1
00:00:01,270 --> 00:00:01,820
>> Brandi Dean: We are back

2
00:00:01,820 --> 00:00:04,430
in the Space Vehicle Mock-Up
Facility, Building 9 here

3
00:00:04,430 --> 00:00:07,040
at Johnson Space Center, where
for the past couple of weeks,

4
00:00:07,040 --> 00:00:10,300
the RATS, Research and
Technology Studies group,

5
00:00:10,300 --> 00:00:12,820
has been simulating a
mission to an asteroid.

6
00:00:12,820 --> 00:00:15,190
We talked last week with a
couple of the specific parts

7
00:00:15,190 --> 00:00:17,610
of the test, and today
we're back to talk

8
00:00:17,610 --> 00:00:18,640
with Andrew Abercromby,

9
00:00:18,640 --> 00:00:21,120
who is the Principal
Investigator for the test.

10
00:00:21,120 --> 00:00:22,900
Thanks so much for
talking with us, Andrew.

11
00:00:22,900 --> 00:00:23,500

>> Andrew Abercromby: Pleasure.

12
00:00:23,500 --> 00:00:25,940
>> Brandi Dean: Okay, so RATS,
Research and Technology Studies,

13
00:00:25,940 --> 00:00:27,580
one of several analogs
that we do.

14
00:00:27,580 --> 00:00:29,480
Tell us why we're doing analogs

15
00:00:29,480 --> 00:00:31,230
and what we're getting
out of this one?

16
00:00:31,230 --> 00:00:33,880
>> Andrew Abercromby:
Okay, so yeah, this is part

17
00:00:33,880 --> 00:00:35,990
of what we call an
Integrated Analogs Program,

18
00:00:35,990 --> 00:00:38,670
where we combine
testing at facilities

19
00:00:38,670 --> 00:00:42,160
such as Johnson Space
Center, mutual buoyancy lab,

20
00:00:42,160 --> 00:00:44,740
as well as field analogs
such as Desert RATS,

21
00:00:44,740 --> 00:00:47,310
which has been right in the
Arizona desert, and NEMO,

22
00:00:47,310 --> 00:00:51,180
which our underwater
analog off of Key Largo.

23
00:00:51,180 --> 00:00:55,080
What we're trying to do
using these analog tests,

24
00:00:55,080 --> 00:00:59,220
is we know that the technologies
that we have affect the way

25
00:00:59,220 --> 00:01:01,540
that we operate when
we're in space.

26
00:01:01,540 --> 00:01:04,460
We know that the way we want to
operate affects the technologies

27
00:01:04,460 --> 00:01:06,980
that we need and what we
need to be able to do for us.

28
00:01:06,980 --> 00:01:09,310
And so by doing tests like this

29
00:01:09,310 --> 00:01:12,490
where we do what we call
Integrated Mission Simulations

30
00:01:12,490 --> 00:01:15,530
where we try and pull
different technologies together,

31
00:01:15,530 --> 00:01:18,580
technologies that are usually
at the prototype stage,

32
00:01:18,580 --> 00:01:21,720
such as the Space Exploration
Vehicle you see behind us,

33
00:01:21,720 --> 00:01:26,510
and have them all work together
in kind of from start to finish

34
00:01:26,510 --> 00:01:29,390
through at least one
phase of a mission,

35
00:01:29,390 --> 00:01:31,890
and then see how those
different technologies interact

36
00:01:31,890 --> 00:01:34,800
with each other, which
things work well together,

37
00:01:34,800 --> 00:01:37,760
which things maybe don't work
well together, which we need,

38
00:01:37,760 --> 00:01:40,300
which maybe we don't need,
and by doing that early

39
00:01:40,300 --> 00:01:43,190
in the design process,
it's relatively quick

40
00:01:43,190 --> 00:01:45,850
and relatively affordable
to make changes,

41
00:01:45,850 --> 00:01:48,490
as well as to decide, hey, maybe
we don't need this technology

42
00:01:48,490 --> 00:01:50,220
after all and instead
we need something

43
00:01:50,220 --> 00:01:54,030
that we previously
hadn't thought about.

44
00:01:54,030 --> 00:01:55,120
And so it's a way

45
00:01:55,120 --> 00:01:58,480
that ultimately we can spend
a little money up front

46
00:01:58,480 --> 00:02:02,580
and have potentially significant
cost and time savings further

47
00:02:02,580 --> 00:02:03,980
on in the development process.

48
00:02:03,980 --> 00:02:06,140
>> Brandi Dean: Right,
so you know early on kind

49
00:02:06,140 --> 00:02:07,550
of what you want
it to look like.

50
00:02:07,550 --> 00:02:08,730
You don't get into
space and say,

51
00:02:08,730 --> 00:02:10,050
I wish I had a window
here, right?

52
00:02:10,050 --> 00:02:11,020

>> Andrew Abercromby: That's
right, that's right, yeah.

53
00:02:11,020 --> 00:02:13,150
The windows actually
are a big part

54
00:02:13,150 --> 00:02:14,800
of the evaluations
we've been doing

55
00:02:14,800 --> 00:02:16,690
with the Space Exploration
Vehicle.

56
00:02:16,690 --> 00:02:20,980
We've gone through -- this
is our Generation 2A Vehicle.

57
00:02:20,980 --> 00:02:24,390
We've had two Generation
1 vehicles before this.

58
00:02:24,390 --> 00:02:26,580
And actually, the windows

59
00:02:26,580 --> 00:02:30,190
on the vehicle behind us
here were generated using --

60
00:02:30,190 --> 00:02:34,880
we did evaluations where we
had a simulation environment,

61
00:02:34,880 --> 00:02:40,280
a large dome onto which we could
project simulations of the moon,

62
00:02:40,280 --> 00:02:45,070
of asteroids, even of Mars,

and then do simulated tasks,

63
00:02:45,070 --> 00:02:47,650
driving, flying, even landing,

64
00:02:47,650 --> 00:02:50,730
and see how the different
configurations of windows,

65
00:02:50,730 --> 00:02:53,130
actually how well
they land themselves

66
00:02:53,130 --> 00:02:54,870
to the different tasks.

67
00:02:54,870 --> 00:02:56,140
And what we're trying to do

68
00:02:56,140 --> 00:02:59,050
with the Space Exploration
Vehicle is have a configuration

69
00:02:59,050 --> 00:03:02,390
that -- you won't have the exact
same vehicle, be able to work

70
00:03:02,390 --> 00:03:07,870
on an asteroid and Mars and the
Moon, but by having a vehicle

71
00:03:07,870 --> 00:03:11,400
that has all of these
potential destinations in mind,

72
00:03:11,400 --> 00:03:15,630
then we can make relatively
small changes to a core concept,

73

00:03:15,630 --> 00:03:17,830
a core module, to
enable exploration

74
00:03:17,830 --> 00:03:19,760
in these different environments.

75
00:03:19,760 --> 00:03:19,870
>> Brandi Dean: Well,

76
00:03:19,870 --> 00:03:21,720
and probably what you're
seeing the background here --

77
00:03:21,720 --> 00:03:24,200
you can't tell much about
it, because the windows

78
00:03:24,200 --> 00:03:27,490
that we're talking about
are covered in video screens

79
00:03:27,490 --> 00:03:30,000
so that we have simulations
of an asteroid

80
00:03:30,000 --> 00:03:33,030
that the crew inside are
seeing as they fly around

81
00:03:33,030 --> 00:03:36,070
and do space walks and
all sorts of things.

82
00:03:36,070 --> 00:03:37,550
>> Andrew Abercromby: That's
right, that's right, yeah.

83
00:03:37,550 --> 00:03:41,070
The screens that are surrounding

the windows right now,

84
00:03:41,070 --> 00:03:42,940
actually displayed on those,

85
00:03:42,940 --> 00:03:46,200
they have a very high
fidelity simulation of Itokawa,

86
00:03:46,200 --> 00:03:49,640
which is a real asteroid,
and actually we used imagery

87
00:03:49,640 --> 00:03:52,880
and data from the Japanese
Space Agency, JAXA,

88
00:03:52,880 --> 00:03:55,010
to help create that simulation.

89
00:03:55,010 --> 00:03:57,290
We have a really fantastic
simulation team here

90
00:03:57,290 --> 00:03:58,300
at Johnson Space Center

91
00:03:58,300 --> 00:04:02,610
who created this
virtual environment.

92
00:04:02,610 --> 00:04:07,140
The pilots inside this SEV
behind us here, they can fly

93
00:04:07,140 --> 00:04:09,560
around this asteroid, they can
interact with it, they can land

94

00:04:09,560 --> 00:04:11,500
on it, and then they
can also see

95
00:04:11,500 --> 00:04:14,520
out of their windows the
space-walking astronauts

96
00:04:14,520 --> 00:04:16,140
who are flying jet packs --

97
00:04:16,140 --> 00:04:18,520
or actually control it from
upstairs in Global 9 here

98
00:04:18,520 --> 00:04:20,550
in the Virtual Reality Lab.

99
00:04:20,550 --> 00:04:23,620
And so really what we're trying
to do, the big part of the test,

100
00:04:23,620 --> 00:04:28,000
is figuring out what's the
most efficient, safest,

101
00:04:28,000 --> 00:04:29,870
the most productive ways

102
00:04:29,870 --> 00:04:32,610
to combine these different
capabilities in asteroid,

103
00:04:32,610 --> 00:04:34,690
a Space Exploration Vehicle.

104
00:04:34,690 --> 00:04:37,000
We have an arm that
can reach out the front

105
00:04:37,000 --> 00:04:39,730
and actually support an
astronaut on the end of it,

106
00:04:39,730 --> 00:04:43,240
so providing them stability
to geological sampling tasks.

107
00:04:43,240 --> 00:04:45,490
>> Brandi Dean: Kind of like,
Canadarm2 on Space Station?

108
00:04:45,490 --> 00:04:48,090
>> Andrew Abercromby: A shorter
version of that, if you like.

109
00:04:48,090 --> 00:04:52,160
Or do we have astronauts
on jet packs be delivered

110
00:04:52,160 --> 00:04:54,550
to the right area by the
Space Exploration Vehicle

111
00:04:54,550 --> 00:04:55,940
and then depart from that,

112
00:04:55,940 --> 00:04:58,090
which is what they're
doing today actually.

113
00:04:58,090 --> 00:05:00,790
They fly close in the
SEV and then once they're

114
00:05:00,790 --> 00:05:04,010
in the proximity, they go to
their jet pack mode, go down,

115

00:05:04,010 --> 00:05:05,550
grab a rock and then
return to the SEV.

116
00:05:05,550 --> 00:05:06,860
So we're really trying

117
00:05:06,860 --> 00:05:11,190
to understand what are the most
efficient productive modes,

118
00:05:11,190 --> 00:05:15,640
how about face crew workloads,
are there potential hazards

119
00:05:15,640 --> 00:05:18,900
of operating one way versus
another, and then also

120
00:05:18,900 --> 00:05:20,440
with that the amount
of propellant

121
00:05:20,440 --> 00:05:23,140
that we would need based
on these different options.

122
00:05:23,140 --> 00:05:26,650
And from that data we then
figure out, what does that mean

123
00:05:26,650 --> 00:05:29,970
for our vehicle design for the
technologies that we require.

124
00:05:29,970 --> 00:05:31,050
>> Brandi Dean: And I know many

125
00:05:31,050 --> 00:05:32,150
of these questions

you've been looking

126
00:05:32,150 --> 00:05:33,680
at over the course
of several tests.

127
00:05:33,680 --> 00:05:35,370
Do you feel like
you're learning stuff

128
00:05:35,370 --> 00:05:37,360
and moving toward
a better product?

129
00:05:37,360 --> 00:05:37,810
>> Andrew Abercromby:
Yeah, yeah.

130
00:05:37,810 --> 00:05:41,680
So with respect to asteroids in
particular, it's been a couple

131
00:05:41,680 --> 00:05:43,420
of years now that we've
been looking at those.

132
00:05:43,420 --> 00:05:45,650
I personally didn't know a
great deal about asteroids

133
00:05:45,650 --> 00:05:48,290
when we started looking at
this a couple of years back.

134
00:05:48,290 --> 00:05:52,070
Now we actually feel that
we have a pretty good handle

135
00:05:52,070 --> 00:05:56,630
on at least the big pieces that

we would need to explore safely

136
00:05:56,630 --> 00:05:58,430
and productively an asteroid.

137
00:05:58,430 --> 00:06:03,040
And with tests like this, we are
starting to figure out, okay,

138
00:06:03,040 --> 00:06:04,800
with those big pieces,
what specifically,

139
00:06:04,800 --> 00:06:06,830
what are the smaller
pieces that we require,

140
00:06:06,830 --> 00:06:11,420
things like software, control
systems, guidance modes,

141
00:06:11,420 --> 00:06:13,500
how big do the tanks
need to be in terms

142
00:06:13,500 --> 00:06:15,390
of propellant, things like that.

143
00:06:15,390 --> 00:06:21,510
And so we're getting closer
to a well-defined package

144
00:06:21,510 --> 00:06:24,790
of how we would explore an
asteroid when the time comes.

145
00:06:24,790 --> 00:06:26,050
>> Brandi Dean: Would
you say that you found

146
00:06:26,050 --> 00:06:28,410
out anything you weren't
expecting throughout

147
00:06:28,410 --> 00:06:30,600
these tests?

148
00:06:30,600 --> 00:06:32,310
>> Andrew Abercromby:
There have been --

149
00:06:32,310 --> 00:06:34,550
we're still at a stage now where
we're testing at the moment.

150
00:06:34,550 --> 00:06:40,800
We're still collecting data, so
it's a little early to draw any,

151
00:06:40,800 --> 00:06:42,020
to make any bold statements

152
00:06:42,020 --> 00:06:44,080
about what we've
learned in this test.

153
00:06:44,080 --> 00:06:47,020
There was a kind of
one day of testing

154
00:06:47,020 --> 00:06:48,810
where we focused
specifically on for example,

155
00:06:48,810 --> 00:06:53,050
the effect of the spin rate of
an asteroid and then how far --

156
00:06:53,050 --> 00:06:54,410

basically how large
of an asteroid

157
00:06:54,410 --> 00:06:57,760
that we're exploring on, and the
effect that has on the amount

158
00:06:57,760 --> 00:07:01,230
of propellant that we need, the
workload of the pilots in terms

159
00:07:01,230 --> 00:07:04,280
of trying to just
position a vehicle

160
00:07:04,280 --> 00:07:06,630
over a specific point
on an asteroid.

161
00:07:06,630 --> 00:07:10,130
And actually as we hypothesized,

162
00:07:10,130 --> 00:07:13,830
we found that it became a
harder task for our pilots

163
00:07:13,830 --> 00:07:16,030
as they were trying to
station people over the larger,

164
00:07:16,030 --> 00:07:17,550
faster spinning asteroids.

165
00:07:17,550 --> 00:07:20,060
But not only that, we were
able to quantify, we were able

166
00:07:20,060 --> 00:07:22,640
to measure the amount of
propellant that we would need

167
00:07:22,640 --> 00:07:26,060
to station people for a
period of time as a function

168
00:07:26,060 --> 00:07:27,750
of asteroid size and spin rate.

169
00:07:27,750 --> 00:07:29,990
So that's the kind of
data that really allows us

170
00:07:29,990 --> 00:07:35,220
to have more confidence when
we're trying to size the systems

171
00:07:35,220 --> 00:07:40,380
for this vehicle and have
confidence that when we go

172
00:07:40,380 --> 00:07:42,140
to an asteroid one
day, we will --

173
00:07:42,140 --> 00:07:44,470
we're going to be
able to operate

174
00:07:44,470 --> 00:07:45,900
for the full mission duration

175
00:07:45,900 --> 00:07:48,860
and have sized our
systems appropriately.

176
00:07:48,860 --> 00:07:49,390
>> Brandi Dean: Okay.

177
00:07:49,390 --> 00:07:50,270

Very interesting.

178
00:07:50,270 --> 00:07:52,790
Just with the Space
Exploration Vehicle itself,

179
00:07:52,790 --> 00:07:55,320
when we first started
talking about Rovers again,

180
00:07:55,320 --> 00:07:58,610
it was just a chassis
-- very cool chassis --

181
00:07:58,610 --> 00:08:00,880
but one that you drove in
a spacesuit standing up,

182
00:08:00,880 --> 00:08:05,200
and now we have a cabin
that people live in for days

183
00:08:05,200 --> 00:08:08,130
and even weeks at a time
and learning more and more

184
00:08:08,130 --> 00:08:11,020
about the best way to do that
once it is time to go out,

185
00:08:11,020 --> 00:08:14,070
back to, outside of
Earth's orbit again.

186
00:08:14,070 --> 00:08:15,470
>> Andrew Abercromby: That's
right, that's right, yeah.

187
00:08:15,470 --> 00:08:20,480
And those developments,

the evolving shape

188
00:08:20,480 --> 00:08:22,010
of the Space Exploration Vehicle

189
00:08:22,010 --> 00:08:24,110
and the capabilities
are a very good example

190
00:08:24,110 --> 00:08:27,540
of how we're using this
kind of testing to kind

191
00:08:27,540 --> 00:08:29,910
of incrementally get smarter

192
00:08:29,910 --> 00:08:33,110
about these different
destinations and have confidence