1
00:00:02,510 --> 00:00:05,730
>> I am joined now by Nic Radford
who's the Deputy Project Manager

2
00:00:05,730 --> 00:00:07,760
for Robonaut here at the Johnson Space Center.

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00:00:07,760 --> 00:00:11,980
You and your team, Nic, have been watching along
this morning as Dan sort of checks out Robonaut,

4
00:00:11,980 --> 00:00:14,450
make sure that the joints are working
and everything, so it's got to pretty,

5
00:00:14,450 --> 00:00:17,480
pretty exciting for your team to see
all this actually happening today.

6
00:00:17,480 --> 00:00:22,060
>> Yeah. Absolutely, it's, it is
incredibly exciting from our point of view.

7
00:00:22,060 --> 00:00:26,760
This is -- actually today
was, was pretty monumental,

8
00:00:26,760 --> 00:00:30,560
this was the end of a long series of, of
checkouts that we've been going through trying

9
00:00:30,560 --> 00:00:35,180
to get all the degrees of freedom or the, you
know, the places that the robot can move up

10
00:00:35,180 --> 00:00:38,010
and running and so over the last four
or five times we've been running it,

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00:00:38,010 --> 00:00:41,950
we've been incrementing our way towards
that, but just finally today, we,

12
00:00:41,950 --> 00:00:44,090
we've been able to run all the
degrees of freedom of the robot.

13
00:00:44,090 --> 00:00:47,610
We got all of them to move and they,
they're checking out very successfully.

14
00:00:47,610 --> 00:00:51,110
So yeah, it's, it's a very exciting
for, for the ground controllers.

15
00:00:51,110 --> 00:00:52,420
>> So what is Danny going to be doing today?

16
00:00:52,420 --> 00:00:55,120
He's basically going to be moving the joints
around, like you said, the degrees of freedom,

17
00:00:55,120 --> 00:00:57,900
making sure they bend like they're
expected to and then he's going to do sort

18
00:00:57,900 --> 00:01:00,080
of like a force test or something
on the forearms, right?

19
00:01:00,080 --> 00:01:05,000
>> Yeah. So what -- after we just completed
all the, the checkouts of the joints,

20
00:01:05,000 --> 00:01:07,300
Dan is now going to go through
and we've got all these,

21
00:01:07,300 --> 00:01:09,150

we've got four sensors all over the robot.

22
00:01:09,150 --> 00:01:11,840
The joints themselves measure force and the,

23
00:01:11,840 --> 00:01:15,190
and there's actually four sensors
that are cross checking those.

24
00:01:15,190 --> 00:01:19,670
So what Dan is doing is he's making sure that
those values are reading as we expect them.

25
00:01:19,670 --> 00:01:24,740
They're going to read within the limits that we
need them to and they're helping us determine,

26
00:01:24,740 --> 00:01:31,390
you know, characterizing the, the, the lack
of gravity that, that obviously isn't there,

27
00:01:31,390 --> 00:01:37,980
and so it's giving us all the, the scientific
insight that we need to make sure that the,

28
00:01:37,980 --> 00:01:42,160
the safety systems of the robot
are, are working properly.

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00:01:42,160 --> 00:01:44,640
>> There's a task board, like let's,
let's explain this for the public.

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00:01:44,640 --> 00:01:47,270
There's a task board that basically once
everything gets checked out on Robonaut,

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00:01:47,270 --> 00:01:51,530
they he's going to be kind of doing
his own sort of thing with this,

32
00:01:51,530 --> 00:01:52,850
with this project board that's in front of him.

33
00:01:52,850 --> 00:01:55,070
Can you kind of talk a little bit -- I
think we've got some video of it, but,

34
00:01:55,070 --> 00:01:58,070
but we kind of talked about about what
he's going to be doing once you guys kind

35
00:01:58,070 --> 00:01:59,600
of give the stamp of approval on him.

36
00:01:59,600 --> 00:02:03,540
>> Right. So we've been using this task
board on the ground to essentially program

37
00:02:03,540 --> 00:02:08,110
in the behaviors and the, the reflexive
behaviors and the knowledge that the robot needs

38
00:02:08,110 --> 00:02:12,710
in order to do useful work for the crew,
ultimately that's our, our, our goal is to,

39
00:02:12,710 --> 00:02:18,090
is to make sure that this robot can assist the
crew in, in ways that are going to aid them.

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00:02:18,090 --> 00:02:23,050
And so we've got a variety of things up on the,
on the task board buttons and switches and,

41
00:02:23,050 --> 00:02:27,970
and levers and, and buckles and straps that
you're going to find on the space station

42

00:02:27,970 --> 00:02:31,460
and so what we're doing is we're doing we're
doing research on the ground in order to program

43
00:02:31,460 --> 00:02:34,870
in the intelligence to the robot, but
what we need to understand is how,

44
00:02:34,870 --> 00:02:37,730
how things change in zero gravity.

45
00:02:37,730 --> 00:02:40,090
They're -- the first series
of checkouts that we did

46
00:02:40,090 --> 00:02:44,860
with the robot were actually tuning the
gains for the robot, for the differences of,

47
00:02:44,860 --> 00:02:50,420
of one gravity that we have down here on earth,
and the zero gravity that the crew operates in.

48
00:02:50,420 --> 00:02:54,830
So, we need to repeat what we've
learned on the ground in orbit,

49
00:02:54,830 --> 00:03:00,160
making sure that there's no surprises and,
and that everything's going to work properly.

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00:03:00,160 --> 00:03:02,950
>> So we're seeing it here, this is exactly
what he'll be doing in space, right?

51
00:03:02,950 --> 00:03:08,590
>> Yeah. So, you know, the crew does a
variety of things that, that are, you know,

52
00:03:08,590 --> 00:03:14,050

that cover the gamut of, of the, of the
mundane to the crazy exciting, right?

53
00:03:14,050 --> 00:03:20,650
And what we're trying to do is, is help the crew
relieve them of some time that they don't need

54
00:03:20,650 --> 00:03:23,990
to focus on the things that are just
housekeeping types of activities.

55
00:03:23,990 --> 00:03:26,510
For example, one of the activities
that's coming up is

56
00:03:26,510 --> 00:03:29,790
to take air velocity measurements
with a VelociCalc.

57
00:03:29,790 --> 00:03:33,080
Well, the crew, you know,
has to spend a certain amount

58
00:03:33,080 --> 00:03:36,600
of their time taking these air measurements
and when they take these air measurements,

59
00:03:36,600 --> 00:03:44,060
they have to hold really still and so robots
can hold really still really well, and so these,

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00:03:44,060 --> 00:03:47,180
this tool that the crew uses was
designed for a human, you know,

61
00:03:47,180 --> 00:03:48,980
it's got buttons, it's got a handle.

62
00:03:48,980 --> 00:03:53,300
And having a robot that has

the same type of shape and form

63
00:03:53,300 --> 00:03:56,100
of a human can just straightaway
use the same tools.

64
00:03:56,100 --> 00:04:00,210
And so now we're going to offload that activity
to the robot so we can get the crew back

65
00:04:00,210 --> 00:04:03,830
into the science related activities where
they're not just checking air quality

66
00:04:03,830 --> 00:04:07,920
for the space station or they're not, you
know, housekeeping the space station, they're,

67
00:04:07,920 --> 00:04:11,510
they're onto the science that, that,
that we want them up there doing.

68
00:04:11,510 --> 00:04:17,210
And so this, this relationship between
the crew and, and the robot is going

69
00:04:17,210 --> 00:04:19,450
to prove incredibly valuable in the future.

70
00:04:19,450 --> 00:04:21,620
>> What are the lights that you see
in his hand there, and [inaudible]

71
00:04:21,620 --> 00:04:25,290
>> That's pretty much bling, really.

72
00:04:25,290 --> 00:04:29,450
So they're, they're indications
that are certain electronics

73
00:04:29,450 --> 00:04:32,280
in the boards are reading
the sensors in the hand,

74
00:04:32,280 --> 00:04:37,000
so the hand is this incredibly
sensate device, it's, it's got just,

75
00:04:37,000 --> 00:04:43,360
just as you can have an incredible, this
incredibly delicate sensation of feeling

76
00:04:43,360 --> 00:04:45,120
when you're touching things
and so does the robot.

77
00:04:45,120 --> 00:04:50,430
And so what really sets this robot apart from
other robots you might see is its ability

78
00:04:50,430 --> 00:04:56,300
to perceive forces in its, you know,
from interacting with its environment.

79
00:04:56,300 --> 00:04:56,590
>> Okay.

80
00:04:56,590 --> 00:04:58,310
>> So if you want to actually do anything

81
00:04:58,310 --> 00:05:01,360
and what we've really designed
this robot to do is to do work.

82
00:05:01,360 --> 00:05:07,050
So if you actually want to do anything, you have
to have this, this, this perception of forces

83
00:05:07,050 --> 00:05:09,830

and so, you know, this robot
can grab something and based

84
00:05:09,830 --> 00:05:13,910
on the tactile information it's getting in
its hand estimate the pose of that object.

85
00:05:13,910 --> 00:05:18,550
So, you know, it can tell whether it has a
good grip, whether it needs to change its grip,

86
00:05:18,550 --> 00:05:21,320
what the size of the object is,
the orientation of the object

87
00:05:21,320 --> 00:05:24,110
and so this robot is just full
of all those types of sensors.

88
00:05:24,110 --> 00:05:25,070
>> It really can touch.

89
00:05:25,070 --> 00:05:26,010
>> Yeah, absolutely it can touch.

90
00:05:26,010 --> 00:05:27,110
It can feel.

91
00:05:27,110 --> 00:05:27,500
Yes.

92
00:05:27,500 --> 00:05:28,220
>> That's fascinating.

93
00:05:28,220 --> 00:05:29,400
Let's talk about the design of it,

94
00:05:29,400 --> 00:05:33,510
'cause I think the first time I ever encountered

this was, was here in our mockup facility here

95
00:05:33,510 --> 00:05:37,180
at the Johnson Space Center, back a couple
of years before it ever flew and one thing

96
00:05:37,180 --> 00:05:40,430
that you guys taught us, which I found
very interesting is that, you know,

97
00:05:40,430 --> 00:05:42,610
it looks humanoid, but, but that's for a reason.

98
00:05:42,610 --> 00:05:46,280
It's not just because it looks cool, it's
because once you start adding serial vision,

99
00:05:46,280 --> 00:05:50,350
you've got two cameras and so it starts
to kind of take on a human, a human shape.

100
00:05:50,350 --> 00:05:50,810
>> Exactly.

101
00:05:50,810 --> 00:05:55,570
So the, the anthropomorphic shape
of the robot is absolutely by design

102
00:05:55,570 --> 00:06:01,060
because we've designed a robot to interface
and interact with all the same tools

103
00:06:01,060 --> 00:06:07,900
and the same structured environment and, and
just all the same objects that you and I do.

104
00:06:07,900 --> 00:06:11,540
Well, we've adapted our environment to
the human form, so what we don't want

105
00:06:11,540 --> 00:06:14,900
to do is design a whole new set
of stuff for our robot, right?

106
00:06:14,900 --> 00:06:15,440
>> Right.

107
00:06:15,440 --> 00:06:19,490
>> So, for example, the space tools,
there's a lot of money in space tools

108
00:06:19,490 --> 00:06:22,950
and NASA has a huge investment in
the qualification of these tools,

109
00:06:22,950 --> 00:06:27,060
so you could go build a robot and then
go build a whole separate suite of tools,

110
00:06:27,060 --> 00:06:28,970
or you could build a robot
that just happens to be able

111
00:06:28,970 --> 00:06:30,890
to use the same tools that the crew does.

112
00:06:30,890 --> 00:06:31,460
>> Same form.

113
00:06:31,460 --> 00:06:35,640
>> Yeah. The same form, and so -- and plus
when you're interacting with the robot,

114
00:06:35,640 --> 00:06:39,320
you have this sense of, you
have this intuitive sense

115
00:06:39,320 --> 00:06:42,810
about how the robot's going to

move when it looks like you.

116
00:06:42,810 --> 00:06:46,560
I mean, if it was some odd shaped robot
that was optimized for some specific task,

117
00:06:46,560 --> 00:06:49,540
you might be a little uneasy when you're
trying to work with it because you're --

118
00:06:49,540 --> 00:06:52,010
it's not, it's not going to
move in an intuitive way.

119
00:06:52,010 --> 00:06:52,400
>> Right.

120
00:06:52,400 --> 00:06:56,110
>> And so when it's got two hands and
two arms and a head that sits right,

121
00:06:56,110 --> 00:07:00,490
right above its shoulders, when it hands
you something, you know exactly the motion

122
00:07:00,490 --> 00:07:02,850
that it's going to give you that object with.

123
00:07:02,850 --> 00:07:09,160
And so that sense of security and
comfort is very important to us designers

124
00:07:09,160 --> 00:07:13,690
because we want the crew to use this robotic
tool and we want them to use it a lot.

125
00:07:13,690 --> 00:07:16,360
And so it needs to be comfort, or
comfortable for them to work with.

126
00:07:16,360 --> 00:07:19,030
>> So, let's talk long term
plans, what, you know,

127
00:07:19,030 --> 00:07:21,360
five years down the line,
what you see Robonaut doing?

128
00:07:21,360 --> 00:07:28,430
>> Oh, we've -- we are very interested in
and we're very motivated to get this robot

129
00:07:28,430 --> 00:07:33,890
in an EVA setting and so what we're doing
IVA right now is preparing for that.

130
00:07:33,890 --> 00:07:39,070
And we're, we're putting the robot up in a, in a
more of a structured environment, being able to,

131
00:07:39,070 --> 00:07:47,310
you know, place objects near it, being able
to investigate how the robot's interacting

132
00:07:47,310 --> 00:07:52,530
with things and we're going to prove out the,
the operational concept for this robot, IVA,

133
00:07:52,530 --> 00:07:57,030
to show its value that will have EVA.

134
00:07:57,030 --> 00:08:03,580
With the, with the absence of the space shuttle,
the crew has a very limited EVA schedule coming

135
00:08:03,580 --> 00:08:09,160
out of the space station and what we feel
might be very advantageous for the crew is

136

00:08:09,160 --> 00:08:13,980
to have a robot resident on the outside of
the space station that the crew could operate.

137
00:08:13,980 --> 00:08:18,750
And so now, you don't have to save up all these
different activities and, and knock them all

138
00:08:18,750 --> 00:08:23,430
out at once or if you have some sort
of, you know, emergency situation,

139
00:08:23,430 --> 00:08:27,810
you might be able to get the robot over to
the situation and just look at what's going

140
00:08:27,810 --> 00:08:30,630
on quicker than what you could
suit up an EVA crew member.

141
00:08:30,630 --> 00:08:40,420
So we really feel this robot has incredible
value once it's EVA and to kind of be the,

142
00:08:40,420 --> 00:08:43,640
the -- a remote pair of eyes for
the crew and a remote pair of hands.

143
00:08:43,640 --> 00:08:48,030
>> Now you guys can actually command this
from the ground or the crew can operate it.

144
00:08:48,030 --> 00:08:51,230
>> And we've actually been training
that on and off today with the crew,

145
00:08:51,230 --> 00:08:55,230
so we've been commanding it from the ground, and
the crew's been commanding it from, from orbit.

146

00:08:55,230 --> 00:08:58,450
So, there's been this kind of
delicate ballet back and forth,

147
00:08:58,450 --> 00:09:02,750
it just depends on what's easier and, you know,
we've been proving that, that concept out of how

148
00:09:02,750 --> 00:09:05,570
to interact with the crew and
how we command it on the ground.

149
00:09:05,570 --> 00:09:08,180
So, yeah, we've been trading
back and forth [inaudible]

150
00:09:08,180 --> 00:09:12,440
>> Okay. So here's my nontechnical question of
the day, whenever you guys command this thing,

151
00:09:12,440 --> 00:09:14,930
is it in realtime, I mean can you actually
steer it in realtime or is it something you have

152
00:09:14,930 --> 00:09:18,410
to kind of input some commands into and then it
gets sent up and then there's sort of the delay.

153
00:09:18,410 --> 00:09:21,270
I mean can you actually, you know, for lack
of a better word, drive it in realtime?

154
00:09:21,270 --> 00:09:24,890
>> Yeah. So, the, the direct teleoperation
mode that you're talking about,

155
00:09:24,890 --> 00:09:29,410
we can do from the ground, but the time delays
are such that, you know, it takes a few seconds

156

00:09:29,410 --> 00:09:32,490
to communicate with the space station once
you go through all the communication hops.

157
00:09:32,490 --> 00:09:35,430
It's not a real practical thing to do.

158
00:09:35,430 --> 00:09:42,310
Now the crew has teleoperation gear on orbit
that they can put on and drive the robot in the,

159
00:09:42,310 --> 00:09:44,850
in the same fashion that you're talking about.

160
00:09:44,850 --> 00:09:48,760
And we could do that on the ground, but the
time delays would make it a little impractical.

161
00:09:48,760 --> 00:09:49,580
>> That's very cool stuff.

162
00:09:49,580 --> 00:09:52,940
Well, keep following along as Robonaut gets
check out today and then we'll have an update

163
00:09:52,940 --> 00:09:54,710
for you tomorrow here on ISS Updates.

164
00:09:54,710 --> 00:09:55,350
Nic, thanks so much.

165
00:09:55,350 --> 00:09:55,660
Appreciate it.

166
00:09:55,660 --> 00:09:56,010
>> No problem.