
PAO

1
00:00:01,233 --> 00:00:02,168
>> Good morning.

2
00:00:02,168 --> 00:00:03,502
Welcome to Mission
Control Houston.

3
00:00:03,502 --> 00:00:05,538
We're here inside the Space
Station flight control room.

4
00:00:05,538 --> 00:00:06,872
I'm Brandi Dean.

5
00:00:06,872 --> 00:00:08,641
I work in Public Affairs here
at NASA, and I've got here

6
00:00:08,641 --> 00:00:11,277
with me Stan Love,
one of our astronauts.

7
00:00:11,277 --> 00:00:13,145
He's been to the
International Space Station,

8
00:00:13,145 --> 00:00:16,782
on board a space shuttle, and
now is working on a lot of kind

9
00:00:16,782 --> 00:00:19,585
of future planning activities
for what's next for NASA.

10
00:00:19,585 --> 00:00:22,555
So, Stan, why don't you tell
us a little bit about yourself?

11
00:00:22,555 --> 00:00:23,222

>> Stan Love: Sure.

12
00:00:23,222 --> 00:00:24,223
My name's Stan Love.

13
00:00:24,223 --> 00:00:26,625
I joined NASA in
1998 as an astronaut.

14
00:00:26,625 --> 00:00:30,496
Before that, my background
was in physics, astronomy,

15
00:00:30,496 --> 00:00:34,733
planetary science and
spacecraft design.

16
00:00:34,733 --> 00:00:37,970
Since then, I've done a
bunch of jobs here at NASA,

17
00:00:37,970 --> 00:00:40,573
including working as a CAPCOM
here in Mission Control

18
00:00:40,573 --> 00:00:42,842
and our other control centers
here at Johnson Space Center.

19
00:00:42,842 --> 00:00:45,311
I spent about eight years doing
that, so I'm used to sitting

20
00:00:45,311 --> 00:00:47,146
at another console in this room.

21
00:00:47,146 --> 00:00:50,483
>> And CAPCOMs are the people
here on the ground who get

22
00:00:50,483 --> 00:00:52,151
to talk to the astronauts
when they're in space.

23
00:00:52,151 --> 00:00:55,454
>> Stan Love: Yes, when you hear
a voice saying, "ISS Houston,

24
00:00:55,454 --> 00:00:58,057
such and such," that's
the CAPCOM speaking.

25
00:00:58,057 --> 00:01:02,428
So I also flew in space on
Space Shuttle Mission STS-122.

26
00:01:02,428 --> 00:01:03,729
That was in 2008.

27
00:01:03,729 --> 00:01:06,999
I did a couple of space
walks, worked the robotic arm

28
00:01:06,999 --> 00:01:09,034
on the shuttle and on the
station, and my crewmates

29
00:01:09,034 --> 00:01:12,338
and I installed the
Columbus Laboratory Module

30
00:01:12,338 --> 00:01:14,807
onto the Space Station, which
is still there today right

31
00:01:14,807 --> 00:01:15,441
on the front part.

32
00:01:15,441 --> 00:01:16,909

It's easy to see.

33
00:01:16,909 --> 00:01:19,578
And I'm with you here
today and would be happy

34
00:01:19,578 --> 00:01:21,914
to answer your questions
about space travel.

35
00:01:21,914 --> 00:01:23,883
>> So if you're ready,
we can go ahead

36
00:01:23,883 --> 00:01:25,417
and start taking your questions.

37
00:01:25,417 --> 00:01:29,622
>> Okay, what effects -- wait.

38
00:01:29,622 --> 00:01:32,525
What do astronauts do in space

39
00:01:32,525 --> 00:01:36,795
to negate the effects
of microgravity?

40
00:01:36,795 --> 00:01:39,565
>> Stan Love: Okay, what
do astronauts do to try

41
00:01:39,565 --> 00:01:41,433
to mitigate the effects
of microgravity?

42
00:01:41,433 --> 00:01:42,801
Quite a lot, actually.

43
00:01:42,801 --> 00:01:45,104

They spend at least two and
a half hours every single day

44
00:01:45,104 --> 00:01:49,341
in space doing mostly
physical exercise

45
00:01:49,341 --> 00:01:51,110
to help counteract the
effects of gravity.

46
00:01:51,110 --> 00:01:54,246
Of course, your body
is like anything else.

47
00:01:54,246 --> 00:01:56,415
It's precious; use
it or lose it.

48
00:01:56,415 --> 00:01:58,417
So when you get up into space
and you get out of the effects

49
00:01:58,417 --> 00:02:00,519
of gravity, you don't have
to carry your body weight up

50
00:02:00,519 --> 00:02:01,720
and down stairs and
things like that

51
00:02:01,720 --> 00:02:04,123
and your muscles get real weak.

52
00:02:04,123 --> 00:02:06,325
Your bones can get real weak.

53
00:02:06,325 --> 00:02:08,160
A whole bunch of
other things happen.

54
00:02:08,160 --> 00:02:10,429
In order to keep your muscles
and bones strong, then,

55
00:02:10,429 --> 00:02:16,435
you have to do a lot of exercise
to try to make your body work

56
00:02:16,435 --> 00:02:19,104
as hard in space as it
has to every day on Earth.

57
00:02:19,104 --> 00:02:21,140
You don't even realize how much
work you're doing just standing

58
00:02:21,140 --> 00:02:22,474
up and moving around.

59
00:02:22,474 --> 00:02:25,444
So the astronauts will
be doing the equivalent

60
00:02:25,444 --> 00:02:26,845
of lifting weights.

61
00:02:26,845 --> 00:02:28,347
Of course, you can lift a lot
of weight on the Space Station.

62
00:02:28,347 --> 00:02:30,649
It's not much of a workout
because there's no gravity.

63
00:02:30,649 --> 00:02:32,918
So instead they've got
a weight-lifting machine

64

00:02:32,918 --> 00:02:35,588
that instead of pushing a
big weight, you're pushing

65
00:02:35,588 --> 00:02:38,457
against a cylinder
of compressed air.

66
00:02:38,457 --> 00:02:39,925
They also have a
treadmill for running.

67
00:02:39,925 --> 00:02:42,294
Of course you don't stay on the
treadmill in weightlessness,

68
00:02:42,294 --> 00:02:44,163
so you have to have a bunch
of bungees to hold you down

69
00:02:44,163 --> 00:02:48,167
and make you feel like you're
running on a surface on Earth.

70
00:02:48,167 --> 00:02:51,303
And again, they're
hard-scheduled for that,

71
00:02:51,303 --> 00:02:52,371
two and a half hours every day,

72
00:02:52,371 --> 00:02:54,173
to try to keep them
in good shape.

73
00:02:54,173 --> 00:02:56,709
In the early history
of the space program,

74
00:02:56,709 --> 00:02:59,311

especially the Russians who
were doing long-duration space

75
00:02:59,311 --> 00:03:02,915
flights before the United
States was, crew members

76
00:03:02,915 --> 00:03:04,783
who didn't exercise
came back and were

77
00:03:04,783 --> 00:03:06,118
in pretty poor physical shape.

78
00:03:06,118 --> 00:03:08,554
It took them a long time and
a lot of rehab on the ground

79
00:03:08,554 --> 00:03:11,390
to get back their strength
and their bone density.

80
00:03:11,390 --> 00:03:13,459
But we're finding that our crews
are coming back from Station

81
00:03:13,459 --> 00:03:16,395
in pretty good shape because
they're doing their exercises.

82
00:03:16,395 --> 00:03:18,530
>> And actually, if you're
really interested in that,

83
00:03:18,530 --> 00:03:20,432
you can find out more
about some of the workouts

84
00:03:20,432 --> 00:03:23,469
that astronauts here on the

ground and also in space do

85
00:03:23,469 --> 00:03:26,372
with our Train Like
an Astronaut Program.

86
00:03:26,372 --> 00:03:28,674
Mike Hopkins, who just launched
to the Space Station yesterday,

87
00:03:28,674 --> 00:03:30,609
has been real involved with
that and he's been sending

88
00:03:30,609 --> 00:03:33,779
down some tips, and we have
some suggested workouts for you.

89
00:03:33,779 --> 00:03:36,015
And you can find out more
about that on Facebook

90
00:03:36,015 --> 00:03:39,351
at Facebook.com/trainastronaut.

91
00:03:39,351 --> 00:03:42,855
And you can see that address on
the bottom of your screen there.

92
00:03:42,855 --> 00:03:43,989
Next question?

93
00:03:43,989 --> 00:03:47,860
>> What materials
like on the outside

94
00:03:47,860 --> 00:03:49,662
of the Space Station are used

95

00:03:49,662 --> 00:03:52,665
that could keep it,
I guess, safe?

96
00:03:52,665 --> 00:03:55,534
And are there better materials
that you could have been --

97
00:03:55,534 --> 00:03:57,169
you can use that
you simply can't get

98
00:03:57,169 --> 00:03:58,170
up there right now or...

99
00:03:58,170 --> 00:04:02,708
you can't afford right now?

100
00:04:02,708 --> 00:04:05,244
>> Stan Love: Okay, the
outside of the Space Station,

101
00:04:05,244 --> 00:04:09,248
to keep it safe, you said, the
main threat to the Space Station

102
00:04:09,248 --> 00:04:13,118
and the crews living on
board is orbital debris.

103
00:04:13,118 --> 00:04:15,554
You'll hear us sometimes at
NASA use the phrase MMOD,

104
00:04:15,554 --> 00:04:19,458
which stands for micrometeorites
and orbital debris.

105
00:04:19,458 --> 00:04:20,759
But up where the Station orbits,

106
00:04:20,759 --> 00:04:23,896
there is actually not
very much micrometeorite.

107
00:04:23,896 --> 00:04:25,397
It's almost all orbital debris.

108
00:04:25,397 --> 00:04:28,334
That is stuff that we have put
up there, either accidentally

109
00:04:28,334 --> 00:04:29,935
or on purpose, that's
orbiting around the Earth

110
00:04:29,935 --> 00:04:33,305
at enormous speeds, much, much
faster than a rifle bullet.

111
00:04:33,305 --> 00:04:37,843
So to keep the Station
safe it has what's called a

112
00:04:37,843 --> 00:04:39,211
debris shield.

113
00:04:39,211 --> 00:04:42,147
So instead of just having your
hull of your Space Station,

114
00:04:42,147 --> 00:04:44,149
which is a single
wall of aluminum,

115
00:04:44,149 --> 00:04:45,451
out there facing
the orbital debris

116

00:04:45,451 --> 00:04:47,920
where if something hits it
it could punch a hole in it,

117
00:04:47,920 --> 00:04:52,825
we put a second wall around the
whole Space Station and stood

118
00:04:52,825 --> 00:04:56,495
out from the inner wall by a
few inches to maybe a foot.

119
00:04:56,495 --> 00:04:59,164
And what that does is, when a
piece of orbital debris comes

120
00:04:59,164 --> 00:05:01,800
in it's coming in so fast
that if it hits anything,

121
00:05:01,800 --> 00:05:04,870
even something as thin as
a sheet of tissue paper,

122
00:05:04,870 --> 00:05:07,272
that projectile is just going
to break up into a spray

123
00:05:07,272 --> 00:05:10,242
of molten droplets and
little, tiny fragments.

124
00:05:10,242 --> 00:05:13,412
And then that stuff spreads
out over the intervening gap

125
00:05:13,412 --> 00:05:15,314
between the debris
shield and the main hull

126

00:05:15,314 --> 00:05:16,448
of the Space Station so that

127
00:05:16,448 --> 00:05:17,850
when it hits the main
hull it's all spread out

128
00:05:17,850 --> 00:05:19,184
and doesn't punch a hole in it.

129
00:05:19,184 --> 00:05:21,987
So that's how you protect
against really high-speed stuff.

130
00:05:21,987 --> 00:05:24,690
So it doesn't really
matter what the material is.

131
00:05:24,690 --> 00:05:27,760
You could make strong armor
or something like that,

132
00:05:27,760 --> 00:05:30,129
and at the speeds of collision
that we're talking about,

133
00:05:30,129 --> 00:05:31,296
it really makes very
little difference.

134
00:05:31,296 --> 00:05:33,899
The important thing is
to have that shield --

135
00:05:33,899 --> 00:05:36,402
it can be very thin, it doesn't
matter what it's made out of --

136
00:05:36,402 --> 00:05:38,937
stood off from your

main pressure hull.

137
00:05:38,937 --> 00:05:42,141
The actual material that we use
for all of that is aluminum.

138
00:05:42,141 --> 00:05:44,276
That's what the aerospace
engineers, the folks who go

139
00:05:44,276 --> 00:05:48,080
to work here at NASA, were
trained to use when they were

140
00:05:48,080 --> 00:05:50,682
in college studying to
be aerospace engineers.

141
00:05:50,682 --> 00:05:52,551
Aluminum is what we're used
to and it works pretty well.

142
00:05:52,551 --> 00:05:54,453
It's also really light,
which is important,

143
00:05:54,453 --> 00:05:56,955
because everything has to
be launched on a rocket,

144
00:05:56,955 --> 00:05:59,858
and we can just barely
shave down the masses

145
00:05:59,858 --> 00:06:01,693
of all the stuff we
throw into space enough

146
00:06:01,693 --> 00:06:03,095
so that it will actually,

147
00:06:03,095 --> 00:06:05,597
the rocket can actually
lift it up into orbit.

148
00:06:05,597 --> 00:06:07,499
So aluminum's a good choice.

149
00:06:07,499 --> 00:06:10,102
I don't think we have anything
waiting in the wings that's

150
00:06:10,102 --> 00:06:13,138
like a super armor
that would be better.

151
00:06:13,138 --> 00:06:16,842
Slowly composite materials you
may have heard of which are made

152
00:06:16,842 --> 00:06:18,877
out of fibers of carbon

153
00:06:18,877 --> 00:06:22,047
and epoxy glue are working
their way into aerospace.

154
00:06:22,047 --> 00:06:25,083
That stuff is stronger than
aluminum and a little lighter.

155
00:06:25,083 --> 00:06:28,954
I don't know how it behaves
in micrometeorite impact.

156
00:06:28,954 --> 00:06:31,557
The physics of micrometeorite
high-speed impacts are a little

157

00:06:31,557 --> 00:06:34,426
bit weird, and things that you
might expect to be super-strong,

158
00:06:34,426 --> 00:06:37,830
like Kevlar -- Kevlar's
great for a bulletproof vest.

159
00:06:37,830 --> 00:06:40,766
It's lousy for orbital
debris, just depending

160
00:06:40,766 --> 00:06:43,068
on the physics of the material.

161
00:06:43,068 --> 00:06:44,269
So I don't think we
have anything waiting

162
00:06:44,269 --> 00:06:45,537
in the wings to replace
aluminum.

163
00:06:45,537 --> 00:06:48,040
It's a good choice.

164
00:06:48,040 --> 00:06:49,641
>> Next question?

165
00:06:51,009 --> 00:06:54,613
>> How do you guys
sleep at night?

166
00:06:54,613 --> 00:06:55,681
[Laughter]

167
00:06:55,681 --> 00:06:57,015
>> Stan Love: How do
you sleep at night?

168
00:06:57,015 --> 00:06:58,617
Pretty much the same
as you do on Earth.

169
00:06:58,617 --> 00:06:59,852
Maybe your first
couple of nights

170
00:06:59,852 --> 00:07:01,687
in space you're a little
excited about where you are

171
00:07:01,687 --> 00:07:06,425
so you may not sleep real well,
but at night you can just go

172
00:07:06,425 --> 00:07:09,728
to sleep wherever you are and
it's really, really comfortable

173
00:07:09,728 --> 00:07:11,897
because there's no gravity
pulling you onto the bed.

174
00:07:11,897 --> 00:07:14,566
But if you just go to sleep
floating around the cabin,

175
00:07:14,566 --> 00:07:17,536
you will wake up on the
ventilation inlet grill,

176
00:07:17,536 --> 00:07:20,539
because the air currents in the
cabin will very slowly pull you

177
00:07:20,539 --> 00:07:21,840
over to the ventilation duct.

178

00:07:21,840 --> 00:07:23,809
So if you don't want to wake
up with all your crewmates

179
00:07:23,809 --> 00:07:25,911
on the ventilation duct, you're
going to have to do something

180
00:07:25,911 --> 00:07:27,713
to kind of restrain yourself.

181
00:07:27,713 --> 00:07:31,517
So there are sleeping bags
which you can strap to the wall

182
00:07:31,517 --> 00:07:34,019
and you just climb
into your sleeping bag,

183
00:07:34,019 --> 00:07:36,688
it has elastic straps
to hold you in,

184
00:07:36,688 --> 00:07:38,223
and hang out and go to sleep.

185
00:07:38,223 --> 00:07:40,759
It takes a little getting used
to the first couple of nights.

186
00:07:40,759 --> 00:07:44,997
Some people miss having a force
pulling them into the bed.

187
00:07:44,997 --> 00:07:47,466
I know a person who,
when they're in space,

188
00:07:47,466 --> 00:07:48,934
sleeps sort of sandwiched

189
00:07:48,934 --> 00:07:51,837
in between two big huge heavy
cargo bags because it gives him

190
00:07:51,837 --> 00:07:53,138
that extra feeling of security.

191
00:07:53,138 --> 00:07:54,473
But once you get used to it,

192
00:07:54,473 --> 00:07:56,808
it's the most comfortable
night's sleep you can ever get.

193
00:07:56,808 --> 00:08:00,979
>> Next question?

194
00:08:08,987 --> 00:08:13,926
>> What are the requirements
in terms of education and merit

195
00:08:13,926 --> 00:08:18,297
to become an astronaut that
might be featured on a mission

196
00:08:18,297 --> 00:08:20,933
to the International
Space Station?

197
00:08:20,933 --> 00:08:22,901
>> Stan Love: Okay, to be an
astronaut you have to have

198
00:08:22,901 --> 00:08:28,006
at least a bachelor's degree in
a technical field, like physics

199
00:08:28,006 --> 00:08:30,909

or engineering or
something like that.

200
00:08:30,909 --> 00:08:33,645
You can also enter the
Astronaut Corps as a teacher

201
00:08:33,645 --> 00:08:35,914
or as a military test pilot.

202
00:08:35,914 --> 00:08:37,516
But everybody has
to have at least

203
00:08:37,516 --> 00:08:39,618
that bachelor's degree
plus some work experience

204
00:08:39,618 --> 00:08:42,354
or else advanced degrees.

205
00:08:42,354 --> 00:08:45,624
Beyond that, you have
to be very healthy.

206
00:08:45,624 --> 00:08:48,427
You have to be pretty fit.

207
00:08:48,427 --> 00:08:49,962
The rigors of working
in a spacesuit

208
00:08:49,962 --> 00:08:53,799
on a space walk are pretty
intense, and if you're not

209
00:08:53,799 --> 00:08:57,235
in good shape, you're not going
to be able to do well at that.

210
00:08:57,235 --> 00:08:58,570
So those are the basics.

211
00:08:58,570 --> 00:09:01,907
And then the hard part is
there's 5,000 other people just

212
00:09:01,907 --> 00:09:05,611
like you who want to go do this
and you have to be lucky enough

213
00:09:05,611 --> 00:09:07,613
to come out on top in
the selection process.

214
00:09:07,613 --> 00:09:08,981
But the basics are very simple.

215
00:09:08,981 --> 00:09:10,515
They are also on the web.

216
00:09:10,515 --> 00:09:11,917
If you look on NASA's website,

217
00:09:11,917 --> 00:09:14,386
you can download
the job application,

218
00:09:14,386 --> 00:09:15,654
and it tells you
exactly what you need.

219
00:09:15,654 --> 00:09:18,724
>> You can find that at
NASA.gov/astronaut if you want

220
00:09:18,724 --> 00:09:20,792
to go do some research.

221
00:09:29,134 --> 00:09:32,471
>> What is being researched
on the Space Station?

222
00:09:32,471 --> 00:09:38,944
I heard something about like
biomechanics and microbiology

223
00:09:38,944 --> 00:09:43,315
and such, and surface
tension for liquids.

224
00:09:43,315 --> 00:09:46,351
What all is being
researched there?

225
00:09:46,351 --> 00:09:48,353
>> Stan Love: I certainly
cannot answer that question.

226
00:09:48,353 --> 00:09:50,722
There are dozens of
investigations going

227
00:09:50,722 --> 00:09:53,125
on on the Space Station
all the time,

228
00:09:53,125 --> 00:09:56,194
and you listed the main
ones, the main classes.

229
00:09:56,194 --> 00:10:01,033
Combustion: the way flames work
in one gravity is very different

230
00:10:01,033 --> 00:10:02,501
from how they work in zero
gravity and we're trying

231
00:10:02,501 --> 00:10:04,403
to understand how flames work.

232
00:10:04,403 --> 00:10:06,838
We're doing work on biology.

233
00:10:06,838 --> 00:10:09,107
We're also doing a lot
of work on human health

234
00:10:09,107 --> 00:10:13,045
so that we can send people, say,
all the way to Mars and back

235
00:10:13,045 --> 00:10:14,613
and keep them healthy in space.

236
00:10:14,613 --> 00:10:17,582
But I'm sorry, I
don't have a full list

237
00:10:17,582 --> 00:10:19,551
for you, but it is a long one.

238
00:10:19,551 --> 00:10:24,156
>> Next question?

239
00:10:29,494 --> 00:10:33,498
>> What is the average
cost for a mission to, say,

240
00:10:33,498 --> 00:10:34,866
the International Space Station?

241
00:10:34,866 --> 00:10:39,905
>> Stan Love: I don't know,
and neither does anybody else.

242

00:10:39,905 --> 00:10:44,242
Right now we're paying
about $60 million per seat

243
00:10:44,242 --> 00:10:46,211
for a seat on the Soyuz.

244
00:10:46,211 --> 00:10:48,914
But the accounting for
how rockets are funded

245
00:10:48,914 --> 00:10:52,017
and how much they cost and which
money comes out of which pot is

246
00:10:52,017 --> 00:10:57,689
so obscure that even I
with a PhD can't follow it.

247
00:10:57,689 --> 00:11:01,860
Cost for an unmanned rocket
launch: $50 to $75 million.

248
00:11:01,860 --> 00:11:04,763
Soyuz, if you multiply the
seat cost times the three crew,

249
00:11:04,763 --> 00:11:07,365
that ends up at about
$200 million.

250
00:11:07,365 --> 00:11:10,102
Of course, rockets that carry
people are more expensive

251
00:11:10,102 --> 00:11:12,137
than rockets that carry
satellites, because the ones

252
00:11:12,137 --> 00:11:14,639

that carry people have to
have extra safety systems,

253
00:11:14,639 --> 00:11:17,943
which cost money, and more
people examining all their parts

254
00:11:17,943 --> 00:11:20,645
and making sure that they're
really, really ready to fly,

255
00:11:20,645 --> 00:11:23,248
because you really don't want an
accident with people on board.

256
00:11:23,248 --> 00:11:26,351
But sort of hundreds of
millions of dollars per launch,

257
00:11:26,351 --> 00:11:28,220
or tens to hundreds of
millions of dollars is kind

258
00:11:28,220 --> 00:11:29,454
of the ballpark for you.

259
00:11:29,454 --> 00:11:34,059
>> Next question?

260
00:11:36,027 --> 00:11:36,928
[Laughter]

261
00:11:36,928 --> 00:11:42,300
>> You mentioned ensuring

262
00:11:42,300 --> 00:11:45,570
that astronauts were
exceptionally healthy.

263

00:11:45,570 --> 00:11:49,474
How do you ensure that no
particularly nasty viruses

264
00:11:49,474 --> 00:11:53,645
or bacteria end up on the
Space Shuttle infecting anyone?

265
00:11:53,645 --> 00:11:56,515
>> Stan Love: The same way we've
done for hundreds of years.

266
00:11:56,515 --> 00:11:58,984
You quarantine everybody
before they go.

267
00:11:58,984 --> 00:12:01,853
So before a crew launches
to the Space Station,

268
00:12:01,853 --> 00:12:04,790
they will enter quarantine
and they will spend a week

269
00:12:04,790 --> 00:12:09,461
to ten days without contacting
basically anyone else.

270
00:12:09,461 --> 00:12:11,663
The few people that they are
in contact with either have

271
00:12:11,663 --> 00:12:14,399
to wear pulla [phonetic]
masks or have to get examined

272
00:12:14,399 --> 00:12:17,402
by a doctor and make sure
that they're healthy.

273

00:12:17,402 --> 00:12:19,838
And we've been doing that
in the space program,

274
00:12:19,838 --> 00:12:21,072
both the U.S. space program

275
00:12:21,072 --> 00:12:23,141
and the Russian space
programs, for decades.

276
00:12:23,141 --> 00:12:25,911
And it works most of the time.

277
00:12:25,911 --> 00:12:28,847
We did get the flu on Space
Station one time a few years

278
00:12:28,847 --> 00:12:32,384
ago, and the crew got sick and
felt lousy for a couple of days,

279
00:12:32,384 --> 00:12:34,085
just like happens
when you get the flu,

280
00:12:34,085 --> 00:12:35,153
and then they got better,

281
00:12:35,153 --> 00:12:36,454
just like happens
when you get the flu.

282
00:12:36,454 --> 00:12:40,458
But we work hard to try to
keep the crews in quarantine

283
00:12:40,458 --> 00:12:42,661
and isolated from germs so
that we don't get any bugs

284
00:12:42,661 --> 00:12:45,096
on the Space Station because
we want our folks up there

285
00:12:45,096 --> 00:12:46,665
to be able to work and
we don't want them stuck

286
00:12:46,665 --> 00:12:48,099
in bed feeling lousy.

287
00:12:48,099 --> 00:12:52,437
>> Next question?

288
00:12:54,739 --> 00:12:56,775
>> And once again, just a
reminder: definitely speak

289
00:12:56,775 --> 00:12:59,911
up so they can hear you
clearly in Mission Control.

290
00:12:59,911 --> 00:13:02,280
And go ahead with
your next question.

291
00:13:02,280 --> 00:13:04,649
>> How do the astronauts
cope with the speeds used

292
00:13:04,649 --> 00:13:06,117
to project them into
outer space?

293
00:13:06,117 --> 00:13:07,419
>> Stan Love: I'm sorry.

294
00:13:07,419 --> 00:13:08,286

Say that again, please?

295
00:13:08,286 --> 00:13:09,554
[Laughter]

296
00:13:09,554 --> 00:13:15,460
>> [Inaudible] How do astronauts
cope with the speed used

297
00:13:15,460 --> 00:13:17,229
to project them into
outer space?

298
00:13:17,229 --> 00:13:18,630
>> Stan Love: I don't know.

299
00:13:18,630 --> 00:13:21,900
How do you cope with the speed
you need to ride in an airplane?

300
00:13:21,900 --> 00:13:23,335
Seems pretty okay, you know.

301
00:13:23,335 --> 00:13:25,437
You're going 500 miles an
hour, but you don't feel

302
00:13:25,437 --> 00:13:26,905
that inside the aircraft.

303
00:13:26,905 --> 00:13:28,673
Same thing in a rocket.

304
00:13:28,673 --> 00:13:30,642
Your environment
travels along with you

305
00:13:30,642 --> 00:13:34,112
and there is little sense

of the speed you're going

306
00:13:34,112 --> 00:13:38,083
at except during launch.

307
00:13:38,083 --> 00:13:39,951
During launch when all
those rockets are firing

308
00:13:39,951 --> 00:13:43,188
and you can hear the howling of
the wind outside the capsule,

309
00:13:43,188 --> 00:13:45,957
when you're still at low
altitude and you're not

310
00:13:45,957 --> 00:13:47,726
up in vacuum yet, and
you can hear that,

311
00:13:47,726 --> 00:13:49,694
there is a sense of speed.

312
00:13:49,694 --> 00:13:52,664
And the way you cope
with that is --

313
00:13:52,664 --> 00:13:55,467
and especially acceleration
that the rocket produces,

314
00:13:55,467 --> 00:13:56,835
which isn't that great --

315
00:13:56,835 --> 00:13:59,170
if you watch a lot of movies
you see people getting whirled

316

00:13:59,170 --> 00:14:01,072
in centrifuges and
things like that.

317
00:14:01,072 --> 00:14:02,941
The acceleration you
feel riding the Soyuz

318
00:14:02,941 --> 00:14:05,410
to the Space Station tops
out about four and a half Gs,

319
00:14:05,410 --> 00:14:06,945
which is enough to
make you notice.

320
00:14:06,945 --> 00:14:08,613
You've got to pay
attention to your breathing.

321
00:14:08,613 --> 00:14:11,016
But you're lying on your back,
you're in a comfortable seat,

322
00:14:11,016 --> 00:14:15,086
and you just ride there with
the rocket, and it's okay.

323
00:14:15,086 --> 00:14:18,256
But there's really very little
sense of speed most of the time.

324
00:14:18,256 --> 00:14:20,859
It's the acceleration
you have to think about.

325
00:14:25,931 --> 00:14:27,599
>> Next question?

326
00:14:31,469 --> 00:14:35,140

>> When returning back
to the surface of Earth,

327
00:14:35,140 --> 00:14:38,843
how do the astronauts acclimate
to the conditions on Earth

328
00:14:38,843 --> 00:14:42,013
and how they differ from
conditions [loud beeping]

329
00:14:42,013 --> 00:14:44,015
in microgravity, not in space?

330
00:14:44,015 --> 00:14:48,520
And do they run into any issues?

331
00:14:48,520 --> 00:14:50,455
>> Stan Love: Okay, getting
used to gravity again is

332
00:14:50,455 --> 00:14:52,457
about as hard as getting
used to weightlessness

333
00:14:52,457 --> 00:14:53,858
at the beginning of a mission.

334
00:14:53,858 --> 00:14:57,295
When you first get into space
you have to sort of re-learn how

335
00:14:57,295 --> 00:14:59,331
to use your body because
you don't have your legs

336
00:14:59,331 --> 00:15:00,165
to support anymore.

337

00:15:00,165 --> 00:15:01,700
If you're working with one hand,

338
00:15:01,700 --> 00:15:03,702
you have to support yourself
with your other hand.

339
00:15:03,702 --> 00:15:06,538
If you're doing a two-hand
job, you run out of hands.

340
00:15:06,538 --> 00:15:08,306
Coming back to the ground, then,

341
00:15:08,306 --> 00:15:09,975
you have to get used
to gravity again.

342
00:15:09,975 --> 00:15:12,043
Your sense of balance
has to re-wire itself,

343
00:15:12,043 --> 00:15:13,244
so you may feel a little dizzy

344
00:15:13,244 --> 00:15:15,880
or even nauseated the
first couple of days back.

345
00:15:15,880 --> 00:15:18,049
And, in fact, your
first three days back

346
00:15:18,049 --> 00:15:19,317
from a short-duration
space flight,

347
00:15:19,317 --> 00:15:20,719
they don't let you
drive your car

348
00:15:20,719 --> 00:15:22,287
because they're afraid you're
going to get dizzy when you go

349
00:15:22,287 --> 00:15:23,989
around a corner and crash.

350
00:15:23,989 --> 00:15:25,523
So they keep the
car keys from you

351
00:15:25,523 --> 00:15:28,727
for three days when
you get back.

352
00:15:28,727 --> 00:15:31,162
You may have lost
some muscle strength.

353
00:15:31,162 --> 00:15:33,832
On my short flight, I actually
lost quite a bit of strength,

354
00:15:33,832 --> 00:15:36,401
so I had to go back to the
gym and work out real hard

355
00:15:36,401 --> 00:15:38,436
to get my strength back.

356
00:15:38,436 --> 00:15:40,939
We even had a couple of people
the first day or two back,

357
00:15:40,939 --> 00:15:45,143
because your heart has
gotten used to pumping blood

358

00:15:45,143 --> 00:15:47,045
around your body without
having to work against gravity,

359
00:15:47,045 --> 00:15:48,446
we've had a couple
of people faint,

360
00:15:48,446 --> 00:15:53,685
which always looks alarming, but
they've been perfectly alright.

361
00:15:53,685 --> 00:15:57,355
Issues -- not really,
especially now

362
00:15:57,355 --> 00:15:58,723
that people are doing
their exercises.

363
00:15:58,723 --> 00:16:00,025
They're coming back
in pretty good shape.

364
00:16:00,025 --> 00:16:03,395
In the past people
lost a lot of bone.

365
00:16:03,395 --> 00:16:05,230
You can rebuild bone with a lot

366
00:16:05,230 --> 00:16:07,799
of heavy-loaded weight
lifting, things like that.

367
00:16:07,799 --> 00:16:10,101
There have been a couple cases

368
00:16:10,101 --> 00:16:12,237
where people didn't get

all their bone back.

369
00:16:12,237 --> 00:16:14,339
But as far as looking
at somebody and seeing

370
00:16:14,339 --> 00:16:15,807
that they have a
health issue, no.

371
00:16:15,807 --> 00:16:17,108
People are great.

372
00:16:17,108 --> 00:16:19,878
I have a chance now, working
out in the astronaut gym,

373
00:16:19,878 --> 00:16:22,313
to see guys when they're two
days back from Space Station

374
00:16:22,313 --> 00:16:23,581
and they look really good.

375
00:16:23,581 --> 00:16:27,452
>> Next question?

376
00:16:35,827 --> 00:16:37,629
>> You mentioned
some physical effects

377
00:16:37,629 --> 00:16:39,597
on the muscles and the skeleton.

378
00:16:39,597 --> 00:16:43,902
Are there any effects
on the immune system,

379
00:16:43,902 --> 00:16:49,841

spending so much time
usually absent from pathogens?

380
00:16:49,841 --> 00:16:52,143
>> Stan Love: Yes, although
we're getting a little outside

381
00:16:52,143 --> 00:16:53,411
my field of expertise here.

382
00:16:53,411 --> 00:16:55,647
If you've got physics
questions, I'm good with that.

383
00:16:55,647 --> 00:16:57,949
Biology, eh, that's not
really what my PhD is,

384
00:16:57,949 --> 00:16:59,751
but I'll tell you what I know.

385
00:16:59,751 --> 00:17:01,653
So actually there are
changes in your immune system.

386
00:17:01,653 --> 00:17:04,289
It has nothing to do with
being isolated from pathogens.

387
00:17:04,289 --> 00:17:05,890
It has everything
to do with being

388
00:17:05,890 --> 00:17:08,593
in a stressful environment.

389
00:17:08,593 --> 00:17:10,795
People on Earth under stress,

390

00:17:10,795 --> 00:17:12,764
like students during
college finals week,

391
00:17:12,764 --> 00:17:14,999
some things like that,
they get stressed out

392
00:17:14,999 --> 00:17:17,001
and it actually depresses
your immune function.

393
00:17:17,001 --> 00:17:19,871
That is, things that would not
ordinarily make you sick will

394
00:17:19,871 --> 00:17:21,840
make you sick because
you're working hard,

395
00:17:21,840 --> 00:17:24,109
you're worrying a lot, you
may not be sleeping too well.

396
00:17:24,109 --> 00:17:26,244
And astronauts get
that in space,

397
00:17:26,244 --> 00:17:28,680
and that's been a
subject of many studies.

398
00:17:28,680 --> 00:17:32,183
Now, fortunately, in space you
are isolated from pathogens,

399
00:17:32,183 --> 00:17:35,653
so even though your immune
system may be weaker,

400

00:17:35,653 --> 00:17:38,490
maybe because of the stress,
maybe because of something else

401
00:17:38,490 --> 00:17:40,425
from being in space, we
don't really know right now.

402
00:17:40,425 --> 00:17:44,963
We have yet to run tests
on astronauts in space

403
00:17:44,963 --> 00:17:47,165
who aren't working hard.

404
00:17:47,165 --> 00:17:49,000
So we don't know
whether it's the stress

405
00:17:49,000 --> 00:17:50,635
or the space that does it.

406
00:17:50,635 --> 00:17:52,604
But because there's no
pathogens on Space Station,

407
00:17:52,604 --> 00:17:54,239
or very few because
of the quarantine,

408
00:17:54,239 --> 00:17:57,909
you have fewer opportunities
to get sick.

409
00:18:12,123 --> 00:18:13,491
>> You mentioned a quarantine,

410
00:18:13,491 --> 00:18:17,262
but what other things do
astronauts do to prepare

411
00:18:17,262 --> 00:18:18,796
for space, like physical
training

412
00:18:18,796 --> 00:18:21,166
or any things they have to do?

413
00:18:21,166 --> 00:18:24,802
I don't know, I saw a bunch
of interesting simulations

414
00:18:24,802 --> 00:18:28,173
that astronauts have to go
through before they enter space.

415
00:18:28,173 --> 00:18:31,442
>> Stan Love: Yeah, it
takes a minimum of two years

416
00:18:31,442 --> 00:18:34,012
of preparing to fly in
space and, for most people,

417
00:18:34,012 --> 00:18:36,414
it ends up being
more like eight.

418
00:18:36,414 --> 00:18:38,216
So you're working hard
for those eight years.

419
00:18:38,216 --> 00:18:40,151
You're not just sitting
at your desk thumbing

420
00:18:40,151 --> 00:18:41,352
through the internet.

421

00:18:41,352 --> 00:18:42,420
You will be doing a lot

422
00:18:42,420 --> 00:18:44,055
of physical training,
as you mentioned.

423
00:18:44,055 --> 00:18:47,325
You'll be doing a lot of flying
in our T-38 trainer jets,

424
00:18:47,325 --> 00:18:50,695
which teaches you how to handle
complicated systems while moving

425
00:18:50,695 --> 00:18:52,530
very, very fast in
a situation where,

426
00:18:52,530 --> 00:18:55,333
if you mess up, you can die.

427
00:18:55,333 --> 00:18:58,336
There is training in the giant
swimming pool in the spacesuit

428
00:18:58,336 --> 00:18:59,437
to learn how to do space walks.

429
00:18:59,437 --> 00:19:00,838
There's training on
the robotic arms,

430
00:19:00,838 --> 00:19:03,775
both using real robotic
arms and also sort

431
00:19:03,775 --> 00:19:07,879
of very sophisticated
simulated environments

432
00:19:07,879 --> 00:19:11,449
which has the same
joysticks as a video game,

433
00:19:11,449 --> 00:19:13,885
but someone's going to
give you a stern talking-to

434
00:19:13,885 --> 00:19:15,220
if you knock your robotic arm

435
00:19:15,220 --> 00:19:17,355
into something during
one of those sims.

436
00:19:17,355 --> 00:19:19,090
There are what we call
integrated simulations

437
00:19:19,090 --> 00:19:22,660
where we have crews in
mockups of the Space Station

438
00:19:22,660 --> 00:19:25,730
on Earth connected to
the real Mission Control

439
00:19:25,730 --> 00:19:29,167
with real flight controllers,
and elsewhere there's a chain

440
00:19:29,167 --> 00:19:31,135
of instructors who are
throwing malfunctions

441
00:19:31,135 --> 00:19:33,204
at the Space Station
every few minutes,

442
00:19:33,204 --> 00:19:35,506
and the flight controllers
and the crew have to respond

443
00:19:35,506 --> 00:19:39,010
to those malfunctions, prevent
further problems from happening

444
00:19:39,010 --> 00:19:40,378
and recover from them.

445
00:19:40,378 --> 00:19:45,116
So it's a very, very intense
and very long training scheme

446
00:19:45,116 --> 00:19:46,618
to take somebody who
just comes in the door

447
00:19:46,618 --> 00:19:48,920
and get them ready
to fly in space.

448
00:19:53,124 --> 00:19:54,525
>> Next question?

449
00:19:54,525 --> 00:19:57,295
>> When you're up in space,

450
00:19:57,295 --> 00:20:02,367
do you have a set area
for waste storage?

451
00:20:02,367 --> 00:20:04,502
Both human waste and food waste?

452
00:20:04,502 --> 00:20:09,641
Or do you release it
into space from the ship?

453
00:20:09,641 --> 00:20:12,043
>> Stan Love: We do not
release waste into space.

454
00:20:12,043 --> 00:20:16,114
And our first question, I
think, was about orbital debris.

455
00:20:16,114 --> 00:20:19,617
And anything you put into
space as waste can come back

456
00:20:19,617 --> 00:20:22,687
to haunt you at 8,000
meters per second.

457
00:20:22,687 --> 00:20:25,657
And we really, really
don't want that.

458
00:20:25,657 --> 00:20:28,059
We want to dispose of
everything in space --

459
00:20:28,059 --> 00:20:30,595
or all waste that we generate in
space, we want to dispose of so

460
00:20:30,595 --> 00:20:33,898
that it does not stay in orbit
and then knock out ourselves

461
00:20:33,898 --> 00:20:36,901
or knock out somebody else's
really expensive satellite.

462
00:20:36,901 --> 00:20:38,569
So all of the waste
that's generated

463
00:20:38,569 --> 00:20:41,172
on the Space Station
gets loaded into one

464
00:20:41,172 --> 00:20:44,909
of our several cargo ships
that go to the Space Station

465
00:20:44,909 --> 00:20:46,844
and they bring fresh supplies.

466
00:20:46,844 --> 00:20:49,314
And when it's empty, they
load it up with trash,

467
00:20:49,314 --> 00:20:51,783
separate the spacecraft
from the Space Station,

468
00:20:51,783 --> 00:20:54,786
and then de-orbit it so that
it burns up in the atmosphere

469
00:20:54,786 --> 00:20:56,487
over the South Pacific,
so that even

470
00:20:56,487 --> 00:20:58,523
if a few little pieces
do reach the ground,

471
00:20:58,523 --> 00:20:59,424
there's no people there.

472
00:20:59,424 --> 00:21:00,558
It's just open ocean.

473
00:21:00,558 --> 00:21:02,427

There are no islands or
anything, and even very,

474
00:21:02,427 --> 00:21:05,530
very few ship, because the
shipping routes don't run

475
00:21:05,530 --> 00:21:07,732
under the place where
we dispose of our stuff.

476
00:21:07,732 --> 00:21:12,236
So of our cargo ships, right
now we have a handful of them,

477
00:21:12,236 --> 00:21:16,574
only the SpaceX Dragon
capsule actually lands intact

478
00:21:16,574 --> 00:21:19,444
under a parachute, and we
use that for returning cargo.

479
00:21:19,444 --> 00:21:22,280
But the trash all gets
burned up in the atmosphere.

480
00:21:30,054 --> 00:21:32,990
>> I was wondering how
you preserve food in space

481
00:21:32,990 --> 00:21:34,992
and keep it from
spoiling with things

482
00:21:34,992 --> 00:21:37,962
like milk, things like that.

483
00:21:37,962 --> 00:21:41,132
>> Stan Love: Now, we don't

get a lot of milk in space.

484
00:21:42,200 --> 00:21:44,168
All the food in space has

485
00:21:44,168 --> 00:21:46,904
to have a shelf life
of a year or more.

486
00:21:46,904 --> 00:21:48,172
It all comes up on cargo ships.

487
00:21:48,172 --> 00:21:49,507
Those are separated by months.

488
00:21:49,507 --> 00:21:51,576
We need to keep a reserve
supply of food on Space Station

489
00:21:51,576 --> 00:21:53,778
in case one of the cargo
ships doesn't make it.

490
00:21:53,778 --> 00:21:54,879
That happened a couple
of years ago.

491
00:21:54,879 --> 00:21:56,748
We had a cargo ship full
of food and supplies

492
00:21:56,748 --> 00:21:59,917
that crashed while it
was heading for orbit

493
00:21:59,917 --> 00:22:02,653
and the crew did not get
that batch of supplies.

494

00:22:02,653 --> 00:22:04,722
So they had to eat stuff
that was in storage.

495
00:22:04,722 --> 00:22:06,657
So what we have for
food is a whole bunch

496
00:22:06,657 --> 00:22:08,960
of freeze-dried stuff
like backpacking food

497
00:22:08,960 --> 00:22:09,961
which you add water to.

498
00:22:09,961 --> 00:22:13,164
We have a lot of
thermostabilized stuff

499
00:22:13,164 --> 00:22:14,499
which is sealed in a package

500
00:22:14,499 --> 00:22:16,934
and then the whole
package gets boiled

501
00:22:16,934 --> 00:22:18,936
so that it kills
all the bacteria

502
00:22:18,936 --> 00:22:21,939
and then the sealed package can
remain on the shelf for years.

503
00:22:21,939 --> 00:22:24,575
You see those in MREs, the
rations that are issued

504
00:22:24,575 --> 00:22:26,377
to our soldiers overseas.

505
00:22:26,377 --> 00:22:28,246
And then we have
some dried foods

506
00:22:28,246 --> 00:22:30,982
and the best treats
anyone can get is

507
00:22:30,982 --> 00:22:32,650
when a cargo ship is just
getting ready to launch,

508
00:22:32,650 --> 00:22:35,953
they'll throw a few things in
like fresh fruit and vegetables,

509
00:22:35,953 --> 00:22:38,022
because you don't get too many
of those on the Space Station.

510
00:22:38,022 --> 00:22:40,892
And the crews remark
about how wonderful some

511
00:22:40,892 --> 00:22:43,861
of those capsules smell when
you first open up the hatch

512
00:22:43,861 --> 00:22:47,064
and it's got some fresh
apples and oranges in it.

513
00:22:54,806 --> 00:22:59,243
>> What future plans does
NASA have for manned missions?

514
00:22:59,243 --> 00:23:03,548
And what are some
eventual goals of NASA?

515
00:23:03,548 --> 00:23:05,249
>> Stan Love: Well, right
now our stated long-term goal

516
00:23:05,249 --> 00:23:10,354
for people is to get
people on Mars by the 2030s.

517
00:23:10,354 --> 00:23:12,190
Closer to that, we are hoping

518
00:23:12,190 --> 00:23:14,826
to get our new human-rated
space capsule

519
00:23:14,826 --> 00:23:16,694
that we can carry
people back into space

520
00:23:16,694 --> 00:23:18,729
from the United States, which
we have not been able to do

521
00:23:18,729 --> 00:23:20,298
since the shuttle retires.

522
00:23:20,298 --> 00:23:23,534
I really hope that we
can do that again soon.

523
00:23:23,534 --> 00:23:25,303
I'd like to see U.S.
astronauts launching

524
00:23:25,303 --> 00:23:27,004
on a U.S. flag carrier.

525
00:23:27,004 --> 00:23:30,842

So we're hoping to be flying
that capsule with people here

526
00:23:30,842 --> 00:23:33,044
in the next five years or so.

527
00:23:33,044 --> 00:23:34,378
There are some test
flights of that coming

528
00:23:34,378 --> 00:23:36,814
up without people
sooner than that.

529
00:23:36,814 --> 00:23:41,152
We've also got a plan to go
out with a robotic spacecraft

530
00:23:41,152 --> 00:23:45,490
and grab a little asteroid
from near Earth space --

531
00:23:45,490 --> 00:23:46,924
and we're busy looking
for asteroids

532
00:23:46,924 --> 00:23:48,759
of the right size right now --

533
00:23:48,759 --> 00:23:51,529
bring that back with the robot
ship, and put it into orbit

534
00:23:51,529 --> 00:23:54,499
around the moon, and then
fly up there with people

535
00:23:54,499 --> 00:23:56,667
and do some work on
that small asteroid.

536
00:23:56,667 --> 00:23:58,803
There's going to be some steps

537
00:23:58,803 --> 00:24:01,272
in between visiting the little
asteroid and going to Mars,

538
00:24:01,272 --> 00:24:04,575
and we're still working out
what those might be like.

539
00:24:11,249 --> 00:24:13,985
>> You talked about
capturing an asteroid.

540
00:24:13,985 --> 00:24:17,021
How do you identify an asteroid?

541
00:24:17,021 --> 00:24:18,623
They don't give off any light.

542
00:24:18,623 --> 00:24:22,093
Is there any way
you can see them?

543
00:24:22,093 --> 00:24:23,661
>> Stan Love: Well, the moon
doesn't give off any light

544
00:24:23,661 --> 00:24:27,198
and you can see that, right?

545
00:24:27,198 --> 00:24:29,233
So asteroids don't give
off light of their own,

546
00:24:29,233 --> 00:24:32,336
but they do reflect sunlight

just like everything else

547
00:24:32,336 --> 00:24:34,171
in the solar system,
including the moon, the Earth

548
00:24:34,171 --> 00:24:36,641
and spacecraft in orbit.

549
00:24:36,641 --> 00:24:41,012
So the problem is,
asteroids are really tiny,

550
00:24:41,012 --> 00:24:43,814
so the moon is a couple
of thousand miles across

551
00:24:43,814 --> 00:24:45,950
and it's close, so
it's easy to see.

552
00:24:45,950 --> 00:24:48,019
Now, when you're talking about
something that's one mile

553
00:24:48,019 --> 00:24:50,721
across or, for the size of
asteroids that we're talking

554
00:24:50,721 --> 00:24:56,427
about now, maybe 20 feet across,
and out many times more distant

555
00:24:56,427 --> 00:24:57,828
than the moon, it's

556
00:24:57,828 --> 00:25:01,332
like a little mosquito that's
pretty far from the street light

557
00:25:01,332 --> 00:25:02,900
and it's very hard to see.

558
00:25:02,900 --> 00:25:05,836
To find those things we use
big telescopes that can --

559
00:25:05,836 --> 00:25:09,073
big mirrors that gather a lot
of light and wide field of view

560
00:25:09,073 --> 00:25:10,741
so that they're not just
looking down a soda straw,

561
00:25:10,741 --> 00:25:13,044
but looking at a
big area of the sky.

562
00:25:13,044 --> 00:25:16,247
And those telescopes, some
of which are automated --

563
00:25:16,247 --> 00:25:18,950
they do everything
robotically -- look for things,

564
00:25:18,950 --> 00:25:20,685
identify moving targets.

565
00:25:20,685 --> 00:25:22,520
And those guys are busy
every night looking

566
00:25:22,520 --> 00:25:24,855
at the skies finding
new asteroids.

567
00:25:24,855 --> 00:25:27,858

In order to find really tiny
ones that are appropriate

568
00:25:27,858 --> 00:25:29,827
for fetching back to the moon,

569
00:25:29,827 --> 00:25:32,697
we may have to actually
build a new telescope.

570
00:25:32,697 --> 00:25:35,433
There's one on the books called
the large synoptic survey

571
00:25:35,433 --> 00:25:37,401
telescope, which is going
to be an eight-meter mirror

572
00:25:37,401 --> 00:25:40,071
that is the light-gathering
mirror is 25 feet across,

573
00:25:40,071 --> 00:25:42,073
so it'll be a good one.

574
00:25:42,073 --> 00:25:44,709
And we're hoping that can
identify asteroids like that.

575
00:25:44,709 --> 00:25:47,545
And incidentally, that
facility and others

576
00:25:47,545 --> 00:25:49,680
like it will help
identify asteroids

577
00:25:49,680 --> 00:25:53,417
that might hit the Earth, which
is also a topic of interest.

578
00:25:53,417 --> 00:25:54,952
We'd rather that didn't happen.

579
00:25:54,952 --> 00:25:57,888
And when we develop the
technology to move asteroids

580
00:25:57,888 --> 00:26:01,058
around to put them near the moon
so that people can visit them,

581
00:26:01,058 --> 00:26:03,194
we'll also be developing
the technology we need

582
00:26:03,194 --> 00:26:07,865
to protect the Earth against
asteroids that might strike it.

583
00:26:09,634 --> 00:26:11,902
>> Alright, it looks like
that is all the time we have

584
00:26:11,902 --> 00:26:13,104
for questions.

585
00:26:13,104 --> 00:26:16,073
So I'd like to thank you
guys for attending today.

586
00:26:16,073 --> 00:26:18,609
And thank you, Dr.
Love, for coming in

587
00:26:18,609 --> 00:26:20,711
and answering all the
students' questions.

588

00:26:20,711 --> 00:26:25,016
For the students, do you guys
have any final words you want

589
00:26:25,016 --> 00:26:25,583
to say?

590
00:26:25,583 --> 00:26:26,417
>> Thank you!

591
00:26:26,417 --> 00:26:28,519
>> Stan Love: You're welcome.