
PAO

1
00:00:00,580 --> 00:00:01,330
>> Pat Ryan: [Background sounds]
[Background talking] Now,

2
00:00:01,330 --> 00:00:02,160
the assembly

3
00:00:02,160 --> 00:00:04,210
of the International
Space Station is a task

4
00:00:04,210 --> 00:00:07,320
that has relied very heavily
on the use of robotics,

5
00:00:07,320 --> 00:00:11,460
most notably, the station's
remote manipulator system,

6
00:00:11,460 --> 00:00:12,580
Canadarm2.

7
00:00:12,580 --> 00:00:15,660
That was used to put entire
modules into place, as well as,

8
00:00:15,660 --> 00:00:19,240
to move astronauts and other
equipment from place to place.

9
00:00:19,240 --> 00:00:22,430
But the fact that the assembly
is almost over doesn't mean

10
00:00:22,430 --> 00:00:25,010
that the use for
robotics is over.

11
00:00:25,010 --> 00:00:29,030

In fact, last week, robots were
front and center on a task --

12
00:00:29,030 --> 00:00:33,250
a cargo transfer job, that
didn't require astronauts

13
00:00:33,250 --> 00:00:34,820
to suit up and go outside.

14
00:00:34,820 --> 00:00:36,850
We're going to take a
few minutes today to talk

15
00:00:36,850 --> 00:00:38,650
about that recent
work and the use

16
00:00:38,650 --> 00:00:40,380
of robotics onboard the station.

17
00:00:40,380 --> 00:00:42,280
With me is Ian Mills, who is one

18
00:00:42,280 --> 00:00:44,870
of the Robotics Officers
here in Mission Control.

19
00:00:44,870 --> 00:00:49,790
The task last week that I was
mentioning was moving things

20
00:00:49,790 --> 00:00:50,630
called CTCs.

21
00:00:50,630 --> 00:00:53,670
Let me get to start by
telling us what a CTC is

22

00:00:53,670 --> 00:00:56,010
and why these needed
to be moved.

23
00:00:56,010 --> 00:00:56,410
>> Ian Mills: Sure.

24
00:00:56,410 --> 00:01:00,500
Okay, the CTCs are a
cargo transport container,

25
00:01:00,500 --> 00:01:04,070
effectively just a big
metal box with a hinged lid.

26
00:01:04,070 --> 00:01:07,750
They contain orbital
replacement units --

27
00:01:07,750 --> 00:01:10,270
ORUs, things that we can replace

28
00:01:10,270 --> 00:01:13,430
on orbit robotically
or EVA crew, but...

29
00:01:13,430 --> 00:01:14,590
>> Pat Ryan: These
are just spare parts

30
00:01:14,590 --> 00:01:15,730
that are just stored out there.

31
00:01:15,730 --> 00:01:16,640
>> Ian Mills: That's correct.

32
00:01:16,640 --> 00:01:20,720
Now, these particular CTCs
contained the remote power

33
00:01:20,720 --> 00:01:25,320
controllers that we use there
to switch boxes that we power on

34
00:01:25,320 --> 00:01:27,170
and off different loads.

35
00:01:27,170 --> 00:01:30,660
Why we were moving
these particular boxes.

36
00:01:30,660 --> 00:01:33,370
While we currently -- or we
had, sorry, at the beginning

37
00:01:33,370 --> 00:01:34,830
of last week -- we had one

38
00:01:34,830 --> 00:01:38,920
of these CTCs stored
onboard Dexter,

39
00:01:38,920 --> 00:01:41,470
as he is commonly referred to.

40
00:01:41,470 --> 00:01:44,600
We refer to him as the Special
Purpose Dexterous Manipulator.

41
00:01:44,600 --> 00:01:47,080
Obviously, you can see
where he gets his name.

42
00:01:47,080 --> 00:01:51,720
We had a CTC already onboard
the SPDM, and that was

43
00:01:51,720 --> 00:01:55,390
to support replacing

a failed RPCM;

44
00:01:55,390 --> 00:01:57,230
however, that did not happen.

45
00:01:57,230 --> 00:01:58,970
There were certain
thermal issues

46
00:01:58,970 --> 00:02:02,150
that were brought forward before
those operations were able

47
00:02:02,150 --> 00:02:06,130
to take place, so we've just
been holding this CTC on,

48
00:02:06,130 --> 00:02:09,230
effectively on our back,
as we have gone along

49
00:02:09,230 --> 00:02:10,170
with other operations.

50
00:02:10,170 --> 00:02:12,400
The time has come now to prepare

51
00:02:12,400 --> 00:02:17,310
for the next H2 Transfer
Vehicle coming, HTV-4,

52
00:02:17,310 --> 00:02:22,820
and the expectation is that we
will not have any cargo onboard

53
00:02:22,820 --> 00:02:26,110
the SPDM because it will be used
as part of those operations.

54

00:02:26,110 --> 00:02:29,500
So, the main goal for
the task last week was

55
00:02:29,500 --> 00:02:33,210
to relocate the CTC that we had
-- we'll call that one a CTC3 --

56
00:02:33,210 --> 00:02:38,130
and put it in its expected
location for the HTV-4 mission.

57
00:02:38,130 --> 00:02:41,770
>> Pat Ryan: And in the
process, freeing up a spot

58
00:02:41,770 --> 00:02:44,630
on the SPDM for other uses.

59
00:02:44,630 --> 00:02:46,730
>> Ian Mills: That's
correct; for the transfers.

60
00:02:46,730 --> 00:02:47,930
The cargo transfer that's coming

61
00:02:47,930 --> 00:02:54,030
up on HTV-4 will utilize
the SPDM storage location,

62
00:02:54,030 --> 00:02:55,620
so we needed to clear that.

63
00:02:55,620 --> 00:02:58,190
Combined with that,
the program had decided

64
00:02:58,190 --> 00:03:03,960
that it made more sense to put
the CTC that was outboard --

65
00:03:03,960 --> 00:03:08,090
we'll call that one CTC5
-- put it in the place,

66
00:03:08,090 --> 00:03:11,880
move it closer to
the crew airlock.

67
00:03:11,880 --> 00:03:16,000
And, since there are orbital
replacement units, the spares,

68
00:03:16,000 --> 00:03:20,410
inside these boxes, putting
that particular CTC closer

69
00:03:20,410 --> 00:03:23,430
to the U.S. airlock makes it
more accessible to EVA crew

70
00:03:23,430 --> 00:03:28,260
if they have to go out and
perform some kind of repair.

71
00:03:28,260 --> 00:03:32,010
So that was the main goal
for the operations last week.

72
00:03:32,010 --> 00:03:33,290
>> Pat Ryan: I mentioned
Canadarm2.

73
00:03:33,290 --> 00:03:34,560
People are very familiar
with that,

74
00:03:34,560 --> 00:03:37,890
and it's very dramatic
when you see it.

75
00:03:37,890 --> 00:03:39,420
You don't see the
SPDM that much.

76
00:03:39,420 --> 00:03:42,830
Tell us what it does
that the arm can't.

77
00:03:42,830 --> 00:03:44,570
What makes it special?

78
00:03:44,570 --> 00:03:47,000
>> Ian Mills: Okay, well, you
may not see it very often...

79
00:03:47,000 --> 00:03:47,700
>> Pat Ryan: Well...

80
00:03:47,700 --> 00:03:50,400
>> Ian Mills: ...but, yeah, it's
come to the forefront as far

81
00:03:50,400 --> 00:03:51,590
as robotic operations.

82
00:03:51,590 --> 00:03:54,270
What it does, allows us to
do, it's different than we do

83
00:03:54,270 --> 00:04:00,540
with the Canadarm, is -- it is
a smaller robot that allows us

84
00:04:00,540 --> 00:04:04,790
to have finer control for
doing the detailed task work

85
00:04:04,790 --> 00:04:08,610

that we need to do to effect
repairs on the station.

86
00:04:08,610 --> 00:04:13,920
Its main purpose is to allow
us to repair certain units

87
00:04:13,920 --> 00:04:15,690
that are robotically
compatible without having

88
00:04:15,690 --> 00:04:19,950
to send EVA crew out, which
frees up the crewmembers

89
00:04:19,950 --> 00:04:22,570
to continue with
science onboard.

90
00:04:22,570 --> 00:04:24,150
So that's the primary difference

91
00:04:24,150 --> 00:04:29,220
between the SPDM
and the Canadarm.

92
00:04:29,220 --> 00:04:32,630
>> Pat Ryan: If the RMS is
an arm, is the SPDM a hand?

93
00:04:32,630 --> 00:04:35,610
>> Ian Mills: It's more -- I
would think of more like a,

94
00:04:35,610 --> 00:04:39,710
it's an extension of a --
yes, that's reasonable.

95
00:04:39,710 --> 00:04:45,030
So, yeah, we use the SRMS, which

is a 56-foot-long manipulator,

96
00:04:45,030 --> 00:04:46,600
and it is -- it was
designed and built

97
00:04:46,600 --> 00:04:48,650
for space station assembly.

98
00:04:48,650 --> 00:04:51,400
It was designed also
to be able to pick

99
00:04:51,400 --> 00:04:53,320
up the SPDM to do the fine work.

100
00:04:53,320 --> 00:04:57,200
So, yeah, that's a fair analogy
to call the SRMS big and the...

101
00:04:57,200 --> 00:04:57,910
>> Pat Ryan: The smaller one.

102
00:04:57,910 --> 00:04:59,380
>> Ian Mills: ...the
smaller one would be the hand

103
00:04:59,380 --> 00:05:00,360
for the dexterous work.

104
00:05:00,360 --> 00:05:01,740
>> Pat Ryan: And in
this particular case,

105
00:05:01,740 --> 00:05:04,770
all of these operations that
went on didn't involve the crew

106
00:05:04,770 --> 00:05:07,080

at all, and by that I don't
mean just the crew didn't have

107
00:05:07,080 --> 00:05:09,600
to go outside to do work;
they weren't involved

108
00:05:09,600 --> 00:05:10,750
in controlling the arm, either.

109
00:05:10,750 --> 00:05:12,380
It was controlled from
the ground, right?

110
00:05:12,380 --> 00:05:13,220
>> Ian Mills: That is correct.

111
00:05:13,220 --> 00:05:15,490
Since, I want to say, 2005,

112
00:05:15,490 --> 00:05:21,130
when we first started executing
maneuvers of the Canadarm2,

113
00:05:21,130 --> 00:05:24,880
we call it the SSRMS,
that's its acronym name.

114
00:05:24,880 --> 00:05:26,320
We have to use those
since we're NASA.

115
00:05:26,320 --> 00:05:26,720
>> Pat Ryan: Yes.

116
00:05:26,720 --> 00:05:28,570
>> Ian Mills: Since we started
ground control with SSRMS

117

00:05:28,570 --> 00:05:34,000
in 2005, we have progressively
increased our capability.

118
00:05:34,000 --> 00:05:38,330
We started out with very
small scripted maneuvers,

119
00:05:38,330 --> 00:05:40,710
and now we're to
the point where --

120
00:05:40,710 --> 00:05:44,520
yes, we are engaged from the
ground, solely from the ground,

121
00:05:44,520 --> 00:05:50,320
with fine ORU replacement
tasks that can also be executed

122
00:05:50,320 --> 00:05:53,450
by the crew by EVA, but it
does make a lot of sense for us

123
00:05:53,450 --> 00:05:54,620
to be able to do
it from the ground.

124
00:05:54,620 --> 00:05:56,690
>> Pat Ryan: When we say that
you can move it from the ground,

125
00:05:56,690 --> 00:05:59,180
we don't mean just over
here in this room, right?

126
00:05:59,180 --> 00:06:03,230
There are more than one place
from which you can run the arm.

127

00:06:03,230 --> 00:06:03,520
>> Ian Mills: There are.

128
00:06:03,520 --> 00:06:06,210
We have -- we do
have a console here

129
00:06:06,210 --> 00:06:09,160
in Mission Control,
where we sit.

130
00:06:09,160 --> 00:06:15,990
We also have a control center
in Canada, at Montreal,

131
00:06:15,990 --> 00:06:19,200
the Canadian Space Agency,
where we do have operators

132
00:06:19,200 --> 00:06:23,470
that are trained and certified
as well, that do the flight,

133
00:06:23,470 --> 00:06:25,020
safe flight control job.

134
00:06:25,020 --> 00:06:28,760
We don't have them -- we don't
have the primary position there

135
00:06:28,760 --> 00:06:30,720
yet, but I know that
that is in work.

136
00:06:30,720 --> 00:06:32,450
So, primarily, it's
run out of here.

137
00:06:32,450 --> 00:06:34,500
And then, the backroom support,

if you want to call it that,

138
00:06:34,500 --> 00:06:36,860
is frequently manned

139
00:06:36,860 --> 00:06:40,780
by our trained personnel
in the -- at CSA.

140
00:06:40,780 --> 00:06:44,170
>> Pat Ryan: What is it like
to sit here in this room

141
00:06:44,170 --> 00:06:49,720
and command a 50-foot-long
robot that's in orbit.

142
00:06:49,720 --> 00:06:51,210
Is that fun?

143
00:06:51,210 --> 00:06:52,640
>> Ian Mills: It is fun.

144
00:06:52,640 --> 00:06:54,990
For me, it's exciting
to sit here and be able

145
00:06:54,990 --> 00:06:59,170
to send the commands --
yes, and have the arm move,

146
00:06:59,170 --> 00:07:04,090
go where you tell it to go, or
complete an install of the CTC,

147
00:07:04,090 --> 00:07:06,110
as we were talking about.

148
00:07:06,110 --> 00:07:07,460

For me, it's very exciting;

149
00:07:07,460 --> 00:07:10,650
there's a high degree
of complexity to it.

150
00:07:10,650 --> 00:07:13,440
I know it's probably not very
fun to watch, because the rates

151
00:07:13,440 --> 00:07:16,480
that we operate with
are very slow.

152
00:07:16,480 --> 00:07:21,020
So, to make it interesting, we
have to do a time lapse playback

153
00:07:21,020 --> 00:07:22,940
so that you can actually
perceive some of the motions,

154
00:07:22,940 --> 00:07:26,490
because that is one of the
constraints that we operate

155
00:07:26,490 --> 00:07:29,310
with to maintain safety,
is that we operate this

156
00:07:29,310 --> 00:07:32,140
in a very controlled,
slow, deliberate manner,

157
00:07:32,140 --> 00:07:37,250
especially when we're in
contact or engaging a mechanism.

158
00:07:37,250 --> 00:07:39,850
>> Pat Ryan: Your CTC

operations last week proved

159
00:07:39,850 --> 00:07:43,830
that it's always
something that can go wrong.

160
00:07:43,830 --> 00:07:46,110
Explain what it was
that happened.

161
00:07:46,110 --> 00:07:48,140
There were operations
on two days, Thursday

162
00:07:48,140 --> 00:07:50,680
and Friday last week, and
Thursday you were starting

163
00:07:50,680 --> 00:07:51,750
to move one of these --

164
00:07:51,750 --> 00:07:54,490
the CTCs, and what
did you encounter?

165
00:07:54,490 --> 00:07:56,860
>> Ian Mills: Well, let
me start by just saying

166
00:07:56,860 --> 00:07:59,110
that I have been here
at NASA for 17 years.

167
00:07:59,110 --> 00:08:01,270
I've been in the
Robotics Operations Group

168
00:08:01,270 --> 00:08:02,580
that entire time.

169
00:08:02,580 --> 00:08:04,890
And one thing for sure
that I have learned is

170
00:08:04,890 --> 00:08:09,200
that nothing ever goes exactly
as you planned, and the issues

171
00:08:09,200 --> 00:08:12,400
that you encounter are not
necessarily what you are

172
00:08:12,400 --> 00:08:13,680
prepared for.

173
00:08:13,680 --> 00:08:14,980
So when we -- what happened

174
00:08:14,980 --> 00:08:18,870
to us last week was the
operation involved first picking

175
00:08:18,870 --> 00:08:21,300
up CTC5 and bringing it

176
00:08:21,300 --> 00:08:24,960
around to the stowage
platform close to the airlock.

177
00:08:24,960 --> 00:08:28,900
When we got over there and began
to put it down, it got stuck;

178
00:08:28,900 --> 00:08:30,740
it would not go all
the way down.

179
00:08:30,740 --> 00:08:34,000
And we, after a quick

video survey,

180
00:08:34,000 --> 00:08:39,080
realized that there are some
straps, some thermal straps,

181
00:08:39,080 --> 00:08:42,250
coming off of the adjacent box
to where we were putting this

182
00:08:42,250 --> 00:08:46,030
down that we did not
account for in our models,

183
00:08:46,030 --> 00:08:51,700
combined with the CTC itself
actually has a handrail.

184
00:08:51,700 --> 00:08:53,910
We also did not have that
handrail in our model.

185
00:08:53,910 --> 00:08:56,290
So, it was the interference
between these straps

186
00:08:56,290 --> 00:09:00,140
and this handrail that
caused us to not be able

187
00:09:00,140 --> 00:09:01,320
to put the CTC down...

188
00:09:01,320 --> 00:09:02,880
>> Pat Ryan: It wouldn't
fit in the spot.

189
00:09:02,880 --> 00:09:04,130
>> Ian Mills: ...in that spot.

190
00:09:04,130 --> 00:09:06,400
>> Pat Ryan: You got
to stop and think

191
00:09:06,400 --> 00:09:07,880
about what you're
going to do next.

192
00:09:07,880 --> 00:09:09,910
How do you resolve
that situation?

193
00:09:09,910 --> 00:09:11,570
What was the answer here?

194
00:09:11,570 --> 00:09:16,530
>> Ian Mills: The answer
ended up being the box,

195
00:09:16,530 --> 00:09:20,190
since it contains spares, they
require thermal conditioning

196
00:09:20,190 --> 00:09:23,780
to maintain their
survivability, their usability,

197
00:09:23,780 --> 00:09:26,440
and so a 10-hour
thermal clock was started

198
00:09:26,440 --> 00:09:29,690
when we pulled the box off
of its original location.

199
00:09:29,690 --> 00:09:31,870
And so, we were working
against that clock.

200

00:09:31,870 --> 00:09:33,810
And so, it may have been
possible for us to figure

201
00:09:33,810 --> 00:09:37,110
out how to work around
these straps, wiggle our way

202
00:09:37,110 --> 00:09:41,190
down at this location;
however, to me, I didn't feel

203
00:09:41,190 --> 00:09:42,420
like we had enough time.

204
00:09:42,420 --> 00:09:45,750
So what we ended up doing
was standing down for an hour

205
00:09:45,750 --> 00:09:47,580
and a half or so,
put together a plan

206
00:09:47,580 --> 00:09:50,640
to just backtrack the same
trajectory that we came from.

207
00:09:50,640 --> 00:09:51,300
>> Pat Ryan: Return it.

208
00:09:51,300 --> 00:09:53,530
>> Ian Mills: Return it back
to its original location.

209
00:09:53,530 --> 00:09:54,830
>> Pat Ryan: And yet
you were ultimately able

210
00:09:54,830 --> 00:09:57,980
to achieve the other

goal, and that was to free

211
00:09:57,980 --> 00:10:01,060
up that spot on the SPDM.

212
00:10:01,060 --> 00:10:01,540
>> Ian Mills: That's correct.

213
00:10:01,540 --> 00:10:05,130
Since both of these boxes that
we're moving around were CTCs,

214
00:10:05,130 --> 00:10:08,460
and they are mounted on a
common attachment system

215
00:10:08,460 --> 00:10:09,340
that we call the FRAM,

216
00:10:09,340 --> 00:10:11,700
that's Flight Releasable
Attachment Mechanism.

217
00:10:11,700 --> 00:10:14,000
Either can go in either spot.

218
00:10:14,000 --> 00:10:19,480
And we did stand down and
evaluate the situation.

219
00:10:19,480 --> 00:10:23,750
Since we ran into our models
being incorrect, we first needed

220
00:10:23,750 --> 00:10:30,190
to validate the CTC config, so
we took some video onboard just

221
00:10:30,190 --> 00:10:32,110

to verify what its config was.

222
00:10:32,110 --> 00:10:34,060
It did not have the
handrails we expected,

223
00:10:34,060 --> 00:10:37,540
so there would not be the
interference between the straps

224
00:10:37,540 --> 00:10:42,240
and that handrail, so we decided
to just go ahead and put the CTC

225
00:10:42,240 --> 00:10:44,440
down where we were
planning to put the CTC5.

226
00:10:44,440 --> 00:10:45,740
And I know that's
a bunch of numbers,

227
00:10:45,740 --> 00:10:48,830
and it gets all jumbled,
but eventually we ended

228
00:10:48,830 --> 00:10:50,410
up in the same config.

229
00:10:50,410 --> 00:10:52,650
We had these two boxes
in their same locations;

230
00:10:52,650 --> 00:10:54,650
they were just reversed
from what we had intended.

231
00:10:54,650 --> 00:10:57,300
>> Pat Ryan: And you
found the solution and got

232
00:10:57,300 --> 00:11:00,300
into the configuration
that you were after,

233
00:11:00,300 --> 00:11:04,890
a little ingenious thinking that
actually won you a lot of praise

234
00:11:04,890 --> 00:11:06,820
at the Mission Management
Team Meeting yesterday,

235
00:11:06,820 --> 00:11:08,310
for creative thinking.

236
00:11:08,310 --> 00:11:08,580
>> Ian Mills: Yes.

237
00:11:08,580 --> 00:11:10,610
I won't necessarily take
that all for myself.

238
00:11:10,610 --> 00:11:11,540
It is a team effort.

239
00:11:11,540 --> 00:11:14,650
We have three people
that man the console

240
00:11:14,650 --> 00:11:18,440
for the robotics
operations, and so,

241
00:11:18,440 --> 00:11:21,890
as well as we had other
people back in the office,

242
00:11:21,890 --> 00:11:23,770

scrambling to help us
put this plan together.

243
00:11:23,770 --> 00:11:25,570
So, it truly was a team effort.

244
00:11:25,570 --> 00:11:27,550
>> Pat Ryan: It's interesting
to hear how it goes,

245
00:11:27,550 --> 00:11:30,340
because it reminds us that
working in space is not as easy

246
00:11:30,340 --> 00:11:31,400
as it sometimes looks.

247
00:11:31,400 --> 00:11:36,240
You've got to do what -- to take
care of things as they crop up.

248
00:11:36,240 --> 00:11:37,920
>> Ian Mills: Absolutely, and
that is one of the other things

249
00:11:37,920 --> 00:11:40,960
that I have learned in my 17
years is that it is important

250
00:11:40,960 --> 00:11:43,730
to prepare for the unknown.

251
00:11:43,730 --> 00:11:47,690
I have rarely, if ever,
encountered the issues

252
00:11:47,690 --> 00:11:50,410
that we planned for; however,
going through that process

253
00:11:50,410 --> 00:11:52,360
of being prepared
to deal with things

254
00:11:52,360 --> 00:11:55,530
in real time just makes
you that much more prepared

255
00:11:55,530 --> 00:11:59,420
to handle whichever scenario
you may be working (inaudible).

256
00:11:59,420 --> 00:11:59,950
>> Pat Ryan: That does come up.

257
00:11:59,950 --> 00:12:00,890
Ian, thanks very much.

258
00:12:00,890 --> 00:12:02,540
Enjoyed hearing about this.

259
00:12:02,540 --> 00:12:04,810
Ian Mills is one of our
Robotics Officers here