1
00:00:00,000 --> 00:00:01,290
[Silence]

2
00:00:01,290 --> 00:00:02,650
>> Josh Byerly: This is
Mission Control Houston.

3
00:00:02,650 --> 00:00:05,290
We're going to be going down
to the NEEMO 16 mission,

4
00:00:05,290 --> 00:00:07,110
which is kicked off, and
it's going to be going

5
00:00:07,110 --> 00:00:09,270
on for the next two weeks.

6
00:00:09,270 --> 00:00:10,810
Yesterday we were
joined by Stan Love.

7
00:00:10,810 --> 00:00:13,190
Today we are lucky to be
joined by Mike Gernhardt

8
00:00:13,190 --> 00:00:15,710
who is the principal
investigator for NEEMO 16.

9
00:00:15,710 --> 00:00:17,530
So Mike, thank you so
much for joining us.

10
00:00:17,530 --> 00:00:19,020
Let's talk about
what's going on today

11
00:00:19,020 --> 00:00:21,640

down there off the
coast of Florida.

12
00:00:21,640 --> 00:00:21,960
>> Mike Gernhardt: Okay.

13
00:00:21,960 --> 00:00:25,260
So what we're trying to do
is jump out into the future,

14
00:00:25,260 --> 00:00:27,540
you know, 15 years and
understand what it's

15
00:00:27,540 --> 00:00:30,280
like at the nuts and bolts
level to work on an asteroid.

16
00:00:30,280 --> 00:00:32,390
And so we've got three
aspects of this mission.

17
00:00:32,390 --> 00:00:35,650
One was a robotic precursor
that we did months ago

18
00:00:35,650 --> 00:00:39,490
to document the remote sensing
of the coral reef in the area

19
00:00:39,490 --> 00:00:41,000
of the Aquarius habitat.

20
00:00:41,000 --> 00:00:43,630
The second element of
that is that we're diving

21
00:00:43,630 --> 00:00:45,200
with these DeepWorker
submersibles

22
00:00:45,200 --> 00:00:49,350
that are highly maneuverable,
single-piloted submersibles,

23
00:00:49,350 --> 00:00:53,160
that are the analog of the
space exploration vehicle

24
00:00:53,160 --> 00:00:55,690
that we're developing
under the AES program.

25
00:00:55,690 --> 00:00:58,810
And then the third aspect
is the saturation crew

26
00:00:58,810 --> 00:01:01,680
who are saturated in the
Aquarius habitat, and the route,

27
00:01:01,680 --> 00:01:05,400
investigating different methods
of restraint, translation,

28
00:01:05,400 --> 00:01:07,770
and different sampling
techniques for what it would be

29
00:01:07,770 --> 00:01:10,100
like to actually
work on an asteroid.

30
00:01:10,100 --> 00:01:14,310
And today they're on Day
Two of the EVA only circuit.

31
00:01:14,310 --> 00:01:17,460
As we said, we've actually
developed an underwater

32
00:01:17,460 --> 00:01:20,310
asteroid, that's
about 500 feet across,

33
00:01:20,310 --> 00:01:22,580
and there's all these
different sampling flights

34
00:01:22,580 --> 00:01:26,600
that we're using consistently
with different restraint

35
00:01:26,600 --> 00:01:29,200
and translation techniques.

36
00:01:29,200 --> 00:01:30,940
>> Josh Byerly: Let's talk
about translation a little bit.

37
00:01:30,940 --> 00:01:32,700
You know, it sounds like
something that would be

38
00:01:32,700 --> 00:01:34,130
so easy here on earth,

39
00:01:34,130 --> 00:01:37,880
but anybody who has watched a
Space Station spacewalk knows

40
00:01:37,880 --> 00:01:39,880
that, you know, moving
around and figuring out where

41
00:01:39,880 --> 00:01:42,030
to put your hands and
your feet is, you know,

42

00:01:42,030 --> 00:01:43,800
one of the biggest challenges
of doing a spacewalk.

43
00:01:43,800 --> 00:01:46,390
So talk a little bit about
how that's different.

44
00:01:46,390 --> 00:01:47,930
How is it more challenging
on an asteroid?

45
00:01:47,930 --> 00:01:50,820
And what are you guys
learning in terms of that?

46
00:01:50,820 --> 00:01:51,730
>> Mike Gernhardt:
Yeah, great question.

47
00:01:51,730 --> 00:01:54,610
And I always say, like, asteroid
is like the worst combination

48
00:01:54,610 --> 00:01:56,240
of lunar and microgravity.

49
00:01:56,240 --> 00:01:59,150
On a Space Station we
have complete control

50
00:01:59,150 --> 00:02:00,880
over the translation pads.

51
00:02:00,880 --> 00:02:01,590
We have handholds.

52
00:02:01,590 --> 00:02:03,510
We have all these different
restraints; foot restraints,

53
00:02:03,510 --> 00:02:04,920
body restraint tethers
and so forth.

54
00:02:04,920 --> 00:02:06,530
On an asteroid we
have none of that.

55
00:02:06,530 --> 00:02:10,310
And so we're investigating
laying out translation lines

56
00:02:10,310 --> 00:02:13,460
that we would anchor at one
point, probably fly the SEV

57
00:02:13,460 --> 00:02:16,820
across to another point where
we could anchor that line.

58
00:02:16,820 --> 00:02:19,860
We're trying to understand
how much stability we get

59
00:02:19,860 --> 00:02:21,830
out of these translation
lines and what kinds

60
00:02:21,830 --> 00:02:23,980
of tasks we can do on them.

61
00:02:23,980 --> 00:02:26,040
The other thing we're looking
at is this thing we've invented

62
00:02:26,040 --> 00:02:27,670
that we call the
Lightweight Boom.

63
00:02:27,670 --> 00:02:32,470
And picture this telescopic
boom that we anchor at one end

64
00:02:32,470 --> 00:02:35,600
and then you deploy it, and then
you can anchor the other end

65
00:02:35,600 --> 00:02:38,570
and then you can short
tether yourself to it

66
00:02:38,570 --> 00:02:41,850
or use a body restraint
tether and then reach down

67
00:02:41,850 --> 00:02:46,220
and do the sampling tasks, and
then you can release the anchor

68
00:02:46,220 --> 00:02:50,570
at one end and sort of step
the boom across the asteroid.

69
00:02:50,570 --> 00:02:54,260
Of course, we don't know if we
really can anchor to asteroids

70
00:02:54,260 --> 00:02:55,540
of different characteristics.

71
00:02:55,540 --> 00:02:59,290
So what we're assessing
here is the benefit

72
00:02:59,290 --> 00:03:02,210
of these different
techniques if we could anchor.

73

00:03:02,210 --> 00:03:04,300
And then the third
thing that we're looking

74
00:03:04,300 --> 00:03:09,980
at with the crew today is use of
jet packs, and that looks good

75
00:03:09,980 --> 00:03:12,370
for certain tasks but
not for other tasks.

76
00:03:12,370 --> 00:03:15,160
Later in the mission we're going
to bring the submersibles up

77
00:03:15,160 --> 00:03:16,710
and work with the crew.

78
00:03:16,710 --> 00:03:19,130
And they'll actually be in
foot restraints on the end

79
00:03:19,130 --> 00:03:22,010
of an astronaut positioning
arm on these submersibles

80
00:03:22,010 --> 00:03:23,460
that are the equivalent
of the SEV,

81
00:03:23,460 --> 00:03:27,780
and then we'll repeat the same
circuit with those techniques.

82
00:03:27,780 --> 00:03:29,370
And we're collecting
all these metrics

83
00:03:29,370 --> 00:03:33,300

to understand what the best
combination of restraint

84
00:03:33,300 --> 00:03:36,530
and translation system,
crew size and distribution,

85
00:03:36,530 --> 00:03:40,290
all those kinds of things that
will inform a more optimal

86
00:03:40,290 --> 00:03:42,410
and cost-effective
development of the hardware

87
00:03:42,410 --> 00:03:45,920
when we actually go to an
asteroid or a moon of Mars.

88
00:03:45,920 --> 00:03:47,430
>> Josh Byerly: So you
said the word, jet packs;

89
00:03:47,430 --> 00:03:48,320
so I have to ask about that.

90
00:03:48,320 --> 00:03:49,790
Are we talking about
looking at something

91
00:03:49,790 --> 00:03:52,020
like what Bruce McCandless
used back during

92
00:03:52,020 --> 00:03:53,290
that famous shuttle picture?

93
00:03:53,290 --> 00:03:54,080
Is it sort of like that?

94
00:03:54,080 --> 00:03:55,300
Or what?

95
00:03:55,300 --> 00:03:56,030
>> Mike Gernhardt: Yeah.

96
00:03:56,030 --> 00:03:58,680
So it's quite a bit -- it
will be quite a bit different

97
00:03:58,680 --> 00:04:00,960
than the safer jet packs that
we have on the Space Station.

98
00:04:00,960 --> 00:04:03,480
We'll have a lot more
Delta V. It will be sort

99
00:04:03,480 --> 00:04:07,390
of a nominal thing versus
a contingency thing.

100
00:04:07,390 --> 00:04:10,030
We're simulating that
underwater with a thruster pack

101
00:04:10,030 --> 00:04:14,060
on the back of the crew members.

102
00:04:14,060 --> 00:04:15,540
And we're -- you
know, we're looking

103
00:04:15,540 --> 00:04:18,920
at it today as a jet pack only.

104
00:04:18,920 --> 00:04:22,240
And that's probably not totally
realistic, in the sense, that,

105
00:04:22,240 --> 00:04:24,420
if we didn't have a space
exploration vehicle,

106
00:04:24,420 --> 00:04:27,000
you would have to go
from the deep space hab,

107
00:04:27,000 --> 00:04:30,110
potentially a kilometer or so
away to the asteroid and back.

108
00:04:30,110 --> 00:04:32,270
And if we have to do
that with a jet pack,

109
00:04:32,270 --> 00:04:35,160
it becomes something
more than a jet pack.

110
00:04:35,160 --> 00:04:38,560
It becomes a device that you can
do targeted burns and so forth.

111
00:04:38,560 --> 00:04:41,680
But what's looking
promising from NEEMO 15

112
00:04:41,680 --> 00:04:45,990
and the work we've done in our
asteroid sim is the combination

113
00:04:45,990 --> 00:04:47,900
of this very capable jet pack

114
00:04:47,900 --> 00:04:51,610
and the space exploration
vehicle where astronauts can be

115
00:04:51,610 --> 00:04:55,420
on a positioning arm, or they
can exert off the vehicle

116
00:04:55,420 --> 00:04:58,600
with this jet pack and do
some local reconnaissance,

117
00:04:58,600 --> 00:05:00,650
maybe pick up what we
call a float sample,

118
00:05:00,650 --> 00:05:03,150
which is just a rock that's
not attached to anything.

119
00:05:03,150 --> 00:05:06,510
And then when we have to do
the more detailed, you know,

120
00:05:06,510 --> 00:05:10,370
hammer chip samples or deploy
seismic devices or drills

121
00:05:10,370 --> 00:05:12,570
and so forth, the SEV
would then come in

122
00:05:12,570 --> 00:05:16,060
and the crew members would get
in the astronaut positioning arm

123
00:05:16,060 --> 00:05:19,480
and do the more fine task,
much the same way we do

124
00:05:19,480 --> 00:05:22,280
on Station with the SSR mask.

125

00:05:22,280 --> 00:05:23,560
>> Josh Byerly: You know,
we talked to Stan yesterday

126
00:05:23,560 --> 00:05:26,950
about what it's like to work
in the water and how closely

127
00:05:26,950 --> 00:05:28,430
that mimics what we
would see in space.

128
00:05:28,430 --> 00:05:29,810
Well, I want to get
your take on it too.

129
00:05:29,810 --> 00:05:30,990
What does the water teach us?

130
00:05:30,990 --> 00:05:34,510
And you know, what are sort of
the pros and cons of doing it?

131
00:05:34,510 --> 00:05:36,200
>> Mike Gernhardt: Yeah,
and there are pros and cons.

132
00:05:36,200 --> 00:05:40,150
The good thing about water is
we can be neutrally buoyant.

133
00:05:40,150 --> 00:05:42,450
We do have the viscosity
and the drag of water,

134
00:05:42,450 --> 00:05:45,340
which becomes more of a
factor the faster you go.

135
00:05:45,340 --> 00:05:50,000

So on these very slow
methodical, you know,

136
00:05:50,000 --> 00:05:53,850
close in task, it's actually
a pretty good simulation.

137
00:05:53,850 --> 00:05:56,580
And then as we know from the
Neutral Buoyancy Lab training

138
00:05:56,580 --> 00:06:00,970
that we do, it's about as good
an integrated choreography

139
00:06:00,970 --> 00:06:03,430
simulated environment
as we can get,

140
00:06:03,430 --> 00:06:05,710
but it's not the
only environment.

141
00:06:05,710 --> 00:06:08,440
So we actually have,
within our analog program,

142
00:06:08,440 --> 00:06:11,820
another simulation of an
asteroid where we've integrated

143
00:06:11,820 --> 00:06:15,760
that with the Virtual
Reality Lab and the jet packs

144
00:06:15,760 --> 00:06:19,880
so that we have the proper
dynamics of microgravity.

145
00:06:19,880 --> 00:06:21,570

And so we kind of
-- I always say

146
00:06:21,570 --> 00:06:24,970
that each analog is one chapter
in the story of how we're going

147
00:06:24,970 --> 00:06:25,990
to work on an asteroid.

148
00:06:25,990 --> 00:06:28,210
So we have to do all of
these different analogues

149
00:06:28,210 --> 00:06:31,950
and then put those chapters
together to have the story

150
00:06:31,950 --> 00:06:35,280
of the pass board to
working on an asteroid.

151
00:06:35,280 --> 00:06:37,320
>> Josh Byerly: So what
is ahead for the crew?

152
00:06:37,320 --> 00:06:39,910
I mean, this is early on
in the NEEMO 16 mission.

153
00:06:39,910 --> 00:06:41,060
So what are they going
to be doing for the rest

154
00:06:41,060 --> 00:06:42,210
of this week and next week?

155
00:06:42,210 --> 00:06:44,650
And what's ahead for them?

156
00:06:44,650 --> 00:06:46,670
>> Mike Gernhardt: So they're
doing what we call the EVA only

157
00:06:46,670 --> 00:06:50,440
circuit now, and they're
evaluating again this standard

158
00:06:50,440 --> 00:06:53,470
set of task across this
500 foot, you know,

159
00:06:53,470 --> 00:06:55,970
simulated asteroid under
different techniques.

160
00:06:55,970 --> 00:06:57,600
So they'll be doing
that through Friday.

161
00:06:57,600 --> 00:07:01,590
And then starting Friday,
we bring the submersibles up

162
00:07:01,590 --> 00:07:04,840
and we start doing the same
circuit with the divers,

163
00:07:04,840 --> 00:07:08,070
saturation diver crew
members, on the submersibles

164
00:07:08,070 --> 00:07:10,560
in different combinations
of working

165
00:07:10,560 --> 00:07:12,250
with just an astronaut
positioning arm,

166
00:07:12,250 --> 00:07:13,780
and one crew member outside.

167
00:07:13,780 --> 00:07:18,320
Another condition we call
Condition 6B, is two astronauts

168
00:07:18,320 --> 00:07:21,980
on the submersible or
space exploration vehicle.

169
00:07:21,980 --> 00:07:23,980
One is on the astronaut
positioning arm,

170
00:07:23,980 --> 00:07:25,150
the other is on a jet pack.

171
00:07:25,150 --> 00:07:28,610
And then we have another
variation where they can go on

172
00:07:28,610 --> 00:07:30,630
and off the arm, the
jet packs and so forth.

173
00:07:30,630 --> 00:07:33,760
And again, we have
very specific metrics

174
00:07:33,760 --> 00:07:36,010
by which we evaluate
our performance

175
00:07:36,010 --> 00:07:38,960
and scientific results.

176
00:07:38,960 --> 00:07:41,500
And so then there will be

like four days of that.

177
00:07:41,500 --> 00:07:47,090
There's also some other, like,
science sort of habitability,

178
00:07:47,090 --> 00:07:50,430
psychological experiments that
we're doing inside the habitat.

179
00:07:50,430 --> 00:07:52,520
And of course, I failed
to mention that all

180
00:07:52,520 --> 00:07:57,660
of this is being done with
a 52nd each way time delay,

181
00:07:57,660 --> 00:08:00,090
and that's a big
difference between them,

182
00:08:00,090 --> 00:08:02,830
anything we've done in space
previously and what we're going

183
00:08:02,830 --> 00:08:04,530
to have to do on an asteroid.

184
00:08:04,530 --> 00:08:08,150
And by simulating that, we
really get into the nuts

185
00:08:08,150 --> 00:08:11,030
and bolts of the best way
to manage the operation,

186
00:08:11,030 --> 00:08:13,260
to simulate the data
to do replant

187
00:08:13,260 --> 00:08:13,920
and so forth [Background
Discussion].

188
00:08:13,920 --> 00:08:18,180
And we're learning tons
every day from that.

189
00:08:18,180 --> 00:08:19,400
>> Josh Byerly: It's the
last question for you, Mike.

190
00:08:19,400 --> 00:08:20,610
It's somebody who's
been in space before.

191
00:08:20,610 --> 00:08:23,080
Does it get you excited
as we get,

192
00:08:23,080 --> 00:08:23,920
you know, closer and closer?

193
00:08:23,920 --> 00:08:25,860
I mean, every time you guys do
one of these tests it puts us

194
00:08:25,860 --> 00:08:27,660
that much closer to actually
going and finding one

195
00:08:27,660 --> 00:08:28,630
of these missions in the future.

196
00:08:28,630 --> 00:08:31,580
So what -- yeah, how do you
feel doing something like that?

197

00:08:31,580 --> 00:08:32,050
>> Mike Gernhardt: Yeah.

198
00:08:32,050 --> 00:08:33,260
No, that's a great question.

199
00:08:33,260 --> 00:08:34,360
And it really is exciting

200
00:08:34,360 --> 00:08:35,970
because I think we're
doing this thing right.

201
00:08:35,970 --> 00:08:38,640
We're -- instead of
writing the requirements

202
00:08:38,640 --> 00:08:40,940
and building hardware for
years and years and years

203
00:08:40,940 --> 00:08:43,990
and then figuring out how we're
going to operate at the nuts

204
00:08:43,990 --> 00:08:47,790
and bolts level, you know, our
great team has jumped out ahead,

205
00:08:47,790 --> 00:08:51,700
and we're trying to understand
those operations early enough

206
00:08:51,700 --> 00:08:54,930
that we can inform the design
of cost-effective hardware.

207
00:08:54,930 --> 00:08:57,130
And I'm very optimistic.

208
00:08:57,130 --> 00:09:00,030
I'm actually very pleased
with what we're learning.

209
00:09:00,030 --> 00:09:01,800
You know, if you go back
two and a half years,

210
00:09:01,800 --> 00:09:04,620
no one had the first clue
of how humans were going

211
00:09:04,620 --> 00:09:06,490
to operate on an asteroid.

212
00:09:06,490 --> 00:09:11,560
Now we're talking specific tool
designs and operational methods,

213
00:09:11,560 --> 00:09:14,860
and it does make it
just that much realer.

214
00:09:14,860 --> 00:09:18,240
And then I also am
optimistic, that,

215
00:09:18,240 --> 00:09:20,160
because of the work
we're doing when we go

216
00:09:20,160 --> 00:09:24,090
to develop this hardware, we
can do it more cost effectively.

217
00:09:24,090 --> 00:09:27,040
And I think we need, as an
agency, to learn how to do that,

218

00:09:27,040 --> 00:09:30,620
because we have, you know,
essentially limited funds,

219
00:09:30,620 --> 00:09:33,720
and we need to go and do
exploration with the funds

220
00:09:33,720 --> 00:09:35,950
that we have, and this is
part of that whole process.

221
00:09:35,950 --> 00:09:38,640
>> Josh Byerly: Well,
Mike Gernhardt,

222
00:09:38,640 --> 00:09:40,220
we want to thank
you for joining us.

223
00:09:40,220 --> 00:09:41,850
It's exciting stuff you
guys are doing down there.

224
00:09:41,850 --> 00:09:44,430
We're going to keep watching,
how the team is operating

225
00:09:44,430 --> 00:09:47,450
over the next several days down
there off the coast of Florida.

226
00:09:47,450 --> 00:09:48,730
Of course, if you would
like to follow along

227
00:09:48,730 --> 00:09:51,180
with the NEEMO 16 mission or
check out some of the WebCams

228

00:09:51,180 --> 00:09:53,260
that are currently
broadcasting from the bottom

229
00:09:53,260 --> 00:09:59,060
of the ocean floor, just log
on to www.NASA.gov/Neemo.