
John Dewitt
Treadmill Kinematics experiment

1
00:00:14,033 --> 00:00:16,495
-1,651 --

2
00:00:16,495 --> 00:00:18,825
That's the total number of investigations

3
00:00:18,825 --> 00:00:21,297
performed on the International Space Station

4
00:00:21,297 --> 00:00:23,462
since it first started operations

5
00:00:23,462 --> 00:00:26,264
through Expeditions 38/39.

6
00:00:26,264 --> 00:00:29,132
Researchers from more than 83 countries

7
00:00:29,132 --> 00:00:31,297
have relied on the unique facility

8
00:00:31,297 --> 00:00:32,792
that is the space station

9
00:00:32,792 --> 00:00:35,231
to help with their scientific discoveries,

10
00:00:35,231 --> 00:00:37,495
contributing in countless ways

11
00:00:37,495 --> 00:00:41,594
to the health and safety of life on Earth and in space.

12
00:00:41,594 --> 00:00:44,132
The collaboration between the station crew

13
00:00:44,132 --> 00:00:45,462

and ground controllers

14
00:00:45,462 --> 00:00:48,330
at Marshall's Payload Operations Integration Center,

15
00:00:48,330 --> 00:00:49,957
Europe, and Japan,

16
00:00:49,957 --> 00:00:53,033
resulted in more than 300 investigations

17
00:00:53,033 --> 00:00:55,000
on station this year alone

18
00:00:55,000 --> 00:00:57,297
and record-breaking hours of science

19
00:00:57,297 --> 00:00:59,891
conducted by the crews each week.

20
00:00:59,891 --> 00:01:01,198
Over the course of the year,

21
00:01:01,198 --> 00:01:02,825
we interviewed several researchers

22
00:01:02,825 --> 00:01:04,396
about their investigations

23
00:01:04,396 --> 00:01:07,297
to learn why and how they're conducting research

24
00:01:07,297 --> 00:01:09,396
on the International Space Station.

25
00:01:09,396 --> 00:01:12,033
Now, while we can't get to everyone in the next 30 minutes,

26
00:01:12,033 --> 00:01:13,660
you'll hear from some of the scientists

27
00:01:13,660 --> 00:01:15,099
about their investigations.

28
00:01:15,099 --> 00:01:17,429
But first, let's hear from Ellen Stofan,

29
00:01:17,429 --> 00:01:19,033
NASA's Chief Scientist,

30
00:01:19,033 --> 00:01:23,165
to find out why this orbiting laboratory is so valuable.

31
00:01:23,165 --> 00:01:26,825
-We have experiments that included a 3-D printer

32
00:01:26,825 --> 00:01:28,396
to start testing --

33
00:01:28,396 --> 00:01:30,957
Can we eventually get to a point where we can produce parts

34
00:01:30,957 --> 00:01:32,627
for the International Space Station

35
00:01:32,627 --> 00:01:34,528
on the International Space Station,

36
00:01:34,528 --> 00:01:36,330
rather than bringing them from Earth?

37
00:01:36,330 --> 00:01:40,132
We took up rodents for the first time since the shuttle days,

38
00:01:40,132 --> 00:01:43,099

and we're going to be using these rodents as model systems

39
00:01:43,099 --> 00:01:45,627
to better understand the effects of microgravity

40
00:01:45,627 --> 00:01:48,000
on the human system,

41
00:01:48,000 --> 00:01:49,033
and using those mice,

42
00:01:49,033 --> 00:01:50,462
potentially for drug development.

43
00:01:50,462 --> 00:01:52,693
Things that happen to the human body in space,

44
00:01:52,693 --> 00:01:54,759
like bone-density loss and muscle wasting,

45
00:01:54,759 --> 00:01:57,000
are things that happen to us as we age,

46
00:01:57,000 --> 00:01:58,297
so can we use the fact

47
00:01:58,297 --> 00:02:01,132
that these processes occur very rapidly in space

48
00:02:01,132 --> 00:02:04,726
to develop new treatments that benefit us right here on Earth?

49
00:02:04,726 --> 00:02:07,330
So, direct benefits to the world of science,

50
00:02:07,330 --> 00:02:09,429
direct benefits to human health --

51
00:02:09,429 --> 00:02:11,759
That's the kind of research we do every day

52
00:02:11,759 --> 00:02:13,891
up on the International Space Station.

53
00:02:13,891 --> 00:02:15,594
-As the Chief Scientist, though,

54
00:02:15,594 --> 00:02:17,198
I'm sure you want to see more.

55
00:02:17,198 --> 00:02:18,396
There's more that can be done.

56
00:02:18,396 --> 00:02:19,858
What do you tell folks about that?

57
00:02:19,858 --> 00:02:22,264
-You know, that's why this extension to 2024

58
00:02:22,264 --> 00:02:23,528
was so important to me,

59
00:02:23,528 --> 00:02:24,858
because as a researcher,

60
00:02:24,858 --> 00:02:26,825
you really want to be able to say,

61
00:02:26,825 --> 00:02:29,561
"Can I come up with a theory, come up with an experiment,

62
00:02:29,561 --> 00:02:32,957
send it up to the ISS, see what my results are,

63
00:02:32,957 --> 00:02:34,726

and tweak my experiment,

64
00:02:34,726 --> 00:02:36,891
go further, go to the next step?"

65
00:02:36,891 --> 00:02:38,495
And that's what that 10-year extension

66
00:02:38,495 --> 00:02:40,033
of the ISS has given us.

67
00:02:40,033 --> 00:02:42,693
And so, the rodent research I was talking about --

68
00:02:42,693 --> 00:02:44,000
We're just beginning.

69
00:02:44,000 --> 00:02:45,264
We're going to have rodents,

70
00:02:45,264 --> 00:02:46,957
model system, fruit-fly experiments

71
00:02:46,957 --> 00:02:48,627
going up on the ISS

72
00:02:48,627 --> 00:02:50,924
that are really going to help us start addressing questions

73
00:02:50,924 --> 00:02:54,297
on how do we send humans on that long journey to Mars,

74
00:02:54,297 --> 00:02:55,924
that eight-month journey to Mars,

75
00:02:55,924 --> 00:02:58,495
eight months back, time on the Martian surface --

76
00:02:58,495 --> 00:02:59,759
That's a lot of time

77
00:02:59,759 --> 00:03:02,363
out of the Earth's protective environment

78
00:03:02,363 --> 00:03:04,528
that protects us from space radiation.

79
00:03:04,528 --> 00:03:06,198
So, we have a lot of research to do

80
00:03:06,198 --> 00:03:07,792
on the International Space Station

81
00:03:07,792 --> 00:03:09,099
over the next 10 years

82
00:03:09,099 --> 00:03:11,264
to really get ready for that journey to Mars.

83
00:03:11,264 --> 00:03:12,561
And we're excited about it.

84
00:03:12,561 --> 00:03:15,297
-And the space station has also given researchers

85
00:03:15,297 --> 00:03:18,330
who may not have ever gotten anything in microgravity --

86
00:03:18,330 --> 00:03:19,825
They've given them an opportunity.

87
00:03:19,825 --> 00:03:21,924
It's easier now to get on the space station, right?

88
00:03:21,924 --> 00:03:23,231

-It is easier.

89
00:03:23,231 --> 00:03:25,825
We're really working at NASA to try to make the ISS

90
00:03:25,825 --> 00:03:27,561
a researcher-friendly environment.

91
00:03:27,561 --> 00:03:29,825
And through our efforts, as well as CASIS,

92
00:03:29,825 --> 00:03:31,561
which is the organization

93
00:03:31,561 --> 00:03:35,231
that runs our national laboratory on the space station,

94
00:03:35,231 --> 00:03:37,066
we're trying to get new partners,

95
00:03:37,066 --> 00:03:39,198
not just our traditional research crowd,

96
00:03:39,198 --> 00:03:42,165
but can we get pharmaceutical companies?

97
00:03:42,165 --> 00:03:45,264
Can we get companies that do materials research?

98
00:03:45,264 --> 00:03:47,033
Can they start seeing the benefits

99
00:03:47,033 --> 00:03:48,495
of doing microgravity research?

100
00:03:48,495 --> 00:03:50,000
So, we really want to exploit

101
00:03:50,000 --> 00:03:51,825
not just the scientific potential

102
00:03:51,825 --> 00:03:53,396
of the International Space Station,

103
00:03:53,396 --> 00:03:55,198
but its potential commercial uses.

104
00:03:55,198 --> 00:03:57,066
-What do you tell folks who say,

105
00:03:57,066 --> 00:03:58,561
"Ah, the space station --

106
00:03:58,561 --> 00:04:00,759
That doesn't mean anything to me"?

107
00:04:00,759 --> 00:04:03,396
-You know, I really try to focus on the fact

108
00:04:03,396 --> 00:04:05,693
that when we're working off the Earth,

109
00:04:05,693 --> 00:04:07,297
we're working for the Earth.

110
00:04:07,297 --> 00:04:09,660
From the RapidScat instrument

111
00:04:09,660 --> 00:04:12,033
that we just put up to help measure ocean winds,

112
00:04:12,033 --> 00:04:13,957
which is going to be able to allow us

113
00:04:13,957 --> 00:04:16,396

to do better weather forecasting,

114
00:04:16,396 --> 00:04:18,033
better understanding of the climate --

115
00:04:18,033 --> 00:04:21,594
That's something that affects us directly right here on Earth.

116
00:04:21,594 --> 00:04:23,858
From things like, again, bone-density loss.

117
00:04:23,858 --> 00:04:27,330
Okay, that's what happens to us as we age -- osteoporosis.

118
00:04:27,330 --> 00:04:29,462
We're looking into developing new treatments

119
00:04:29,462 --> 00:04:31,528
based on what we're doing on the space station.

120
00:04:31,528 --> 00:04:33,858
So, while we're not right here on Earth,

121
00:04:33,858 --> 00:04:36,231
everything we do is to benefit the Earth,

122
00:04:36,231 --> 00:04:38,561
and those technologies that we develop

123
00:04:38,561 --> 00:04:40,759
are being done right here on Earth.

124
00:04:40,759 --> 00:04:42,561
We send them up to space and test them,

125
00:04:42,561 --> 00:04:45,330
and there's huge numbers of spin-offs that come from that.

126
00:04:45,330 --> 00:04:48,660
The benefits of the ISS, to me, are just endless.

127
00:04:48,660 --> 00:04:50,066
The One Year mission is something

128
00:04:50,066 --> 00:04:51,693
that we've really been looking forward to

129
00:04:51,693 --> 00:04:53,198
in the Human Research Program,

130
00:04:53,198 --> 00:04:55,132
because there are a lot of things that happen, again,

131
00:04:55,132 --> 00:04:56,363
to the human body in space,

132
00:04:56,363 --> 00:04:58,726
from, again, the muscle wasting, bone-density loss,

133
00:04:58,726 --> 00:05:01,429
the rise in intercranial pressure that affects vision,

134
00:05:01,429 --> 00:05:03,429
changes in the immune system.

135
00:05:03,429 --> 00:05:05,429
Our crews mostly go up for six months.

136
00:05:05,429 --> 00:05:07,495
So, okay, what happens after six months?

137
00:05:07,495 --> 00:05:09,132
Do those effects plateau?

138
00:05:09,132 --> 00:05:11,462

Do they lessen? Do they get worse?

139
00:05:11,462 --> 00:05:13,693
Those are things we really want to know,

140
00:05:13,693 --> 00:05:15,726
and so by having the two astronauts

141
00:05:15,726 --> 00:05:16,858
up there for a year --

142
00:05:16,858 --> 00:05:18,759
a Russian astronaut, a U.S. astronaut --

143
00:05:18,759 --> 00:05:21,363
it's a great opportunity to really push that envelope

144
00:05:21,363 --> 00:05:24,495
in what we understand about the affects of microgravity,

145
00:05:24,495 --> 00:05:27,924
and again, critical for this much longer trip to Mars.

146
00:05:27,924 --> 00:05:29,660
The other exciting aspect, of course,

147
00:05:29,660 --> 00:05:30,891
of the One Year mission

148
00:05:30,891 --> 00:05:33,594
is that Scott Kelly, who's going up for a year,

149
00:05:33,594 --> 00:05:36,132
happens to have a twin brother, Mark Kelly,

150
00:05:36,132 --> 00:05:38,198
former astronaut, who's here on the ground.

151
00:05:38,198 --> 00:05:40,957
And so not only are we going to be doing the one-year studies

152
00:05:40,957 --> 00:05:42,297
of the long-duration effects,

153
00:05:42,297 --> 00:05:45,561
we're also doing a number of twin studies to say,

154
00:05:45,561 --> 00:05:47,396
"Okay, we've got one in space and one on the ground,

155
00:05:47,396 --> 00:05:48,660
same genetics.

156
00:05:48,660 --> 00:05:50,066
What can we learn from that?"

157
00:05:50,066 --> 00:05:51,165
Really exciting.

158
00:05:51,165 --> 00:05:53,495
-So, let's take a look at some of those investigations,

159
00:05:53,495 --> 00:05:54,858
from growing veggies

160
00:05:54,858 --> 00:05:57,858
to studying how flames behave in microgravity,

161
00:05:57,858 --> 00:05:59,462
and what we've learned

162
00:05:59,462 --> 00:06:03,132
by observing our planet from more than 200 miles up.

163
00:06:07,330 --> 00:06:11,726

-It's the first continuous HD downlink from the ISS.

164
00:06:11,726 --> 00:06:13,330
We've had other cameras up there before,

165
00:06:13,330 --> 00:06:15,033
but they have sort of been spotty coverage.

166
00:06:15,033 --> 00:06:17,033
This is the first one that's on all the time.

167
00:06:17,033 --> 00:06:18,462
It's actually four cameras --

168
00:06:18,462 --> 00:06:20,759
four commercial, off-the-shelf, HD cameras --

169
00:06:20,759 --> 00:06:24,033
in an enclosure that's built to test temperature control.

170
00:06:24,033 --> 00:06:25,198
And the cameras --

171
00:06:25,198 --> 00:06:27,792
The main purpose of this, of the HDEV project,

172
00:06:27,792 --> 00:06:29,528
is not to take Earth imagery.

173
00:06:29,528 --> 00:06:31,759
That's just a very cool added bonus of it.

174
00:06:31,759 --> 00:06:33,693
The real purpose is to test

175
00:06:33,693 --> 00:06:37,495
how long these cameras can survive in the space environment

176
00:06:37,495 --> 00:06:39,264
before they degrade so much

177
00:06:39,264 --> 00:06:41,066
through things like cosmic-ray hits

178
00:06:41,066 --> 00:06:42,693
that they're not usable anymore.

179
00:06:42,693 --> 00:06:44,066
So, the four cameras.

180
00:06:44,066 --> 00:06:46,660
There's one pointed in the ram direction,

181
00:06:46,660 --> 00:06:48,957
the forward-velocity vector of the ISS.

182
00:06:48,957 --> 00:06:50,627
There's two facing aft,

183
00:06:50,627 --> 00:06:53,000
and one facing nadir, looking right down on the Earth.

184
00:06:53,000 --> 00:06:56,099
And the way the system is currently set up right now,

185
00:06:56,099 --> 00:07:01,330
the video feeds cycle through all four cameras.

186
00:07:01,330 --> 00:07:05,429
But there's two educational opportunities that are coming up

187
00:07:05,429 --> 00:07:09,297
that we're working with student groups in Germany,

188
00:07:09,297 --> 00:07:10,528

University of Bonn,

189
00:07:10,528 --> 00:07:12,858
through the German Space Agency, DLR,

190
00:07:12,858 --> 00:07:15,231
and also University of Houston, Clear Lake,

191
00:07:15,231 --> 00:07:16,396
has a group of students also

192
00:07:16,396 --> 00:07:17,924
that will be looking at the camera

193
00:07:17,924 --> 00:07:20,033
both to collect data for specific areas

194
00:07:20,033 --> 00:07:23,066
but also to monitor the primary purpose of the experiment --

195
00:07:23,066 --> 00:07:25,726
see how the cameras are degrading over time.

196
00:07:25,726 --> 00:07:28,528
And so, those programs are just getting spun up.

197
00:07:28,528 --> 00:07:31,429
But in the meantime, yeah, the HDEV is returning

198
00:07:31,429 --> 00:07:33,594
spectacular HD views of the Earth.

199
00:07:33,594 --> 00:07:36,066
-The first one is an area called Los Glaciares.

200
00:07:36,066 --> 00:07:37,693
It's a national park in Argentina.

201
00:07:37,693 --> 00:07:39,759
It's right on the Argentinean/Chilean border,

202
00:07:39,759 --> 00:07:41,429
and it's particularly significant

203
00:07:41,429 --> 00:07:43,132
because it's one of the few areas

204
00:07:43,132 --> 00:07:44,759
where there are glaciers,

205
00:07:44,759 --> 00:07:47,627
specifically a glacier called Perito Moreno,

206
00:07:47,627 --> 00:07:48,660
which is actually growing.

207
00:07:48,660 --> 00:07:50,561
Most of the glaciers in that area,

208
00:07:50,561 --> 00:07:52,792
in that particular glaciation field there,

209
00:07:52,792 --> 00:07:54,660
are shrinking.

210
00:07:54,660 --> 00:07:56,660
But Perito Moreno is growing.

211
00:07:56,660 --> 00:07:58,594
And there's a lot of research there

212
00:07:58,594 --> 00:08:00,594
trying to figure out exactly what's going on,

213
00:08:00,594 --> 00:08:03,099

why this one particular area, as opposed to the other areas,

214
00:08:03,099 --> 00:08:04,660
are increasing.

215
00:08:04,660 --> 00:08:06,363
Glaciation is one of those things that has --

216
00:08:06,363 --> 00:08:09,462
It's a fingerprint of what the current climate is

217
00:08:09,462 --> 00:08:11,363
and how things may be trending,

218
00:08:11,363 --> 00:08:14,561
so glaciation studies around the world are very important.

219
00:08:14,561 --> 00:08:17,264
The next one is Lake Titicaca.

220
00:08:17,264 --> 00:08:21,363
This particular image is on the northwestern shore of Titicaca,

221
00:08:21,363 --> 00:08:25,528
right at the border between Peru and Bolivia.

222
00:08:25,528 --> 00:08:28,264
Titicaca is a very important area.

223
00:08:28,264 --> 00:08:30,924
It's a huge local fishery.

224
00:08:30,924 --> 00:08:32,924
It's a very important local area

225
00:08:32,924 --> 00:08:35,462
because of the tourism business there.

226
00:08:35,462 --> 00:08:38,627
And it also in an indicator of the health of the planet.

227
00:08:38,627 --> 00:08:40,363
As the water level rises and falls,

228
00:08:40,363 --> 00:08:42,495
as the water quality increases and decreases,

229
00:08:42,495 --> 00:08:44,627
it's a good indicator of what's going on, generally,

230
00:08:44,627 --> 00:08:46,033
in the environment.

231
00:08:46,033 --> 00:08:48,429
The next image that we have is the upper Nile in Sudan.

232
00:08:48,429 --> 00:08:49,792
This is a late-afternoon shot.

233
00:08:49,792 --> 00:08:53,066
You can see there's a pink glow cast across the landscape

234
00:08:53,066 --> 00:08:54,627
from the setting sun there.

235
00:08:54,627 --> 00:08:58,792
The Nile, of course, is critical for agriculture in the area.

236
00:08:58,792 --> 00:09:01,891
Most of the population in the desert environments

237
00:09:01,891 --> 00:09:03,363
live along riverbanks.

238
00:09:03,363 --> 00:09:04,561

The Nile, of course,

239
00:09:04,561 --> 00:09:06,528
is the focus of the population in that area.

240
00:09:06,528 --> 00:09:08,462
What you see here is a set of villages

241
00:09:08,462 --> 00:09:10,363
that are interspersed with agriculture

242
00:09:10,363 --> 00:09:12,033
along the banks of the Nile.

243
00:09:12,033 --> 00:09:15,099
The Nile itself is the source both of the water

244
00:09:15,099 --> 00:09:17,297
and the fertilization for those fields.

245
00:09:17,297 --> 00:09:21,528
And the people in those areas depend on the agriculture

246
00:09:21,528 --> 00:09:23,528
that's in their local area to survive.

247
00:09:23,528 --> 00:09:25,132
And modifications to the environment --

248
00:09:25,132 --> 00:09:29,099
The Nile has been modified over the last 50 years or so

249
00:09:29,099 --> 00:09:31,330
to have some significant effect

250
00:09:31,330 --> 00:09:32,825
on the ability of the people

251
00:09:32,825 --> 00:09:35,066
to conduct their agricultural activities.

252
00:09:39,132 --> 00:09:43,231
-The hardware consists of an LED lid

253
00:09:43,231 --> 00:09:44,858
with lighting underneath it

254
00:09:44,858 --> 00:09:46,396
with a bellows system

255
00:09:46,396 --> 00:09:48,396
and a skeleton that holds that all together.

256
00:09:48,396 --> 00:09:51,099
We have root maps with seeds inside of them,

257
00:09:51,099 --> 00:09:56,363
and it's an accordion-type system

258
00:09:56,363 --> 00:09:58,891
that will raise as the plants grow.

259
00:09:58,891 --> 00:10:00,330
And the lighting system

260
00:10:00,330 --> 00:10:03,594
is only the light that is necessary for plants to live,

261
00:10:03,594 --> 00:10:06,627
and it's a 24/7 cycle, so there is no nighttime.

262
00:10:06,627 --> 00:10:08,132
So it grows very quickly,

263
00:10:08,132 --> 00:10:10,099

and we turn the crops very quickly.

264
00:10:10,099 --> 00:10:11,396
It's unique in a way

265
00:10:11,396 --> 00:10:14,165
that it's very interactive to the astronauts.

266
00:10:14,165 --> 00:10:16,693
They can touch it, feel it, have the goodness.

267
00:10:16,693 --> 00:10:18,693
There's been plant science up there,

268
00:10:18,693 --> 00:10:23,066
but it's all been enclosed in a very controlled environment.

269
00:10:23,066 --> 00:10:26,462
This environment is outside.

270
00:10:26,462 --> 00:10:31,957
It's very, very interactive to the astronauts.

271
00:10:31,957 --> 00:10:35,000
We are very interested

272
00:10:35,000 --> 00:10:37,924
in the environmental control and life-support systems.

273
00:10:37,924 --> 00:10:42,132
With this plant technology, ISS, with zero G,

274
00:10:42,132 --> 00:10:46,330
we're able to take and assess what the plants do in the grow,

275
00:10:46,330 --> 00:10:47,957
and what we're trying to do

276
00:10:47,957 --> 00:10:50,330
is capture the humidity, condensation,

277
00:10:50,330 --> 00:10:54,264
and recycle it back into the environmental control systems.

278
00:10:54,264 --> 00:10:59,825
So, in this effort to resource utilize as much as possible.

279
00:10:59,825 --> 00:11:03,000
Now, it's critical to do this at zero G

280
00:11:03,000 --> 00:11:06,033
because if we're going to do long-duration space --

281
00:11:06,033 --> 00:11:08,198
Moon, Mars -- this has to be done,

282
00:11:08,198 --> 00:11:10,099
and we have to recover

283
00:11:10,099 --> 00:11:13,363
and take those resources as far as they can.

284
00:11:13,363 --> 00:11:15,759
-People have been studying fruit flies

285
00:11:15,759 --> 00:11:18,660
and using them to understand important questions

286
00:11:18,660 --> 00:11:20,363
for over 100 years.

287
00:11:20,363 --> 00:11:24,594
And so genetically, we know a lot about them.

288
00:11:24,594 --> 00:11:26,231

They're very well-characterized.

289
00:11:26,231 --> 00:11:29,363
They also, because they're so small --

290
00:11:29,363 --> 00:11:32,528
in a small area, when you do a space-flight experiment,

291
00:11:32,528 --> 00:11:36,924
you can fly a lot of these little fruit flies.

292
00:11:36,924 --> 00:11:39,627
And so, when you get the data back,

293
00:11:39,627 --> 00:11:41,792
you have a lot of information,

294
00:11:41,792 --> 00:11:44,561
a lot of samples to do your studies.

295
00:11:44,561 --> 00:11:47,759
Another thing that I think surprises a lot of people

296
00:11:47,759 --> 00:11:49,792
but is important to know

297
00:11:49,792 --> 00:11:53,264
is that fruit flies actually are very --

298
00:11:53,264 --> 00:11:54,660
When you look at their DNA

299
00:11:54,660 --> 00:11:57,957
and you compare it with DNA, say, of humans,

300
00:11:57,957 --> 00:11:59,462
there's a lot of similarity.

301
00:11:59,462 --> 00:12:01,858
So, when you look at the database

302
00:12:01,858 --> 00:12:04,165
which has the collection of genes

303
00:12:04,165 --> 00:12:07,330
which are important for human function --

304
00:12:07,330 --> 00:12:09,957
so, when you get any kind of anomaly,

305
00:12:09,957 --> 00:12:13,099
then you can show a human disease.

306
00:12:13,099 --> 00:12:14,759
When you look at that collection

307
00:12:14,759 --> 00:12:17,000
and you compare it against the fruit fly DNA,

308
00:12:17,000 --> 00:12:20,264
you actually find more than 70% similarity.

309
00:12:20,264 --> 00:12:23,231
So more than 70% of those genes are similar.

310
00:12:23,231 --> 00:12:28,396
So, there's a lot that you can use the fly to do studies with

311
00:12:28,396 --> 00:12:30,561
and then a lot you can understand

312
00:12:30,561 --> 00:12:32,858
about other more complex systems,

313
00:12:32,858 --> 00:12:34,165

like the human being,

314
00:12:34,165 --> 00:12:38,066
and how an astronaut would experience space flight.

315
00:12:42,066 --> 00:12:46,165
-We study the behavior of colloidal samples.

316
00:12:46,165 --> 00:12:48,000
What does that mean?

317
00:12:48,000 --> 00:12:50,033
Colloid is fluid

318
00:12:50,033 --> 00:12:53,033
that has particles in it that we may not see.

319
00:12:53,033 --> 00:12:56,759
Everyday products are colloidal,

320
00:12:56,759 --> 00:13:02,660
like toothpaste, shaving cream, detergent.

321
00:13:02,660 --> 00:13:05,000
Milk is even a colloid,

322
00:13:05,000 --> 00:13:08,660
and the researchers want to find ways

323
00:13:08,660 --> 00:13:12,033
to extend the shelf life of some products

324
00:13:12,033 --> 00:13:15,627
and also understand the behavior

325
00:13:15,627 --> 00:13:18,132
of the particles inside these products

326
00:13:18,132 --> 00:13:21,132
and probably for many of them,

327
00:13:21,132 --> 00:13:24,363
improve the manufacturing of those products.

328
00:13:24,363 --> 00:13:26,066
-One of the things that we discovered

329
00:13:26,066 --> 00:13:27,099
in the FLEX experiments

330
00:13:27,099 --> 00:13:30,561
is the so-called cool-flame combustion.

331
00:13:30,561 --> 00:13:33,462
What happens there is the hot flame goes out,

332
00:13:33,462 --> 00:13:37,330
and then the droplet continues to burn at a very vigorous rate,

333
00:13:37,330 --> 00:13:39,264
but without any visible flame.

334
00:13:39,264 --> 00:13:41,792
So this has got practical applications

335
00:13:41,792 --> 00:13:44,792
in the form of using liquid fuels

336
00:13:44,792 --> 00:13:46,825
in an efficient and a clean way.

337
00:13:46,825 --> 00:13:48,726
And the space applications for this

338
00:13:48,726 --> 00:13:50,528

is also very critical because --

339
00:13:50,528 --> 00:13:52,561
from the point of view of fire safety.

340
00:13:52,561 --> 00:13:54,660
So, if you have a fire-fighting strategy

341
00:13:54,660 --> 00:13:57,495
in a microgravity environment or a spacecraft environment,

342
00:13:57,495 --> 00:14:00,462
so if you think that once that hot flame is gone,

343
00:14:00,462 --> 00:14:03,825
then you can't think that the fire is extinguished.

344
00:14:03,825 --> 00:14:04,957
What is happening --

345
00:14:04,957 --> 00:14:07,957
It's almost like smoldering combustion on Earth.

346
00:14:07,957 --> 00:14:11,165
Like, if you put a piece of log in the fireplace

347
00:14:11,165 --> 00:14:13,264
and the flame goes out

348
00:14:13,264 --> 00:14:16,627
but it can still smolder and produce toxic gases.

349
00:14:16,627 --> 00:14:17,759
Just like that.

350
00:14:17,759 --> 00:14:19,957
This is the first time anybody has observed this.

351
00:14:19,957 --> 00:14:23,330
Hot flame goes out and there's no visible flame

352
00:14:23,330 --> 00:14:25,792
and still the liquid fuel continues to burn,

353
00:14:25,792 --> 00:14:28,033
partially oxidizing this fuel,

354
00:14:28,033 --> 00:14:31,594
spewing out, you know, combustible mixtures.

355
00:14:31,594 --> 00:14:35,066
So, it is very important to know that

356
00:14:35,066 --> 00:14:38,429
so that, in principle, at least,

357
00:14:38,429 --> 00:14:41,132
we have demonstrated that after hot flame,

358
00:14:41,132 --> 00:14:43,297
the cool flame can be a fire hazard

359
00:14:43,297 --> 00:14:46,594
because it can re-ignite and then bring back the hot flame.

360
00:14:46,594 --> 00:14:48,891
-I never tire of those amazing images,

361
00:14:48,891 --> 00:14:51,627
but that's not all that happened on space station this year.

362
00:14:51,627 --> 00:14:54,495
There were laser beams, 3-D printing,

363
00:14:54,495 --> 00:14:57,066

and even a bedtime story from space.

364
00:14:57,066 --> 00:14:58,330
And let's not forget

365
00:14:58,330 --> 00:15:01,726
those ever-important human research investigations.

366
00:15:06,264 --> 00:15:09,495
-We're looking at the immunosuppression in astronauts.

367
00:15:09,495 --> 00:15:13,264
We're using very complicated bioinformatics

368
00:15:13,264 --> 00:15:16,660
in order to look at all 30,000 genes involved.

369
00:15:16,660 --> 00:15:18,198
And from there,

370
00:15:18,198 --> 00:15:24,627
we are finding the way to modulate the immune system,

371
00:15:24,627 --> 00:15:26,924
not only for people in space flight,

372
00:15:26,924 --> 00:15:29,132
but also for people on the ground.

373
00:15:29,132 --> 00:15:32,957
For instance, older people, as they age,

374
00:15:32,957 --> 00:15:35,198
they have an immunosuppression.

375
00:15:35,198 --> 00:15:39,627
Something like 70% of the people in ICU that die

376
00:15:39,627 --> 00:15:42,132
have had pneumonia.

377
00:15:42,132 --> 00:15:46,132
We're also looking at ways to modulate the immune system

378
00:15:46,132 --> 00:15:48,825
for autoimmune disease.

379
00:15:48,825 --> 00:15:51,462
That would be when it's turned on too high.

380
00:15:51,462 --> 00:15:54,693
So the hope for our research is

381
00:15:54,693 --> 00:15:59,396
that we're going to be able to pinpoint the target areas

382
00:15:59,396 --> 00:16:02,363
that might make a good pharmaceutical target.

383
00:16:02,363 --> 00:16:03,726
My experiment --

384
00:16:03,726 --> 00:16:07,198
The first one flew on station some time ago.

385
00:16:07,198 --> 00:16:12,363
We published the paper in 2012 about the experiment,

386
00:16:12,363 --> 00:16:14,957
and this is the next experiment following.

387
00:16:14,957 --> 00:16:17,033
-So, what did you find in the first study?

388
00:16:17,033 --> 00:16:18,462

-In the first study,

389
00:16:18,462 --> 00:16:21,759
we found some of the very early signaling events

390
00:16:21,759 --> 00:16:25,132
that change in the immune system in microgravity.

391
00:16:25,132 --> 00:16:26,198
With this study,

392
00:16:26,198 --> 00:16:28,429
we're carrying it one step further.

393
00:16:28,429 --> 00:16:31,330
We're able to look at micro RNA

394
00:16:31,330 --> 00:16:33,495
where we will be able to have

395
00:16:33,495 --> 00:16:36,165
brand-new pharmaceutical targets.

396
00:16:36,165 --> 00:16:37,792
-We hadn't had any data

397
00:16:37,792 --> 00:16:40,429
that allowed us to show specifically

398
00:16:40,429 --> 00:16:41,825
how there were changes.

399
00:16:41,825 --> 00:16:43,891
We just knew there probably were.

400
00:16:43,891 --> 00:16:45,759
So this was the first activity

401
00:16:45,759 --> 00:16:48,825
that we did a formal evaluation of how people run

402
00:16:48,825 --> 00:16:52,264
and compared running styles in normal gravity

403
00:16:52,264 --> 00:16:54,297
to running styles up on the space station.

404
00:16:54,297 --> 00:16:57,429
We learned a lot of really cool things.

405
00:16:57,429 --> 00:17:00,198
First of all, from an exercise perspective,

406
00:17:00,198 --> 00:17:04,066
we found out that running fast is really, really important.

407
00:17:04,066 --> 00:17:05,330
The faster you run,

408
00:17:05,330 --> 00:17:08,231
the greater the force is between the foot and the ground.

409
00:17:08,231 --> 00:17:10,561
From a brain perspective,

410
00:17:10,561 --> 00:17:13,033
and this is where people who study motor control

411
00:17:13,033 --> 00:17:14,231
and how the brain works

412
00:17:14,231 --> 00:17:16,297
and maybe people who are interested in studying

413
00:17:16,297 --> 00:17:18,132

how the brain might change due to injury

414
00:17:18,132 --> 00:17:22,198
or due to aging or these sort of things,

415
00:17:22,198 --> 00:17:26,231
what this means is that gravity is not necessary

416
00:17:26,231 --> 00:17:27,429
for someone to run

417
00:17:27,429 --> 00:17:30,297
the same way that they would run on the ground.

418
00:17:30,297 --> 00:17:33,693
So, the data tell us that, when it comes to running,

419
00:17:33,693 --> 00:17:35,825
people pretty much do this automatically,

420
00:17:35,825 --> 00:17:38,528
even though that input is different from on the ground,

421
00:17:38,528 --> 00:17:40,462
and there hasn't been any other studies

422
00:17:40,462 --> 00:17:41,792
that have been able to study

423
00:17:41,792 --> 00:17:45,858
a real, large-scale, multi-joint movement like running

424
00:17:45,858 --> 00:17:49,198
where you take away gravity to see what the effects are.

425
00:17:49,198 --> 00:17:50,330
So, this is one of the first

426
00:17:50,330 --> 00:17:51,759
that's ever been able to do that.

427
00:17:51,759 --> 00:17:53,891
It was kind of a serendipitous finding.

428
00:17:53,891 --> 00:17:56,099
Our purpose was to understand exercise,

429
00:17:56,099 --> 00:17:58,066
but we also found out a little bit

430
00:17:58,066 --> 00:18:00,165
about how the body controls running.

431
00:18:04,495 --> 00:18:06,594
-The printer has two windows,

432
00:18:06,594 --> 00:18:08,891
and we're placing the imaging cameras

433
00:18:08,891 --> 00:18:10,594
very closely to those windows

434
00:18:10,594 --> 00:18:14,231
so we can monitor the actual extrusion process.

435
00:18:14,231 --> 00:18:16,429
As the prints and the layers are being deposited,

436
00:18:16,429 --> 00:18:18,231
we'll be able to see that in detail.

437
00:18:18,231 --> 00:18:20,429
The real objective of this first phase

438
00:18:20,429 --> 00:18:22,099

of the technology demonstration

439
00:18:22,099 --> 00:18:25,561
is just to verify that the process works in microgravity

440
00:18:25,561 --> 00:18:27,693
the same way it does on the ground.

441
00:18:27,693 --> 00:18:31,264
NASA in main space have flown parabolic flights

442
00:18:31,264 --> 00:18:32,561
and tested this,

443
00:18:32,561 --> 00:18:34,627
but you only get the short spurts of microgravity.

444
00:18:34,627 --> 00:18:37,099
So being able to test this on space station

445
00:18:37,099 --> 00:18:39,462
and print complete parts in microgravity,

446
00:18:39,462 --> 00:18:40,627
as you mentioned,

447
00:18:40,627 --> 00:18:42,726
space station is actually the only platform

448
00:18:42,726 --> 00:18:44,726
where we're able to test this technology

449
00:18:44,726 --> 00:18:47,429
before we use it in further out exploration missions.

450
00:18:47,429 --> 00:18:48,594
The first phase

451
00:18:48,594 --> 00:18:50,858
is really focused around those engineering samples

452
00:18:50,858 --> 00:18:51,627
that we'll be studying,

453
00:18:51,627 --> 00:18:52,924
but then the second phase,

454
00:18:52,924 --> 00:18:55,198
once we see that the process works in microgravity

455
00:18:55,198 --> 00:18:56,528
the same way,

456
00:18:56,528 --> 00:18:59,330
will turn its focus more towards the parts that we print

457
00:18:59,330 --> 00:19:03,000
and demonstrating their utilization on space station.

458
00:19:03,000 --> 00:19:05,726
So this is actually, truly, a historical moment.

459
00:19:05,726 --> 00:19:08,363
Since the inception of the human space program,

460
00:19:08,363 --> 00:19:10,363
we have been completely dependent

461
00:19:10,363 --> 00:19:13,957
on launching every single thing we need from Earth to space,

462
00:19:13,957 --> 00:19:17,825
so it's a very constrained supply and demand chain.

463
00:19:17,825 --> 00:19:20,264

For exploration missions, you mentioned earlier,

464
00:19:20,264 --> 00:19:22,429
that's just not plausible, it's not feasible.

465
00:19:22,429 --> 00:19:25,330
So I think we're making history by, for the first time ever,

466
00:19:25,330 --> 00:19:29,297
being able to make what we need when we need it in space.

467
00:19:29,297 --> 00:19:32,561
And even though it may sound a little bit like science fiction,

468
00:19:32,561 --> 00:19:35,297
we're actually able to e-mail our hardware to space

469
00:19:35,297 --> 00:19:36,495
instead of launching it.

470
00:19:36,495 --> 00:19:39,297
-What we're trying to do is transmit data over laser beam,

471
00:19:39,297 --> 00:19:40,429
which is very focused,

472
00:19:40,429 --> 00:19:42,429
as opposed to a radio-frequency beam,

473
00:19:42,429 --> 00:19:45,000
which diverges quite a bit over time.

474
00:19:45,000 --> 00:19:46,891
And because we have a focused laser beam,

475
00:19:46,891 --> 00:19:48,726
we can get a lot of data to the ground.

476
00:19:48,726 --> 00:19:52,495
So, with higher data rates, we can get data moving faster,

477
00:19:52,495 --> 00:19:54,429
and we get things like high-definition video

478
00:19:54,429 --> 00:19:56,033
across that data stream.

479
00:19:56,033 --> 00:19:57,825
It's very important for going out and exploring

480
00:19:57,825 --> 00:19:59,627
and getting our science data back to the ground.

481
00:19:59,627 --> 00:20:02,165
The ISS gives us a platform that's already existing.

482
00:20:02,165 --> 00:20:04,726
It's an existing infrastructure.

483
00:20:04,726 --> 00:20:07,264
You can think of infrastructures used today,

484
00:20:07,264 --> 00:20:09,231
like using Windows on a PC.

485
00:20:09,231 --> 00:20:10,660
That's a platform.

486
00:20:10,660 --> 00:20:12,132
The ISS is a platform,

487
00:20:12,132 --> 00:20:13,726
and that gives us a window, really,

488
00:20:13,726 --> 00:20:15,627

to look down at the Earth and to demonstrate

489
00:20:15,627 --> 00:20:18,561
and really use this optical link as a test bed

490
00:20:18,561 --> 00:20:21,066
as if we're in the laboratory.

491
00:20:21,066 --> 00:20:22,528
It rotates over the Earth

492
00:20:22,528 --> 00:20:25,033
just like a orbiter would rotate over Mars,

493
00:20:25,033 --> 00:20:26,561
and we can test things out like

494
00:20:26,561 --> 00:20:28,858
what if a Mars rover were to communicate

495
00:20:28,858 --> 00:20:30,264
with an orbiter in space?

496
00:20:30,264 --> 00:20:31,495
We can test that out

497
00:20:31,495 --> 00:20:34,297
by communicating between the ISS in Earth orbit

498
00:20:34,297 --> 00:20:36,231
and a ground station on the Earth

499
00:20:36,231 --> 00:20:37,924
and test out those technologies.

500
00:20:37,924 --> 00:20:39,891
We have been tracking the space station

501
00:20:39,891 --> 00:20:41,891
with our telescope at Table Mountain.

502
00:20:41,891 --> 00:20:45,891
What we do is we get a GPS state from GPS,

503
00:20:45,891 --> 00:20:47,693
same way you get it on your iPhone,

504
00:20:47,693 --> 00:20:49,231
and we use that to predict

505
00:20:49,231 --> 00:20:52,561
where the ISS is going to be in the sky from our telescope.

506
00:20:52,561 --> 00:20:55,891
And so we've tracked the ISS on our telescope, overhead,

507
00:20:55,891 --> 00:20:58,594
early in the morning when it's dark on the ground

508
00:20:58,594 --> 00:21:00,594
but the ISS is lit up by the sun,

509
00:21:00,594 --> 00:21:03,066
so we can actually see the ISS passing through our telescope,

510
00:21:03,066 --> 00:21:04,231
which is pretty neat to see.

511
00:21:04,231 --> 00:21:05,396
So, the next time we'll do this,

512
00:21:05,396 --> 00:21:07,000
we'll see a laser pointing back down at us,

513
00:21:07,000 --> 00:21:09,792

sending data down to the ground, which will be very exciting.

514
00:21:14,330 --> 00:21:16,396
-We have, right now,

515
00:21:16,396 --> 00:21:20,396
13 schools that participated last year,

516
00:21:20,396 --> 00:21:24,429
flew on the zero-gravity plane out of Ellington Field,

517
00:21:24,429 --> 00:21:30,891
and of them, one school was selected this year

518
00:21:30,891 --> 00:21:33,198
and two in previous years

519
00:21:33,198 --> 00:21:36,957
to go to the International Space Station.

520
00:21:36,957 --> 00:21:40,858
However, none have reached that spot yet.

521
00:21:40,858 --> 00:21:43,561
All three schools are working on it,

522
00:21:43,561 --> 00:21:47,726
but we have yet to send one to the ISS.

523
00:21:47,726 --> 00:21:49,264
-But it's a learning process, right?

524
00:21:49,264 --> 00:21:50,561
The whole thing --

525
00:21:50,561 --> 00:21:52,759
the procedures, working with NASA --

526
00:21:52,759 --> 00:21:54,693
It's all a learning experience for these kids.

527
00:21:54,693 --> 00:21:57,066
-It's a huge learning experience,

528
00:21:57,066 --> 00:22:02,165
and the schools who have been selected

529
00:22:02,165 --> 00:22:05,099
have actually been working for --

530
00:22:05,099 --> 00:22:07,165
two of them for five years.

531
00:22:07,165 --> 00:22:09,759
So, every year they fly on the zero-gravity plane,

532
00:22:09,759 --> 00:22:11,429
they improve their experiment.

533
00:22:11,429 --> 00:22:12,759
-I'm astronaut Alvin Drew

534
00:22:12,759 --> 00:22:14,231
aboard the Space Shuttle Discovery.

535
00:22:14,231 --> 00:22:15,891
I'd like to read you a bedtime story.

536
00:22:15,891 --> 00:22:17,858
This one is called "Max Goes to the Moon"

537
00:22:17,858 --> 00:22:20,495
by Jeffrey Bennett, illustrated by Alan Okamoto.

538
00:22:20,495 --> 00:22:22,132

-A really cool moment for you, though,

539
00:22:22,132 --> 00:22:24,726
was when an astronaut read your book from space, right?

540
00:22:24,726 --> 00:22:26,759
-That was a pretty incredible moment

541
00:22:26,759 --> 00:22:29,198
when I got the phone call from Patricia Tribe

542
00:22:29,198 --> 00:22:30,825
saying that Alvin Drew

543
00:22:30,825 --> 00:22:33,000
would like to read one of my books from space.

544
00:22:33,000 --> 00:22:35,000
I didn't believe it was a real phone call,

545
00:22:35,000 --> 00:22:37,462
and once I finally accepted that it was,

546
00:22:37,462 --> 00:22:39,594
I sent them the PDF, in that case,

547
00:22:39,594 --> 00:22:41,528
and Astronaut Drew read the book

548
00:22:41,528 --> 00:22:44,858
from the final mission of the Space Shuttle Discovery,

549
00:22:44,858 --> 00:22:47,099
and that's posted up on YouTube.

550
00:22:47,099 --> 00:22:48,561
-The thing about the book is

551
00:22:48,561 --> 00:22:50,297
it's not just a children's book.

552
00:22:50,297 --> 00:22:53,264
I mean, the basic story itself is, you know, meant

553
00:22:53,264 --> 00:22:55,825
so that, you know, children 2, 3, or 4 years old

554
00:22:55,825 --> 00:22:57,198
can enjoy the story and see the great pictures,

555
00:22:57,198 --> 00:22:58,363
but on the side,

556
00:22:58,363 --> 00:22:59,957
there are these things called "Big Kid Science"

557
00:22:59,957 --> 00:23:02,297
where they go into all the actual physics

558
00:23:02,297 --> 00:23:03,495
and things like that.

559
00:23:03,495 --> 00:23:04,957
So, you know, if you're like me,

560
00:23:04,957 --> 00:23:07,000
when I used to have my favorite kids' books I grew up with,

561
00:23:07,000 --> 00:23:08,264
and when you're 12 or 13,

562
00:23:08,264 --> 00:23:10,396
you don't want to pull those books back off the shelf

563
00:23:10,396 --> 00:23:12,462

because, like, even though you might still like the pictures

564
00:23:12,462 --> 00:23:13,264
and everything...

565
00:23:13,264 --> 00:23:14,429
So now you've got an excuse

566
00:23:14,429 --> 00:23:16,132
to pull the book off the shelf and go,

567
00:23:16,132 --> 00:23:17,924
"I'm reading up on the science here, man.

568
00:23:17,924 --> 00:23:19,429
That's why I've got the book back off."

569
00:23:19,429 --> 00:23:21,495
So even now, it's got good science in it,

570
00:23:21,495 --> 00:23:23,495
and I like pulling it down off the shelf

571
00:23:23,495 --> 00:23:25,924
and pretending that I'm getting science out of it, too.

572
00:23:25,924 --> 00:23:27,891
-Hi. I'm NASA astronaut Mike Hopkins

573
00:23:27,891 --> 00:23:30,099
on board the International Space Station,

574
00:23:30,099 --> 00:23:32,330
and it's one of my favorite times.

575
00:23:32,330 --> 00:23:33,957
It's story time from space.

576
00:23:33,957 --> 00:23:37,264
-Hi. I am JAXA astronaut Koichi Wakata.

577
00:23:37,264 --> 00:23:40,957
Welcome to story time from space.

578
00:23:40,957 --> 00:23:42,792
-Well, after Astronaut Drew

579
00:23:42,792 --> 00:23:45,957
read "Max Goes to the Moon" from the Discovery,

580
00:23:45,957 --> 00:23:47,891
that was sort of a pilot project,

581
00:23:47,891 --> 00:23:52,099
and Patricia Tribe went out with the demo tape

582
00:23:52,099 --> 00:23:55,528
and polled a lot of teachers and looked into it,

583
00:23:55,528 --> 00:23:57,660
and people were real excited about the idea.

584
00:23:57,660 --> 00:24:01,462
And then CASIS got excited about the idea, as well,

585
00:24:01,462 --> 00:24:05,066
and they decided they would take all five of my children's books

586
00:24:05,066 --> 00:24:08,924
up to the station to be read from the cupola up there.

587
00:24:08,924 --> 00:24:11,099
So, it's the four Max books and a fifth one I have

588
00:24:11,099 --> 00:24:13,000

called "The Wizard Who Saved the World,"

589
00:24:13,000 --> 00:24:14,825
which also has a little bit of space in it.

590
00:24:14,825 --> 00:24:16,330
-Aww, I love that.

591
00:24:16,330 --> 00:24:19,165
Now let's hear from NASA's Associate Administrator

592
00:24:19,165 --> 00:24:21,099
for Human Exploration and Operations,

593
00:24:21,099 --> 00:24:22,429
William Gerstenmaier,

594
00:24:22,429 --> 00:24:26,396
about what's to come on the International Space Station.

595
00:24:26,396 --> 00:24:28,891
-One of the crews carried a little --

596
00:24:28,891 --> 00:24:32,462
on their lapel pins or badges, they said,

597
00:24:32,462 --> 00:24:34,000
"Off the Earth, for the Earth,"

598
00:24:34,000 --> 00:24:36,132
and I think that's what, really, station is doing.

599
00:24:36,132 --> 00:24:38,066
The work we're doing in space,

600
00:24:38,066 --> 00:24:41,198
its ultimate benefit is to us here on the Earth,

601
00:24:41,198 --> 00:24:45,198
so, you know, from the areas of the colloidals

602
00:24:45,198 --> 00:24:46,693
that we talked about earlier

603
00:24:46,693 --> 00:24:48,858
and some of the combustion research --

604
00:24:48,858 --> 00:24:52,594
All of these things have very exciting applications

605
00:24:52,594 --> 00:24:54,264
to folks here every day on Earth.

606
00:24:54,264 --> 00:24:56,099
-We're looking into the future, as well.

607
00:24:56,099 --> 00:24:57,924
I mean, we've got, we hope,

608
00:24:57,924 --> 00:25:00,429
a lot more years on space station,

609
00:25:00,429 --> 00:25:02,891
so what does that look like to you?

610
00:25:02,891 --> 00:25:07,033
-Yeah, it's exciting that station's been extended to 2024,

611
00:25:07,033 --> 00:25:08,891
and I think that's really important

612
00:25:08,891 --> 00:25:10,429
to this research community

613
00:25:10,429 --> 00:25:14,066

that they see now a much longer horizon to go do their research

614
00:25:14,066 --> 00:25:18,429
and to really see the fruits of what they do come about.

615
00:25:18,429 --> 00:25:20,561
You know, when we were thinking just 2020,

616
00:25:20,561 --> 00:25:22,033
that's a pretty short horizon.

617
00:25:22,033 --> 00:25:23,330
By the time you build your experiment,

618
00:25:23,330 --> 00:25:24,792
you fly it,

619
00:25:24,792 --> 00:25:26,891
and then you get a chance to see if it works or it doesn't work,

620
00:25:26,891 --> 00:25:28,198
that's pretty short.

621
00:25:28,198 --> 00:25:30,594
But when you think you've got all the way to 2024,

622
00:25:30,594 --> 00:25:32,726
you can get some real results and move forward.

623
00:25:32,726 --> 00:25:35,594
So, you know, hopefully the International Space Station

624
00:25:35,594 --> 00:25:37,693
is used to spawn other space stations.

625
00:25:37,693 --> 00:25:42,561
Hopefully, this space station is kind of the innovation incubator

626
00:25:42,561 --> 00:25:45,726
that gives folks new ideas on how to do research in space

627
00:25:45,726 --> 00:25:48,528
and it actually builds a larger commercial market

628
00:25:48,528 --> 00:25:50,726
for low-Earth-orbit research.

629
00:25:50,726 --> 00:25:52,891
You know, the last thing I would add is

630
00:25:52,891 --> 00:25:54,132
we talked a little bit

631
00:25:54,132 --> 00:25:56,528
about human exploration beyond space station

632
00:25:56,528 --> 00:26:00,099
and what the role is space station has in Mars

633
00:26:00,099 --> 00:26:02,231
and in moon and other activities,

634
00:26:02,231 --> 00:26:04,693
and you can see space station playing a critical role

635
00:26:04,693 --> 00:26:05,858
even in those areas.

636
00:26:05,858 --> 00:26:08,495
So, as we are addressing the human health problems

637
00:26:08,495 --> 00:26:12,297
needed for adaptation for long-duration space flight,

638
00:26:12,297 --> 00:26:14,132

you can see how this space station

639
00:26:14,132 --> 00:26:15,462
is really that first step,

640
00:26:15,462 --> 00:26:17,363
and that first real step in exploration.

641
00:26:17,363 --> 00:26:20,231
So, as we push human presence into the solar system

642
00:26:20,231 --> 00:26:22,561
and we do this thing we call pioneering,

643
00:26:22,561 --> 00:26:24,891
space station is going to play that pivotal role.

644
00:26:24,891 --> 00:26:27,198
So, it's neat to see station.

645
00:26:27,198 --> 00:26:29,264
It's neat to see it in this venue

646
00:26:29,264 --> 00:26:32,858
where we get a chance to see not only the typical NASA research,

647
00:26:32,858 --> 00:26:34,627
we get to see the commercial activity,

648
00:26:34,627 --> 00:26:37,132
and we get to see how station fits in the exploration role

649
00:26:37,132 --> 00:26:38,462
moving forward.

650
00:26:38,462 --> 00:26:40,264
-Finally, while it may not have had

651
00:26:40,264 --> 00:26:42,792
the biggest impact on scientific research this year,

652
00:26:42,792 --> 00:26:44,561
astronauts having a little fun

653
00:26:44,561 --> 00:26:46,759
with water-surface tension in space

654
00:26:46,759 --> 00:26:49,660
certainly made a big splash on the Internet.

655
00:26:49,660 --> 00:26:51,462
Earlier this year, some of the crew

656
00:26:51,462 --> 00:26:54,693
grew a softball-sized ball of water floating in space

657
00:26:54,693 --> 00:26:56,891
and nudged a compact video camera

658
00:26:56,891 --> 00:26:59,891
encased in a waterproof housing into the middle of it.

659
00:26:59,891 --> 00:27:02,528
They also broke out the station's 3-D camera

660
00:27:02,528 --> 00:27:03,891
to record the exercise.

661
00:27:03,891 --> 00:27:06,000
When they sent the images back home,

662
00:27:06,000 --> 00:27:08,165
our television crew edited the footage

663
00:27:08,165 --> 00:27:11,396

and posted both a 3-D version and a regular version

664
00:27:11,396 --> 00:27:13,396
to the agency's YouTube channel.

665
00:27:13,396 --> 00:27:15,429
In a little over two months,

666
00:27:15,429 --> 00:27:18,627
this video received more than two million views.

667
00:27:18,627 --> 00:27:21,495
By the way, that 3-D video camera on station

668
00:27:21,495 --> 00:27:24,561
is part of a legitimate scientific investigation

669
00:27:24,561 --> 00:27:26,330
run here at the Marshall Center

670
00:27:26,330 --> 00:27:28,693
studying why a 3-D video camera in orbit

671
00:27:28,693 --> 00:27:32,594
does not degrade as fast as a traditional video camera.

672
00:27:32,594 --> 00:27:36,165
Right now, regular cameras are replaced every 8 to 12 months

673
00:27:36,165 --> 00:27:39,165
due to the high number of hot or burned-out pixels,

674
00:27:39,165 --> 00:27:43,396
those little white dots you see is some footage from station.

675
00:27:43,396 --> 00:27:46,759
A 3-D camera has virtually zero burned-out pixels,

676
00:27:46,759 --> 00:27:49,000
meaning it can be used a lot longer

677
00:27:49,000 --> 00:27:52,462
and save on the cost of sending up replacement cameras.

678
00:27:52,462 --> 00:27:54,264
The team here, led by Rodney Grubbs,

679
00:27:54,264 --> 00:27:55,660
is looking into the phenomenon

680
00:27:55,660 --> 00:27:57,000
and, at the same time,

681
00:27:57,000 --> 00:27:59,462
helping bring back some incredible images

682
00:27:59,462 --> 00:28:03,000
of our astronauts living and working in space.

683
00:28:03,000 --> 00:28:05,726
And that will do it for our look back at the year in research

684
00:28:05,726 --> 00:28:07,429
on the International Space Station.

685
00:28:07,429 --> 00:28:09,759
Be sure and visit nasa.gov/station

686
00:28:09,759 --> 00:28:11,561
and follow us on social media