



1  
00:00:03,889 --> 00:00:02,060  
everybody from Mission Control Houston

2  
00:00:06,019 --> 00:00:03,899  
I'm Josh Byerly I'm joined once again

3  
00:00:08,419 --> 00:00:06,029  
here by Nick Radford who is the deputy

4  
00:00:09,919 --> 00:00:08,429  
project manager for Robonaut if you've

5  
00:00:11,180 --> 00:00:09,929  
been watching our coverage this week you

6  
00:00:13,100 --> 00:00:11,190  
saw quite a bit of activity with

7  
00:00:15,259 --> 00:00:13,110  
Robonaut getting checked out on board by

8  
00:00:16,490 --> 00:00:15,269  
the crew of expedition 30 Nick talked

9  
00:00:18,349 --> 00:00:16,500  
about us a big week for you guys

10  
00:00:20,980 --> 00:00:18,359  
everything went according to plan right

11  
00:00:23,269 --> 00:00:20,990  
yeah it's it's been a tremendous week

12  
00:00:24,460 --> 00:00:23,279  
this this week was special for a couple

13  
00:00:27,849 --> 00:00:24,470

of reasons one we had our first

14

00:00:30,140 --> 00:00:27,859

back-to-back ops so on Tuesday

15

00:00:31,900 --> 00:00:30,150

Valentine's Day we you know got the

16

00:00:35,030 --> 00:00:31,910

control center early in the morning and

17

00:00:38,330 --> 00:00:35,040

set up did our ops and then Tim stowed

18

00:00:40,819 --> 00:00:38,340

it overnight and came back Wednesday

19

00:00:42,650 --> 00:00:40,829

morning and completed our second round

20

00:00:43,959 --> 00:00:42,660

of ops so that was good it was good

21

00:00:45,950 --> 00:00:43,969

training for the ground

22

00:00:47,959 --> 00:00:45,960

you know we envisioned a lot of that

23

00:00:50,209 --> 00:00:47,969

type of operation in the future where we

24

00:00:51,770 --> 00:00:50,219

are you know we wanted we want to do

25

00:00:53,810 --> 00:00:51,780

more and more with this robot which is

26

00:00:55,970 --> 00:00:53,820

gonna require back-to-back activities

27

00:00:59,860 --> 00:00:55,980

like that but Wednesday was tremendously

28

00:01:02,510 --> 00:00:59,870

successful everybody on the ground and

29

00:01:04,340 --> 00:01:02,520

especially the crew in orbit was having

30

00:01:06,560 --> 00:01:04,350

a fantastic time checking out the robot

31

00:01:08,210 --> 00:01:06,570

and we've successfully checked out every

32

00:01:11,510 --> 00:01:08,220

every joint on the robot and every

33

00:01:13,429 --> 00:01:11,520

sensor and big smiles on our face here

34

00:01:17,390 --> 00:01:13,439

in the control center where we had all

35

00:01:19,249 --> 00:01:17,400

the all the systems are good and we were

36

00:01:20,840 --> 00:01:19,259

we are ready to go now talk about what

37

00:01:21,890 --> 00:01:20,850

he were seeing the video now he I mean

38

00:01:23,240 --> 00:01:21,900

there was quite a bit of movement and

39

00:01:25,249 --> 00:01:23,250

activity with his hands and his fingers

40

00:01:27,230 --> 00:01:25,259

in his arm yeah absolutely we've flown a

41

00:01:28,730 --> 00:01:27,240

Robert we've flown a robot for one

42

00:01:30,679 --> 00:01:28,740

primary purpose and that's to do work

43

00:01:33,440 --> 00:01:30,689

and in order to do work we need to have

44

00:01:35,780 --> 00:01:33,450

very capable hands and very sensate

45

00:01:37,429 --> 00:01:35,790

hands and so we are we wanted to make

46

00:01:39,679 --> 00:01:37,439

sure that we got all the degrees of

47

00:01:42,050 --> 00:01:39,689

freedom working in the hands getting all

48

00:01:43,280 --> 00:01:42,060

the data as we expected it and and

49

00:01:44,719 --> 00:01:43,290

making sure that we were going to be

50

00:01:46,969 --> 00:01:44,729

able to complete the tasks that we have

51  
00:01:48,170 --> 00:01:46,979  
scheduled for this robot I think coming

52  
00:01:49,910 --> 00:01:48,180  
up a little bit after this you'll see

53  
00:01:51,920 --> 00:01:49,920  
the famous handshake in space between

54  
00:01:54,920 --> 00:01:51,930  
yeah that was an amazing moment we

55  
00:01:57,200 --> 00:01:54,930  
actually adjusted the timeline slightly

56  
00:01:59,749 --> 00:01:57,210  
because we wanted to make sure we got to

57  
00:02:03,200 --> 00:01:59,759  
this to this handshake but yeah dan dan

58  
00:02:04,550 --> 00:02:03,210  
Burbank was absolutely fantastic and you

59  
00:02:06,859 --> 00:02:04,560  
know Robonaut reaching its hand out

60  
00:02:08,960 --> 00:02:06,869  
sensing all the forces that Dan was

61  
00:02:11,479 --> 00:02:08,970  
going to impart into the robot and then

62  
00:02:13,610 --> 00:02:11,489  
initiating the closure and I believe Dan

63  
00:02:14,000 --> 00:02:13,620

said it was a firm handshake so let's

64

00:02:15,140 --> 00:02:14,010

talk about

65

00:02:16,759 --> 00:02:15,150

you guys were watching this on the

66

00:02:18,649 --> 00:02:16,769

ground you can actually see the data

67

00:02:20,420 --> 00:02:18,659

coming down from robonaut so it's dan

68

00:02:22,520 --> 00:02:20,430

squeeze it and we're gonna keep

69

00:02:24,740 --> 00:02:22,530

everything yeah so we have you know

70

00:02:27,530 --> 00:02:24,750

predetermined limits that the that we

71

00:02:30,319 --> 00:02:27,540

have accepted in the safety community

72

00:02:31,759 --> 00:02:30,329

that the robot is allowed to impart in

73

00:02:33,949 --> 00:02:31,769

its environment let's not forget this is

74

00:02:35,240 --> 00:02:33,959

one of the first payloads ever on the

75

00:02:37,850 --> 00:02:35,250

space station that actually in part

76  
00:02:40,610 --> 00:02:37,860  
forces in its environment so there

77  
00:02:43,369 --> 00:02:40,620  
really wasn't a specification for how to

78  
00:02:45,440 --> 00:02:43,379  
how to fly a payload such as this so we

79  
00:02:46,640 --> 00:02:45,450  
used a lot of the framework from how the

80  
00:02:48,680 --> 00:02:46,650  
crew would interact with the space

81  
00:02:50,509 --> 00:02:48,690  
station and so we've made sure that the

82  
00:02:52,610 --> 00:02:50,519  
robot doesn't import you know anything

83  
00:02:54,920 --> 00:02:52,620  
above its limits and so we record all

84  
00:02:56,869 --> 00:02:54,930  
that data on the ground and make sure

85  
00:02:58,039 --> 00:02:56,879  
that it's that our sensors are always

86  
00:03:00,860 --> 00:02:58,049  
reading the values that they should

87  
00:03:04,009 --> 00:03:00,870  
because it is a very serious it's a very

88  
00:03:05,390 --> 00:03:04,019

serious you know thing we want to we

89

00:03:07,099 --> 00:03:05,400

want to make sure that it's always

90

00:03:08,509 --> 00:03:07,109

remain safe well I mean there's been you

91

00:03:10,039 --> 00:03:08,519

know there's been people on the Twitter

92

00:03:11,390 --> 00:03:10,049

accounts and things like that they they

93

00:03:12,619 --> 00:03:11,400

smile about this because they compared

94

00:03:14,539 --> 00:03:12,629

to either you know one of the Cylons

95

00:03:16,849 --> 00:03:14,549

from Battlestar Galactica or whatever it

96

00:03:19,099 --> 00:03:16,859

is to try to take over the space station

97

00:03:21,170 --> 00:03:19,109

so we you know we're not trying to

98

00:03:23,150 --> 00:03:21,180

promote that too much but fly it away

99

00:03:24,439 --> 00:03:23,160

well I mean you know talk about some of

100

00:03:25,970 --> 00:03:24,449

this because we saw you know one of the

101  
00:03:27,890 --> 00:03:25,980  
crew members just sort of bumped into a

102  
00:03:29,750 --> 00:03:27,900  
little bit before and it shut down yeah

103  
00:03:31,189 --> 00:03:29,760  
absolutely we have a we have a

104  
00:03:34,460 --> 00:03:31,199  
hair-trigger safety system right now

105  
00:03:35,539 --> 00:03:34,470  
that is by design we have when one of

106  
00:03:37,610 --> 00:03:35,549  
the agreements we made with the safety

107  
00:03:39,770 --> 00:03:37,620  
community was it was going to be almost

108  
00:03:42,140 --> 00:03:39,780  
difficult to operate at first because we

109  
00:03:44,059 --> 00:03:42,150  
wanted every small little contact to

110  
00:03:45,229 --> 00:03:44,069  
safe the robot and we wanted to assess

111  
00:03:47,210 --> 00:03:45,239  
what happened and what you're referring

112  
00:03:49,039 --> 00:03:47,220  
to I think is one of the crew members

113  
00:03:50,240 --> 00:03:49,049

was floating by right before we were

114

00:03:52,729 --> 00:03:50,250

getting ready to do the handshake and

115

00:03:55,430 --> 00:03:52,739

just brushed up against the robot and

116

00:03:57,860 --> 00:03:55,440

the robot wasn't expecting it it hit it

117

00:04:00,470 --> 00:03:57,870

in an area we weren't we weren't ready

118

00:04:01,939 --> 00:04:00,480

for for that upcoming task and the robot

119

00:04:04,159 --> 00:04:01,949

said let's shut down

120

00:04:05,539 --> 00:04:04,169

yeah let's restart and so we were

121

00:04:07,550 --> 00:04:05,549

actually very excited to see that

122

00:04:08,930 --> 00:04:07,560

because you know that it operated

123

00:04:10,490 --> 00:04:08,940

exactly the way that it was supposed to

124

00:04:13,699 --> 00:04:10,500

and we recovered really quickly from

125

00:04:15,259 --> 00:04:13,709

that and and so it's it's it's operating

126

00:04:16,279 --> 00:04:15,269

very anomaly oh and it boots back up

127

00:04:18,199 --> 00:04:16,289

pretty fast I mean I don't think my

128

00:04:20,180 --> 00:04:18,209

laptop starts back up as fast as what

129

00:04:21,680 --> 00:04:20,190

you guys had it turned back on and ready

130

00:04:23,089 --> 00:04:21,690

to go with a handshake meet in a matter

131

00:04:25,279 --> 00:04:23,099

of minutes and well that's been a very

132

00:04:27,350 --> 00:04:25,289

interesting learning experience for us

133

00:04:27,610 --> 00:04:27,360

as well because the data connections the

134

00:04:29,860 --> 00:04:27,620

net

135

00:04:31,000 --> 00:04:29,870

connections you know they're not they're

136

00:04:32,620 --> 00:04:31,010

not like being down here

137

00:04:34,840 --> 00:04:32,630

you know operating the robot in the lab

138

00:04:36,550 --> 00:04:34,850

yeah so having to deal with comm

139

00:04:39,070 --> 00:04:36,560

dropouts and refresh rates that are

140

00:04:40,930 --> 00:04:39,080

really slow it's been been a great

141

00:04:42,460 --> 00:04:40,940

learning experience that we're going to

142

00:04:44,920 --> 00:04:42,470

it'll definitely pay

143

00:04:46,629 --> 00:04:44,930

it'll pay dividends in the future for

144

00:04:48,100 --> 00:04:46,639

more complicated operations so let's

145

00:04:49,270 --> 00:04:48,110

talk once again about this taskbar now

146

00:04:51,400 --> 00:04:49,280

we talked about this earlier this week

147

00:04:53,290 --> 00:04:51,410

that there's this sort of kind of an

148

00:04:54,490 --> 00:04:53,300

experiment kit that the robots gonna be

149

00:04:56,050 --> 00:04:54,500

taking you know trying to flip some

150

00:04:57,850 --> 00:04:56,060

switches and do some other things when

151  
00:05:00,159 --> 00:04:57,860  
is that going to happen and what's next

152  
00:05:01,659 --> 00:05:00,169  
yes so we've essentially divided the

153  
00:05:02,980 --> 00:05:01,669  
operations the robot into two stages

154  
00:05:05,020 --> 00:05:02,990  
when we have all these free space

155  
00:05:06,430 --> 00:05:05,030  
motions right and then the second stage

156  
00:05:10,060 --> 00:05:06,440  
of the operation is all contact

157  
00:05:13,480 --> 00:05:10,070  
operations so we've we wanted to make

158  
00:05:14,680 --> 00:05:13,490  
sure that the robot behaves and then so

159  
00:05:17,590 --> 00:05:14,690  
the commissioning of the robot is going

160  
00:05:19,360 --> 00:05:17,600  
to transition from you know more or less

161  
00:05:21,879 --> 00:05:19,370  
waving its arms around if you will and

162  
00:05:23,260 --> 00:05:21,889  
an assessing and retuning the robot is

163  
00:05:25,480 --> 00:05:23,270

required for the differences between

164

00:05:26,830 --> 00:05:25,490

here on the ground and in orbit and then

165

00:05:28,540 --> 00:05:26,840

we are going to move on to all right

166

00:05:30,100 --> 00:05:28,550

let's start touching things let's start

167

00:05:31,570 --> 00:05:30,110

interacting with objects let's start

168

00:05:33,640 --> 00:05:31,580

making contact deliberately making

169

00:05:36,180 --> 00:05:33,650

contact with objects now you can say the

170

00:05:39,879 --> 00:05:36,190

handshake yesterday was that's kind of a

171

00:05:41,980 --> 00:05:39,889

you know a contact operation but you

172

00:05:43,390 --> 00:05:41,990

know that things are very compliant

173

00:05:45,640 --> 00:05:43,400

still you know you're not making contact

174

00:05:46,839 --> 00:05:45,650

with rigid objects and where you switch

175

00:05:47,920 --> 00:05:46,849

to flip you switch where you have the

176

00:05:50,200 --> 00:05:47,930

potential to build up really large

177

00:05:52,150 --> 00:05:50,210

forces yeah and so you know on the

178

00:05:53,770 --> 00:05:52,160

docket for us is absolutely to use the

179

00:05:55,510 --> 00:05:53,780

busy board that we have we are we're

180

00:05:56,969 --> 00:05:55,520

training the robot on the ground and

181

00:06:00,610 --> 00:05:56,979

you're seeing some video right now that

182

00:06:01,990 --> 00:06:00,620

and it's not just necessarily hey let's

183

00:06:03,969 --> 00:06:02,000

have the robot perform these but let's

184

00:06:05,770 --> 00:06:03,979

have it perform it intelligently did it

185

00:06:07,150 --> 00:06:05,780

flip the switch did it recognize it flip

186

00:06:08,650 --> 00:06:07,160

the switch it when it needed to is it

187

00:06:12,070 --> 00:06:08,660

going to correct back when it didn't

188

00:06:14,890 --> 00:06:12,080

flip the switch the button presses did

189

00:06:16,659 --> 00:06:14,900

it did it understand that it did a

190

00:06:19,060 --> 00:06:16,669

successful operation and so it's

191

00:06:21,310 --> 00:06:19,070

combining the intelligence that it takes

192

00:06:23,770 --> 00:06:21,320

to actually interact with the the

193

00:06:25,000 --> 00:06:23,780

objects and the crew and and that's and

194

00:06:26,770 --> 00:06:25,010

that's what we are learning here on the

195

00:06:28,360 --> 00:06:26,780

ground and we want to upload those

196

00:06:30,189 --> 00:06:28,370

capabilities to the one in orbit and

197

00:06:33,879 --> 00:06:30,199

that's that's why we have an identical

198

00:06:37,750 --> 00:06:33,889

copy here on the ground that that is a

199

00:06:39,279 --> 00:06:37,760

complete replica of both the busy board

200

00:06:41,390 --> 00:06:39,289

and the robot because we want to be able

201  
00:06:43,280 --> 00:06:41,400  
to simulate everything on the ground

202  
00:06:45,020 --> 00:06:43,290  
and hardware and then upload those

203  
00:06:46,400 --> 00:06:45,030  
routines to the one in orbit so they're

204  
00:06:47,749 --> 00:06:46,410  
gonna do this and in the Destiny

205  
00:06:51,350 --> 00:06:47,759  
laboratory where it's stored right now

206  
00:06:54,110 --> 00:06:51,360  
yeah absolutely we this this first panel

207  
00:06:56,570 --> 00:06:54,120  
here that you're looking at is is on our

208  
00:06:58,820 --> 00:06:56,580  
on our list of things coming up that we

209  
00:07:01,010 --> 00:06:58,830  
want to do it involves an integration

210  
00:07:03,650 --> 00:07:01,020  
between our vision system the tactile

211  
00:07:05,240 --> 00:07:03,660  
feedback and the sensors at the hand and

212  
00:07:07,610 --> 00:07:05,250  
the control systems that are controlling

213  
00:07:10,370 --> 00:07:07,620

this robot all have to be act you know

214

00:07:12,520 --> 00:07:10,380

acting and harmoniously and and and

215

00:07:14,629 --> 00:07:12,530

successfully so it's it's it's a very

216

00:07:16,640 --> 00:07:14,639

there's a lot of serial things that I'll

217

00:07:18,020 --> 00:07:16,650

have to be working before the robot does

218

00:07:19,790 --> 00:07:18,030

a function well this is all very cool

219

00:07:21,050 --> 00:07:19,800

stuff so I'd say it's been a cool be

220

00:07:22,939 --> 00:07:21,060

sitting here watching you know this is

221

00:07:24,860 --> 00:07:22,949

this activity take place yeah it's been

222

00:07:26,540 --> 00:07:24,870

an amazing week for the for the

223

00:07:29,000 --> 00:07:26,550

engineering team and the flight control

224

00:07:32,210 --> 00:07:29,010

team and the crew went and we actually

225

00:07:34,070 --> 00:07:32,220

got a call from from Dan right after the

226

00:07:36,080 --> 00:07:34,080

op he called down to our lab and just

227

00:07:38,540 --> 00:07:36,090

wanted to say you know a few words to us

228

00:07:39,830 --> 00:07:38,550

personally and and he's tremendously

229

00:07:42,850 --> 00:07:39,840

excited to be working with this and I

230

00:07:45,080 --> 00:07:42,860

can't say enough about about Dan he is

231

00:07:48,020 --> 00:07:45,090

unbelievable when when operating this

232

00:07:50,060 --> 00:07:48,030

robot he he just gets it and it's been

233

00:07:51,350 --> 00:07:50,070

he's been an absolute pleasure to work

234

00:07:53,150 --> 00:07:51,360

with it's gonna be fun doing something

235

00:07:55,670 --> 00:07:53,160

you know this literally brand-new like

236

00:08:01,219 --> 00:07:55,680

this yes oh yeah there's it's it has

237

00:08:03,200 --> 00:08:01,229

been very just it's hard to describe it

238

00:08:05,719 --> 00:08:03,210

really is because our whole lab has this

239

00:08:07,760 --> 00:08:05,729

sense of you know of ushering in this