,910 --> 00:14:12,399
your back you're in a comfortable seat

410
00:14:15,750 --> 00:14:13,920
and uh

411
00:14:18,150 --> 00:14:15,760
you just ride there with the rocket and

412
00:14:19,750 --> 00:14:18,160
it's okay but there's really very little

413
00:14:27,189 --> 00:14:19,760

sense of speed most of the time it's the

414
00:14:27,199 --> 00:14:32,790
next question

415
00:14:38,790 --> 00:14:35,110
when uh returning back to the surface of

416
00:14:40,710 --> 00:14:38,800
earth uh how do the astronauts acclimate

417
00:14:44,389 --> 00:14:40,720
to the conditions on earth and how they

418
00:14:46,389 --> 00:14:44,399
differ from on the conditions in uh

419
00:14:49,829 --> 00:14:46,399
microgravity and outer space

420
00:14:53,269 --> 00:14:51,750
okay getting used to gravity again is

421
00:14:54,389 --> 00:14:53,279
about as hard as getting used to

422
00:14:57,430 --> 00:14:54,399
weightlessness at the beginning of a

423
00:14:58,870 --> 00:14:57,440
mission when you first get into space

424
00:15:00,310 --> 00:14:58,880
you have to sort of learn how to use

425
00:15:02,150 --> 00:15:00,320
your body because you don't have your

426
00:15:03,269 --> 00:15:02,160
legs to support anymore you have to if

427
00:15:05,110 --> 00:15:03,279
you're working with one hand you have to

428
00:15:06,629 --> 00:15:05,120
support yourself with your other hand if

429
00:15:08,470 --> 00:15:06,639
you're doing a two-hand job you run out

430
00:15:09,910 --> 00:15:08,480
of hands

431
00:15:11,750 --> 00:15:09,920
coming back to the ground then you have

432
00:15:13,590 --> 00:15:11,760
to get used to gravity again your sense

433
00:15:14,949 --> 00:15:13,600
of balance has to rewire itself so you

434
00:15:17,269 --> 00:15:14,959
may feel a little dizzy or even

435
00:15:19,350 --> 00:15:17,279
nauseated the first couple of days back

436
00:15:20,790 --> 00:15:19,360
in fact uh your first three days back

437
00:15:22,150 --> 00:15:20,800
from a short duration spaceflight they

438
00:15:23,269 --> 00:15:22,160

don't let you drive your car because

439
00:15:25,829 --> 00:15:23,279
they're afraid you're going to get dizzy

440
00:15:27,030 --> 00:15:25,839
when you go around a corner and crash so

441
00:15:30,230 --> 00:15:27,040
they keep the car keys from you for

442
00:15:34,629 --> 00:15:32,470
you may have lost some muscle strength

443
00:15:36,150 --> 00:15:34,639
on my short flight i actually lost quite

444
00:15:38,230 --> 00:15:36,160
a bit of strength so i had to go back to

445
00:15:39,910 --> 00:15:38,240
the gym and work out real hard to get my

446
00:15:41,430 --> 00:15:39,920
strength back

447
00:15:43,189 --> 00:15:41,440
we even had a couple people the first

448
00:15:44,550 --> 00:15:43,199
day or two back

449
00:15:46,470 --> 00:15:44,560
because your

450
00:15:47,749 --> 00:15:46,480
heart has gotten used to pumping blood

451
00:15:48,949 --> 00:15:47,759
around your body without having to work

452
00:15:50,710 --> 00:15:48,959
against gravity we've had a couple

453
00:15:52,389 --> 00:15:50,720
people faint

454
00:15:55,030 --> 00:15:52,399
which always looks alarming but they've

455
00:15:56,310 --> 00:15:55,040
been perfectly all right

456
00:15:57,269 --> 00:15:56,320
issues

457
00:15:59,030 --> 00:15:57,279
not

458
00:16:00,389 --> 00:15:59,040
really especially now that people are

459
00:16:02,470 --> 00:16:00,399
doing their exercises they're coming

460
00:16:04,710 --> 00:16:02,480
back in pretty good shape in the past

461
00:16:07,189 --> 00:16:04,720
people lost a lot of bone

462
00:16:10,310 --> 00:16:07,199
you can rebuild bone with a lot of heavy

463
00:16:11,590 --> 00:16:10,320

loaded weight lifting things like that

464
00:16:13,509 --> 00:16:11,600
there have been a couple cases where

465
00:16:15,110 --> 00:16:13,519
people didn't get all their bone back

466
00:16:16,069 --> 00:16:15,120
but as far as you know looking at

467
00:16:18,470 --> 00:16:16,079
somebody and seeing that they have a

468
00:16:20,150 --> 00:16:18,480
health issue no people look great i have

469
00:16:21,509 --> 00:16:20,160
a chance now working in the astronaut

470
00:16:23,110 --> 00:16:21,519
working out in the astronaut gym see

471
00:16:27,110 --> 00:16:23,120
guys when they're two days back from

472
00:16:27,120 --> 00:16:37,110
next question

473
00:16:41,509 --> 00:16:39,189
you mentioned some physical effects on

474
00:16:44,230 --> 00:16:41,519
the muscles and the skeleton

475
00:16:47,189 --> 00:16:44,240
are there any effects on the immune

476
00:16:50,470 --> 00:16:47,199
system uh spending so much time usually

477
00:16:53,110 --> 00:16:50,480
absent from pathogens

478
00:16:54,550 --> 00:16:53,120
uh yes although we're getting a little

479
00:16:56,150 --> 00:16:54,560
outside my field of expertise here if

480
00:16:58,150 --> 00:16:56,160
you've got physics questions i'm i'm

481
00:16:59,590 --> 00:16:58,160
good with that biology

482
00:17:01,030 --> 00:16:59,600
that's not where my phd is but i'll tell

483
00:17:02,470 --> 00:17:01,040
you what i know

484
00:17:04,069 --> 00:17:02,480
so actually there are changes in your

485
00:17:06,309 --> 00:17:04,079
immune system and has nothing to do with

486
00:17:07,510 --> 00:17:06,319
being isolated from pathogens it has

487
00:17:09,990 --> 00:17:07,520
everything to do with being in a

488
00:17:12,549 --> 00:17:10,000

stressful environment

489
00:17:13,990 --> 00:17:12,559
people on earth under stress like you

490
00:17:15,590 --> 00:17:14,000
know students during college finals

491
00:17:16,870 --> 00:17:15,600
weeks and things like that

492
00:17:18,870 --> 00:17:16,880
they get stressed out and it actually

493
00:17:20,630 --> 00:17:18,880
depresses your immune function that is

494
00:17:22,470 --> 00:17:20,640
things that would not ordinarily make

495
00:17:23,750 --> 00:17:22,480
you sick will make you sick because

496
00:17:25,990 --> 00:17:23,760
you're working hard you're worrying a

497
00:17:27,909 --> 00:17:26,000
lot you may not be sleeping too well and

498
00:17:30,470 --> 00:17:27,919
astronauts get that in spades and that's

499
00:17:32,310 --> 00:17:30,480
been the subject of many studies

500
00:17:34,230 --> 00:17:32,320
now fortunately in space you are

501
00:17:37,029 --> 00:17:34,240
isolated from pathogens so even though

502
00:17:38,390 --> 00:17:37,039
your immune system may be weaker

503
00:17:40,230 --> 00:17:38,400
maybe because of the stress maybe

504
00:17:42,710 --> 00:17:40,240
because of something else from being in

505
00:17:44,310 --> 00:17:42,720
space we don't really know right now

506
00:17:46,789 --> 00:17:44,320
we have yet to run

507
00:17:48,390 --> 00:17:46,799
tests on astronauts in space who aren't

508
00:17:50,310 --> 00:17:48,400
working hard

509
00:17:51,990 --> 00:17:50,320
so we don't know whether it's the stress

510
00:17:53,430 --> 00:17:52,000
or the space that does it

511
00:17:55,029 --> 00:17:53,440
but because there's no pathogens on

512
00:17:57,029 --> 00:17:55,039
space station or very few because of the

513
00:18:12,830 --> 00:17:57,039

quarantine you have fewer opportunities

514
00:18:17,909 --> 00:18:15,750
uh you mentioned quarantine but what

515
00:18:20,150 --> 00:18:17,919
what other things do uh astronauts do to

516
00:18:21,430 --> 00:18:20,160
prepare for space like physical training

517
00:18:22,950 --> 00:18:21,440
or like things

518
00:18:24,950 --> 00:18:22,960
they have to do

519
00:18:26,549 --> 00:18:24,960
i don't know i saw a bunch of

520
00:18:27,750 --> 00:18:26,559
interesting like simulations that

521
00:18:29,510 --> 00:18:27,760
astronauts have to go through before

522
00:18:32,870 --> 00:18:29,520
they enter space

523
00:18:35,110 --> 00:18:32,880
yeah it takes a minimum of two years of

524
00:18:37,750 --> 00:18:35,120
preparing to fly in space and for most

525
00:18:39,350 --> 00:18:37,760
people it ends up being more like eight

526
00:18:40,470 --> 00:18:39,360
so you're working hard for those eight

527
00:18:43,029 --> 00:18:40,480
years you're not just sitting at your

528
00:18:44,390 --> 00:18:43,039
desk coming through the internet you

529
00:18:46,230 --> 00:18:44,400
will be doing a lot of physical training

530
00:18:48,870 --> 00:18:46,240
as you mentioned you'll be doing a lot

531
00:18:51,190 --> 00:18:48,880
of flying in our t-38 trainer jets which

532
00:18:53,029 --> 00:18:51,200
teaches you how to handle complicated

533
00:18:54,870 --> 00:18:53,039
systems while moving very very fast in a

534
00:18:56,630 --> 00:18:54,880
situation where if you mess up you can

535
00:18:58,710 --> 00:18:56,640
die

536
00:19:00,230 --> 00:18:58,720
there's training in the giant swimming

537
00:19:01,430 --> 00:19:00,240
pool in the spacesuit to learn how to do

538
00:19:03,350 --> 00:19:01,440

spacewalks there's training on the

539
00:19:05,830 --> 00:19:03,360
robotic arms both using

540
00:19:06,789 --> 00:19:05,840
real robotic arms and also sort of

541
00:19:09,270 --> 00:19:06,799
very

542
00:19:10,549 --> 00:19:09,280
sophisticated simulated environments

543
00:19:12,150 --> 00:19:10,559
which

544
00:19:14,310 --> 00:19:12,160
you know has the same joysticks as a

545
00:19:15,990 --> 00:19:14,320
video game but someone's going to give

546
00:19:17,669 --> 00:19:16,000
you a stern talking to if you knock your

547
00:19:19,430 --> 00:19:17,679
robotic arm into something during one of

548
00:19:21,270 --> 00:19:19,440
those sims there are what we call

549
00:19:22,310 --> 00:19:21,280
integrated simulations where we have

550
00:19:24,310 --> 00:19:22,320
crews

551
00:19:25,590 --> 00:19:24,320
in mock-ups of the space station on

552
00:19:27,190 --> 00:19:25,600
earth

553
00:19:29,510 --> 00:19:27,200
connected to the real mission control

554
00:19:31,110 --> 00:19:29,520
with real flight controllers and

555
00:19:32,789 --> 00:19:31,120
elsewhere there's a team of instructors

556
00:19:34,789 --> 00:19:32,799
who are throwing malfunctions at the

557
00:19:36,470 --> 00:19:34,799
space station every few minutes and the

558
00:19:38,470 --> 00:19:36,480
flight controllers and the crew have to

559
00:19:40,390 --> 00:19:38,480
respond to those malfunctions

560
00:19:43,270 --> 00:19:40,400
prevent further problems from happening

561
00:19:45,669 --> 00:19:43,280
and recover from them so it's a very

562
00:19:47,510 --> 00:19:45,679
very intense and very long training

563
00:19:48,870 --> 00:19:47,520

scheme to take somebody who just comes

564
00:19:54,470 --> 00:19:48,880
in the door and get them ready to fly in

565
00:19:54,480 --> 00:19:57,669
next question

566
00:20:04,470 --> 00:20:00,390
when you're up in space do you have a

567
00:20:06,230 --> 00:20:04,480
set area for waste storage both

568
00:20:07,270 --> 00:20:06,240
human waste and food waste or do you

569
00:20:10,950 --> 00:20:07,280
release it

570
00:20:14,070 --> 00:20:10,960
uh into space from the ship

571
00:20:15,990 --> 00:20:14,080
we do not release waste into space

572
00:20:17,510 --> 00:20:16,000
and i we our first question i think was

573
00:20:20,390 --> 00:20:17,520
about orbital debris

574
00:20:22,710 --> 00:20:20,400
and anything you put into space as waste

575
00:20:25,430 --> 00:20:22,720
can come back to haunt you at 8 000

576
00:20:28,070 --> 00:20:25,440
meters per second and we really really

577
00:20:30,070 --> 00:20:28,080
don't want that we want to dispose of

578
00:20:31,190 --> 00:20:30,080
everything in space that are all waste

579
00:20:33,430 --> 00:20:31,200
that we generate in space we want to

580
00:20:35,270 --> 00:20:33,440
dispose of so that it does not stay in

581
00:20:36,549 --> 00:20:35,280
orbit and then knock out ourselves or

582
00:20:38,149 --> 00:20:36,559
knock out somebody else's really

583
00:20:39,990 --> 00:20:38,159
expensive satellite

584
00:20:42,470 --> 00:20:40,000
so all of the waste that's generated on

585
00:20:44,070 --> 00:20:42,480
the space station gets loaded into one

586
00:20:46,230 --> 00:20:44,080
of our several

587
00:20:48,549 --> 00:20:46,240
cargo ships that go to the space station

588
00:20:50,710 --> 00:20:48,559

they bring fresh supplies and when it's

589
00:20:52,230 --> 00:20:50,720
empty they load it up with trash

590
00:20:54,789 --> 00:20:52,240
separate the spacecraft from the space

591
00:20:56,390 --> 00:20:54,799
station and then de-orbit it so that it

592
00:20:58,149 --> 00:20:56,400
burns up in the atmosphere over the

593
00:20:59,669 --> 00:20:58,159
south pacific so that even if a few

594
00:21:01,270 --> 00:20:59,679
little pieces do reach the ground

595
00:21:03,029 --> 00:21:01,280
there's no people there it's just open

596
00:21:05,190 --> 00:21:03,039
ocean there are no islands or anything

597
00:21:06,870 --> 00:21:05,200
and even very very few ships because the

598
00:21:08,310 --> 00:21:06,880
shipping routes don't run

599
00:21:11,590 --> 00:21:08,320
under the place where we dispose our

600
00:21:13,590 --> 00:21:11,600
stuff so of our cargo ships

601
00:21:16,310 --> 00:21:13,600
right now we have a handful of them

602
00:21:19,510 --> 00:21:16,320
only the spacex dragon capsule actually

603
00:21:21,270 --> 00:21:19,520
lands intact under parachute and we use

604
00:21:31,190 --> 00:21:21,280
that for returning cargo but the trash

605
00:21:36,070 --> 00:21:33,750
um i was wondering how you preserve food

606
00:21:37,430 --> 00:21:36,080
in space and keep it from spoiling with

607
00:21:39,190 --> 00:21:37,440
things like milk

608
00:21:43,510 --> 00:21:39,200
things like that

609
00:21:48,149 --> 00:21:45,750
um all the food in space has to have a

610
00:21:49,669 --> 00:21:48,159
shelf life of a year or more

611
00:21:51,190 --> 00:21:49,679
it all comes up on cargo ships those are

612
00:21:52,870 --> 00:21:51,200
separated by months we need to keep a

613
00:21:54,310 --> 00:21:52,880

reserve supply of food on space station

614
00:21:56,149 --> 00:21:54,320
in case one of the cargo ships doesn't

615
00:21:57,430 --> 00:21:56,159
make it that happened a couple years ago

616
00:22:00,310 --> 00:21:57,440
we had a cargo ship full of food and

617
00:22:02,230 --> 00:22:00,320
supplies that uh crashed while it was

618
00:22:03,190 --> 00:22:02,240
heading for orbit and the crew did not

619
00:22:04,630 --> 00:22:03,200
get that

620
00:22:06,549 --> 00:22:04,640
batch of supplies so they had to eat

621
00:22:08,070 --> 00:22:06,559
stuff that was in storage so what we

622
00:22:10,149 --> 00:22:08,080
have for food is a whole bunch of

623
00:22:12,710 --> 00:22:10,159
freeze-dried stuff like backpacking food

624
00:22:15,110 --> 00:22:12,720
which you add water to we have a lot of

625
00:22:16,710 --> 00:22:15,120
thermal stabilized stuff which is sealed

626
00:22:18,230 --> 00:22:16,720
in a package and then the whole package

627
00:22:20,390 --> 00:22:18,240
gets boiled

628
00:22:22,070 --> 00:22:20,400
so that it kills all the bacteria and

629
00:22:23,990 --> 00:22:22,080
then the sealed package can remain on

630
00:22:26,149 --> 00:22:24,000
the shelf for years you see those in

631
00:22:27,750 --> 00:22:26,159
mres the rations that are issued to our

632
00:22:29,669 --> 00:22:27,760
soldiers overseas

633
00:22:32,230 --> 00:22:29,679
and then we have some dried foods and

634
00:22:33,590 --> 00:22:32,240
then the best treats anyone can get is

635
00:22:35,430 --> 00:22:33,600
when a cargo ship is just getting ready

636
00:22:37,270 --> 00:22:35,440
to launch they'll throw a few things in

637
00:22:38,390 --> 00:22:37,280
like fresh fruit and vegetables

638
00:22:41,190 --> 00:22:38,400

because you don't get too many of those

639
00:22:42,470 --> 00:22:41,200
on space station and the crew's remark

640
00:22:44,789 --> 00:22:42,480
about how wonderful some of those

641
00:22:46,230 --> 00:22:44,799
capsules smell when you first open up

642
00:22:56,149 --> 00:22:46,240
the hatch and it's got some fresh apples

643
00:23:01,270 --> 00:22:59,029
what future plans does nasa have for

644
00:23:04,870 --> 00:23:01,280
manned missions and what's like uh what

645
00:23:06,630 --> 00:23:04,880
are some eventual goals of nasa

646
00:23:09,350 --> 00:23:06,640
well right now our stated long-term goal

647
00:23:11,590 --> 00:23:09,360
for people is to get people on mars by

648
00:23:13,909 --> 00:23:11,600
the 2030s

649
00:23:16,470 --> 00:23:13,919
closer to that we are hoping to get our

650
00:23:18,310 --> 00:23:16,480
new human rated space capsule we can

651
00:23:19,590 --> 00:23:18,320
carry people back into space from the

652
00:23:22,710 --> 00:23:19,600
united states which we have not been

653
00:23:24,070 --> 00:23:22,720
able to do since the shuttle retires

654
00:23:25,830 --> 00:23:24,080
and i really hope that we can do that

655
00:23:27,590 --> 00:23:25,840
again soon i'd like to see u.s

656
00:23:29,190 --> 00:23:27,600
astronauts launching on a u.s flag

657
00:23:30,630 --> 00:23:29,200
carrier

658
00:23:32,149 --> 00:23:30,640
so we're hoping to

659
00:23:34,390 --> 00:23:32,159
be flying that capsule with people here

660
00:23:35,669 --> 00:23:34,400
in the next five or five years or so

661
00:23:37,990 --> 00:23:35,679
there's some test flights of that coming

662
00:23:41,190 --> 00:23:38,000
up without people sooner than that

663
00:23:43,510 --> 00:23:41,200

we've also got a plan to um go out with

664
00:23:45,510 --> 00:23:43,520
a robotic spacecraft and grab a little

665
00:23:47,590 --> 00:23:45,520
asteroid from

666
00:23:49,110 --> 00:23:47,600
near earth space and we're busy looking

667
00:23:51,750 --> 00:23:49,120
for asteroids of the right size right

668
00:23:54,390 --> 00:23:51,760
now bring that back with the robot ship

669
00:23:56,390 --> 00:23:54,400
and put it into orbit around the moon

670
00:23:59,110 --> 00:23:56,400
and then fly up there with people and do

671
00:24:00,230 --> 00:23:59,120
some work on that small asteroid

672
00:24:01,830 --> 00:24:00,240
there's going to be some steps in

673
00:24:03,750 --> 00:24:01,840
between visiting a little asteroid and

674
00:24:13,350 --> 00:24:03,760
going to mars and we're still working

675
00:24:18,470 --> 00:24:16,549
you talked about capturing an asteroid

676
00:24:20,470 --> 00:24:18,480
how do you identify an asteroid they

677
00:24:23,350 --> 00:24:20,480
don't give off any light is there any

678
00:24:24,950 --> 00:24:23,360
way you can see them

679
00:24:28,470 --> 00:24:24,960
well the moon doesn't give off any light

680
00:24:31,110 --> 00:24:29,909
so asteroids don't give off light of

681
00:24:33,110 --> 00:24:31,120
their own

682
00:24:34,310 --> 00:24:33,120
but they do reflect sunlight just like

683
00:24:35,990 --> 00:24:34,320
everything else in the solar system

684
00:24:37,990 --> 00:24:36,000
including the moon the earth and

685
00:24:40,230 --> 00:24:38,000
spacecraft in orbit

686
00:24:44,470 --> 00:24:40,240
so

687
00:24:46,549 --> 00:24:44,480
the moon is a couple thousand miles

688
00:24:48,070 --> 00:24:46,559

across and it's close so it's easy to

689
00:24:50,470 --> 00:24:48,080
see now when you're talking about

690
00:24:52,070 --> 00:24:50,480
something that's one mile across or for

691
00:24:55,669 --> 00:24:52,080
the size of asteroids that we're talking

692
00:24:57,990 --> 00:24:55,679
about now maybe 20 feet across

693
00:24:59,350 --> 00:24:58,000
and out many times more distant than the

694
00:25:01,110 --> 00:24:59,360
moon

695
00:25:02,870 --> 00:25:01,120
it's like a little mosquito that's

696
00:25:04,470 --> 00:25:02,880
pretty far from the street light and

697
00:25:05,909 --> 00:25:04,480
it's very hard to see

698
00:25:07,830 --> 00:25:05,919
to find those things we use big

699
00:25:10,149 --> 00:25:07,840
telescopes they can big mirrors that

700
00:25:11,350 --> 00:25:10,159
gather a lot of light and wide field of

701
00:25:12,950 --> 00:25:11,360
view so that they're not just looking

702
00:25:14,470 --> 00:25:12,960
down a soda straw but looking at a big

703
00:25:16,070 --> 00:25:14,480
area of the sky

704
00:25:17,830 --> 00:25:16,080
and those

705
00:25:19,669 --> 00:25:17,840
telescopes some of which are automated

706
00:25:21,990 --> 00:25:19,679
they do everything robotically

707
00:25:23,590 --> 00:25:22,000
look for things identify moving targets

708
00:25:24,870 --> 00:25:23,600
and those guys are busy every night

709
00:25:26,549 --> 00:25:24,880
looking at the skies finding new

710
00:25:28,390 --> 00:25:26,559
asteroids

711
00:25:30,230 --> 00:25:28,400
in order to find really tiny ones that

712
00:25:32,390 --> 00:25:30,240
are appropriate for fetching back to the

713
00:25:33,990 --> 00:25:32,400

moon uh we may have to have to actually

714
00:25:35,590 --> 00:25:34,000
build a new telescope

715
00:25:37,430 --> 00:25:35,600
there's one on the books called the

716
00:25:39,029 --> 00:25:37,440
large synoptic survey telescope which is

717
00:25:41,110 --> 00:25:39,039
going to be an 8 meter mirror that is

718
00:25:43,430 --> 00:25:41,120
the light gathering mirror is 25 feet

719
00:25:45,029 --> 00:25:43,440
across that'll be a good one

720
00:25:47,510 --> 00:25:45,039
and we're hoping that that can identify

721
00:25:49,269 --> 00:25:47,520
asteroids like that incidentally

722
00:25:52,149 --> 00:25:49,279
that facility and others like it will

723
00:25:53,269 --> 00:25:52,159
help identify asteroids that might hit

724
00:25:54,950 --> 00:25:53,279
the earth

725
00:25:56,710 --> 00:25:54,960
which is also a topic of interest we'd

726
00:25:58,630 --> 00:25:56,720
rather that didn't happen and when we

727
00:26:00,230 --> 00:25:58,640
developed the technology to move

728
00:26:01,830 --> 00:26:00,240
asteroids around

729
00:26:03,590 --> 00:26:01,840
to put them near the moon so that people

730
00:26:05,350 --> 00:26:03,600
can visit them we'll also be developing

731
00:26:07,190 --> 00:26:05,360
the technology we need to protect the

732
00:26:11,269 --> 00:26:07,200
earth against asteroids that might

733
00:26:14,549 --> 00:26:12,630
all right it looks like that was all the

734
00:26:17,430 --> 00:26:14,559
time we have for questions so i'd like

735
00:26:19,990 --> 00:26:17,440
to thank you guys uh for attending today

736
00:26:21,990 --> 00:26:20,000
and uh thank you dr love for coming in

737
00:26:23,510 --> 00:26:22,000
and answering all the students questions

738
00:26:29,269 --> 00:26:23,520

uh for the students do you guys have any