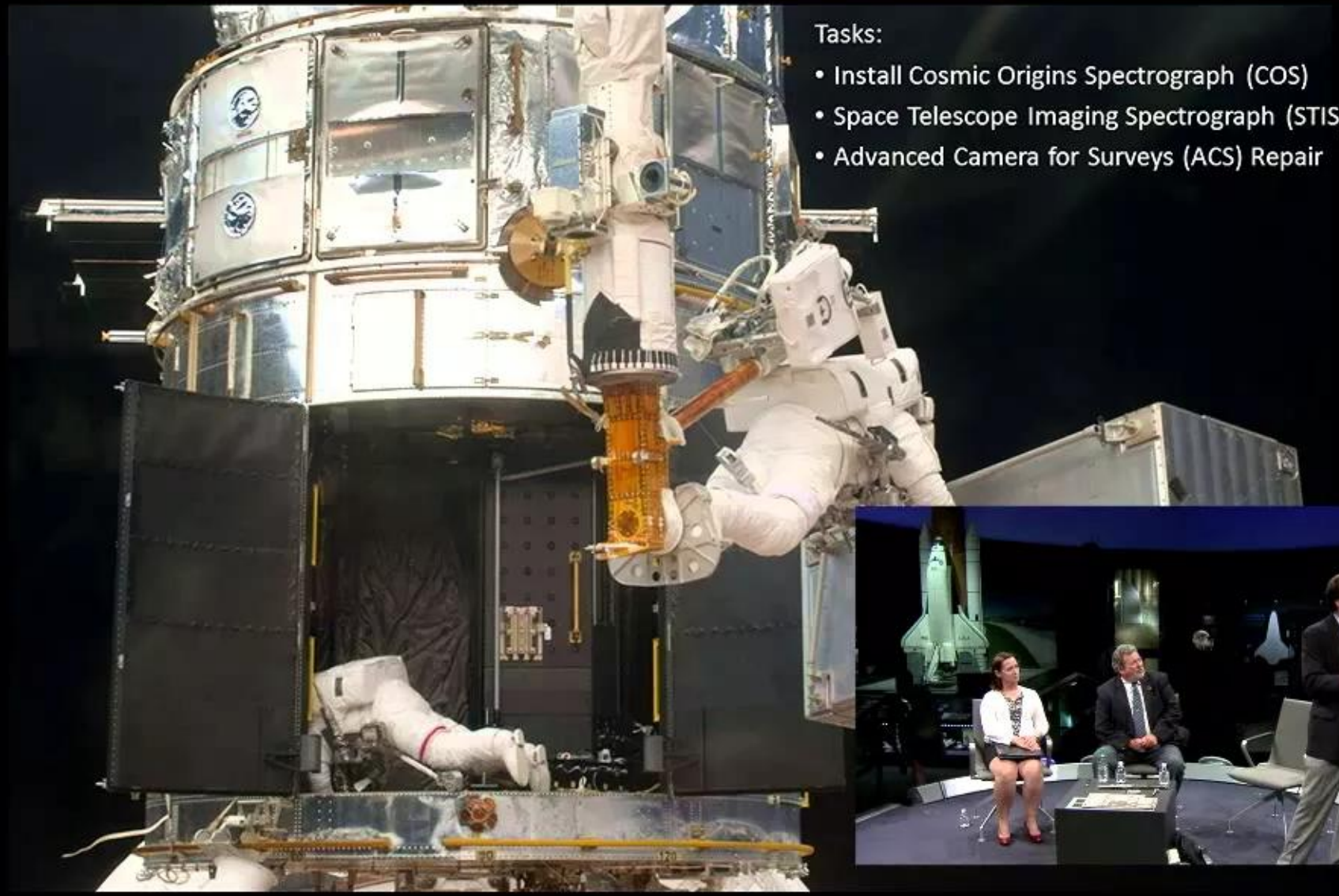
SM4 - EVA Days 3 & 4



Tasks:

- Install Cosmic Origins Spectrograph (COS)
- Space Telescope Imaging Spectrograph (STIS) Repair
- Advanced Camera for Surveys (ACS) Repair

1
00:00:00,650 --> 00:00:01,650
>>> GOOD AFTERNOON.

2
00:00:01,650 --> 00:00:02,650
WELCOME TO THE SPACE MUSEUM.

3
00:00:02,650 --> 00:00:04,609
I AM JENNIFER.

4
00:00:04,609 --> 00:00:13,910
CURATOR HERE FOR A RECENT
EXHIBIT THAT WE FEATURED ON

5
00:00:13,910 --> 00:00:16,010
SPACE WALKING.

6
00:00:16,010 --> 00:00:20,310
I WANT TO WELCOME ALL OF YOU TO
OUR AEROSPACE PROGRAM.

7
00:00:20,310 --> 00:00:22,310
EVA TOOLS OF THE TRADE.

8
00:00:22,310 --> 00:00:25,720
I WANT TO GIVE THANKS TO OUR
SPONSORS FOR THE PROGRAM TODAY

9
00:00:25,720 --> 00:00:30,630
BOEING.

10
00:00:30,630 --> 00:00:33,680
I WANT TO REMIND YOU AT HOME
THAT YOU'LL BE ABLE TO SUBMIT

11
00:00:33,680 --> 00:00:38,260
QUESTIONS ONLINE AND HOPEFULLY
OUR SPEAKERS WILL HAVE TIME TO

12

00:00:38,260 --> 00:00:39,260
ANSWER THE QUESTIONS.

13
00:00:39,260 --> 00:00:42,470
AND THAT GOES TO ALL OF YOU IN
THE AUDIENCE AS WELL.

14
00:00:42,470 --> 00:00:44,950
WE HAVE BEEN CELEBRATING THE
EARLIER PART OF THIS YEAR, THE

15
00:00:44,950 --> 00:00:48,100
50th ANNIVERSARY OF SPACE
WALKING AND THE CAPABILITY OF

16
00:00:48,100 --> 00:00:54,180
SPACE WALKING IS VERY FOR LONG
DURATIONS SPACE EXPLORATION AND

17
00:00:54,180 --> 00:00:59,300
DEVELOPING LIVING AND WORKING IN
SPACE BY HUMANS.

18
00:00:59,300 --> 00:01:03,830
THE SPACE SHUTTLE RETIRED A FEW
YEARS AGO HAD THE CAPABILITY OF

19
00:01:03,830 --> 00:01:09,470
TAKING HUMANS TO SATELLITE AND
CONSTRUCTING THE SPACE STATION.

20
00:01:09,470 --> 00:01:14,120
ASTRONAUTS CONTINUE TO MAINTAIN
AND OPERATE THE ISS TODAY AND DO

21
00:01:14,120 --> 00:01:16,510
SPACE WALKS TO DO THAT.

22
00:01:16,510 --> 00:01:19,330
BUT NOW WE'RE LOOKING AT

DIFFERENT CAPABILITIES AND COULD

23
00:01:19,330 --> 00:01:24,220
POTENTIALLY BE USING ROBOTS TO
SERVICE SATELLITES AND DOING

24
00:01:24,220 --> 00:01:27,150
OPERATIONS INSTEAD OF HUMANS.

25
00:01:27,150 --> 00:01:32,700
TODAY OWES SPEAKERS WILL TALK
MORE ABOUT HUMAN SERVICING OF

26
00:01:32,700 --> 00:01:36,030
SATELLITES AND HAVE BEEN
INCIDENTALLY INVOLVED IN THAT

27
00:01:36,030 --> 00:01:38,659
PROCESS OVER THE COURSE OF THEIR
CAREERS.

28
00:01:38,659 --> 00:01:41,650
AND I WILL SAY THEY BOTH JOIN US
TODAY FROM THE NASA'S GODARD

29
00:01:41,650 --> 00:01:46,530
SPACE FLIGHT CENTER SATELLITE
SERVICING CAPABILITIES OFFICE.

30
00:01:46,530 --> 00:01:49,360
I'LL INTRODUCE JUSTIN ON MY FAR
LEFT.

31
00:01:49,360 --> 00:01:53,820
HE'S THE ROBOTIC REFUELING
MISSION DEPUTY PROJECT MANAGER.

32
00:01:53,820 --> 00:01:59,450
HE WAS PREVIOUSLY A SYSTEMS
ENGINEER AT GODARD AND WILL TELL

33
00:01:59,450 --> 00:02:02,360
US MORE ABOUT DEVELOPING THOSE
TOOLS.

34
00:02:02,360 --> 00:02:06,740
HE'S WORKED AT NASA SINCE 1988
AND SPENT 15 YEARS WORKING ON

35
00:02:06,740 --> 00:02:08,700
SERVICING MISSIONS.

36
00:02:08,700 --> 00:02:11,730
ON MY IMMEDIATE LEFT IS ED
REZAK, THE ROBOTICS FACILITY

37
00:02:11,730 --> 00:02:14,920
MANAGER RIGHT NOW BUT HAS WORKED
IN A NUMBER OF DIFFERENT ROLES

38
00:02:14,920 --> 00:02:20,409
OVER THE COURSE OF HIS MANY YEAR
CAREER AT NASA STARTING IN 1976

39
00:02:20,409 --> 00:02:24,310
WORKING ON A VARIETY OF PROJECTS
FROM SPACE SUIT DEVELOPMENT TO

40
00:02:24,310 --> 00:02:29,409
SUPPORTING LIFE AND MICRO
GRAVITY RESEARCH AND TRAINING

41
00:02:29,409 --> 00:02:32,239
ASTRONAUTS AND SUPPORTING THOSE
MISSIONS.

42
00:02:32,239 --> 00:02:39,269
LET'S WELCOME THEM AND GET
STARTED WITH OUR PROGRAM.

43
00:02:39,269 --> 00:02:41,540
[APPLAUSE]
>> JUSTIN.

44
00:02:41,540 --> 00:02:42,540
>> THANK YOU.

45
00:02:42,540 --> 00:02:43,540
GOOD AFTERNOON EVERYONE.

46
00:02:43,540 --> 00:02:50,999
ARE WE GOING TO START THE SLIDE
SHOW, PLEASE?

47
00:02:50,999 --> 00:02:51,999
>> YEAH.

48
00:02:51,999 --> 00:02:53,529
>> SOUNDS GREAT.

49
00:02:53,529 --> 00:02:56,200
SO WHILE THE SLIDE SHOW IS
LOADING UP, GOOD AFTERNOON

50
00:02:56,200 --> 00:02:57,200
AGAIN.

51
00:02:57,200 --> 00:02:58,209
I'M JUSTIN CASSIDY.

52
00:02:58,209 --> 00:03:02,829
WHAT WE WANTED TO SHOW YOU TODAY
ARE AN EXPERIENCE OF WHAT IS

53
00:03:02,829 --> 00:03:06,690
HUBBLE SPACE TELESCOPE AND WHAT
SERVICING OF A TELESCOPE MEANS

54

00:03:06,690 --> 00:03:07,690
TO US.

55
00:03:07,690 --> 00:03:10,859
WE HAD DEVELOPED A LOT OF
CUSTOMIZED TOOLS, BOTH MYSELF

56
00:03:10,859 --> 00:03:14,019
AND ED REZAK ARE GOING TO GO
THROUGH A PRESENTATION AND GIVE

57
00:03:14,019 --> 00:03:17,500
AN OVERVIEW AND DETAILS ABOUT
WHAT IT TOOK TO BE AN ASTRONAUT

58
00:03:17,500 --> 00:03:21,090
AND THE TOOLS TO BE CREATED TO
MAKE THESE SERVICING MISSIONS

59
00:03:21,090 --> 00:03:22,190
POSSIBLE.

60
00:03:22,190 --> 00:03:25,500
NEXT SLIDE, PLEASE.

61
00:03:25,500 --> 00:03:26,609
GREAT.

62
00:03:26,609 --> 00:03:27,779
HUBBLE SPACE TELESCOPE.

63
00:03:27,779 --> 00:03:31,439
EVERYONE HAS HEARD ABOUT IT
SIZE-WISE, ABOUT THE SIZE OF A

64
00:03:31,439 --> 00:03:32,439
SCHOOL BUS.

65
00:03:32,439 --> 00:03:35,430

THE REASONS WHY WE DIDN'T PAINT
IT YELLOW IS BECAUSE IT LIVES IN

66
00:03:35,430 --> 00:03:39,469
A VACUUM SPACE, IT'S DARK AND A
VACUUM.

67
00:03:39,469 --> 00:03:43,689
IT HAS SHINY BLANKETSCH BECAUSE
OF THAT, IT HAS UNIQUE COVERINGS

68
00:03:43,689 --> 00:03:49,219
ON IT AND A CHROME FINISH IF YOU
WILL.

69
00:03:49,219 --> 00:03:51,810
ENGINEERS DESIGNED HUBBLE TO BE
SERVICED.

70
00:03:51,810 --> 00:03:57,359
THERE ARE UNIQUE FIXTURES ON
HERE, HERE AND HERE, WHERE THE

71
00:03:57,359 --> 00:04:02,099
SHUTTLE WOULD RENDEZVOUS AND
REACH OUT AND GRAB ONE OF THE

72
00:04:02,099 --> 00:04:04,829
FIXTURES AS YOU SEE IN THIS
PICTURE AND BRING IT INTO THE

73
00:04:04,829 --> 00:04:08,739
CARGO BAY WHERE IT WOULD DOCK ON
TO A FIXTURE IN THE BACK OF THE

74
00:04:08,739 --> 00:04:13,760
SHUTTLE IN ORDER TO BRING IT IN
AND LATCH TO THE SHUTTLE.

75
00:04:13,760 --> 00:04:17,349

FROM THERE THAT WAS THE PLATFORM
WHERE ASTRONAUTS WOULD FORM

76
00:04:17,349 --> 00:04:18,349
SERVICING.

77
00:04:18,349 --> 00:04:23,010
THE RING IT ATTACHED TO WAS LIKE
A LAZY SUZANNE.

78
00:04:23,010 --> 00:04:26,240
THE ASTRONAUT HAD THE EASE OF
ACCESSING THE ONE SIDE OF THE

79
00:04:26,240 --> 00:04:31,150
TELESCOPE WHILE BEING ON THE
REMOTE SYSTEM AS THEY PERFORMED

80
00:04:31,150 --> 00:04:33,310
THEIR ACTIVITIES.

81
00:04:33,310 --> 00:04:36,389
BECAUSE HUBBLE WAS SUPPOSED TO
BE SERVICED BY ASTRONAUTS THEY

82
00:04:36,389 --> 00:04:40,650
ADDED FEATURES.

83
00:04:40,650 --> 00:04:43,150
A FOOT RESTRAINT IS A PLACE
BECAUSE AN ASTRONAUT IS FLOATING

84
00:04:43,150 --> 00:04:46,210
AROUND THEY NEED TO TIE
THEMSELVES TO A STRUCTURE AND

85
00:04:46,210 --> 00:04:48,120
THEY WOULD DO THAT WITH A FOOT
RESTRAINT.

86
00:04:48,120 --> 00:04:50,699
THERE'S ONE ON THIS DISPLAY
CASE.

87
00:04:50,699 --> 00:04:53,770
ONE OF THE TYPICAL FOOT
RESTRAINTS.

88
00:04:53,770 --> 00:04:55,250
HANDRAILS.

89
00:04:55,250 --> 00:04:56,250
THEY ARE FLOATING AROUND.

90
00:04:56,250 --> 00:04:59,319
SO THEY HAD TO MOVE AROUND THE
TELESCOPE HAND OVER HAND.

91
00:04:59,319 --> 00:05:03,860
BECAUSE OF THAT, WE PUT A LOT OF
LINEAR FEET OF HANDRAILS.

92
00:05:03,860 --> 00:05:07,360
WE CALLED THEM YELLOW WHICH HAVE
THEM SEE AS THEY TRANSLATE

93
00:05:07,360 --> 00:05:11,710
AROUND DOING THE SERVICING.

94
00:05:11,710 --> 00:05:13,330
HUBBLE WAS MEANT TO BE SERVICED.

95
00:05:13,330 --> 00:05:17,979
WE KNEW OVER TIME THAT
INSTRUMENTS AND DIFFERENT BOXES

96
00:05:17,979 --> 00:05:21,020
OVER TIME WOULD FAIL, THEY COULD
BE CHANGED OUT.

97
00:05:21,020 --> 00:05:24,599
SO WE MADE ALL THE INTERFACES,
MOSTLY ALL THE INTERFACES A

98
00:05:24,599 --> 00:05:26,030
716th BOLT.

99
00:05:26,030 --> 00:05:30,540
WE HAVE A COUPLE OF EXAMPLES.

100
00:05:30,540 --> 00:05:35,000
HUBBLE HAS BEEN UP ORBITING AND
DOING WORK FOR THE LAST 25 YEARS

101
00:05:35,000 --> 00:05:40,540
RACKING UP OVER 135,000 ORBITS
AND 3.7 BILLION MILES.

102
00:05:40,540 --> 00:05:46,930
NEXT SLIDE, PLEASE.

103
00:05:46,930 --> 00:05:50,500
SO HUBBLE WAS DESIGNED IN THE
'70s BUT NOT LAUNCHED UNTIL

104
00:05:50,500 --> 00:05:52,370
1995.

105
00:05:52,370 --> 00:05:55,539
BACK THEN IT WAS A STATE OF THE
ART TECHNOLOGY BUT OVER TIME

106
00:05:55,539 --> 00:05:56,539
THINGS BECOME OBSOLETE.

107
00:05:56,539 --> 00:06:01,479
THANKS TO THE SERVICING WE ARE
ABLE TO MAINTAIN HUSHLE TO KEEP

108
00:06:01,479 --> 00:06:04,949
IT OPERATING.

109
00:06:04,949 --> 00:06:08,090
FOR EXAMPLE, I WONDER IF ANYONE
IN THIS AUDIENCE HAS A CELL

110
00:06:08,090 --> 00:06:09,800
PHONE TEN YEARS OLD?

111
00:06:09,800 --> 00:06:12,289
IS THAT EVEN POSSIBLE?

112
00:06:12,289 --> 00:06:13,590
PROBABLY NOT.

113
00:06:13,590 --> 00:06:16,250
I HAVE A FLIP PHONE IN MY
POCKET.

114
00:06:16,250 --> 00:06:17,250
THAT'S PRETTY OLD.

115
00:06:17,250 --> 00:06:22,300
NOT REALLY A SLIDER OR WHAT NOT.

116
00:06:22,300 --> 00:06:24,870
DOES ANYONE STILL HAVE THEIR
FIRST TELEPHONE?

117
00:06:24,870 --> 00:06:29,069
THIS IS MY FIRST TELEPHONE.

118
00:06:29,069 --> 00:06:32,800
I GOT IT AROUND 1990 WHEN THE
TELESCOPE LAUNCHED.

119

00:06:32,800 --> 00:06:34,960
THIS WAS REALLY COOL TECHNOLOGY.

120
00:06:34,960 --> 00:06:39,419
I HAD THE ABILITY TO UPGRADE BY
GOING TO THE STORE AND GETTING A

121
00:06:39,419 --> 00:06:40,419
NEW PHONE.

122
00:06:40,419 --> 00:06:41,639
YOU CAN'T DO THAT WITH HUBBLE.

123
00:06:41,639 --> 00:06:46,289
HUBBLE WAS THE ENGINEERS WHO
CREATED IT WERE SMART TO MAKE IT

124
00:06:46,289 --> 00:06:49,900
SERVICEABLE AND MAKE IT MODULAR
AND GIVE IT THE ABILITY TO

125
00:06:49,900 --> 00:06:50,900
UPGRADE.

126
00:06:50,900 --> 00:06:54,479
KEEP UP THE TECHNOLOGY BY
VISITING WITH ASTRONAUTS OVER 15

127
00:06:54,479 --> 00:06:55,479
YEARS.

128
00:06:55,479 --> 00:06:59,849
ADDING TO THAT ALL THE DIFFERENT
SERVICING MISSIONS AND UPGRADING

129
00:06:59,849 --> 00:07:02,280
THE BOXES TO KEEP THEM
OPERATING.

130

00:07:02,280 --> 00:07:05,300
EVEN YOUR CELL PHONE CAMERA.

131
00:07:05,300 --> 00:07:06,889
THEY NOW HAVE LARGE CAMERAS.

132
00:07:06,889 --> 00:07:10,569
HUBBLE WAS ABLE TO COPE UP BY
CHANGING TECHNOLOGY AND BEING

133
00:07:10,569 --> 00:07:13,229
ABLE TO HAVE ASTRONAUTS VISIT TO
PERFORM SERVICING.

134
00:07:13,229 --> 00:07:17,879
NEXT SLIDE, PLEASE.

135
00:07:17,879 --> 00:07:20,460
HERE'S KIND OF A SUMMARY OF WHAT
THE HUBBLE SERVICING MISSIONS

136
00:07:20,460 --> 00:07:26,610
WERE FROM THE LAUNCH IN 1990
THROUGH 1, 2, 3, 4, ALL OF THEM

137
00:07:26,610 --> 00:07:29,969
PERFORMED DIFFERENT FUNCTIONS
DOING DIFFERENT THINGS.

138
00:07:29,969 --> 00:07:33,990
NOW, THE ISSUE WE HAD WAS THESE
INSTRUMENTS GOT BETTER AND

139
00:07:33,990 --> 00:07:34,990
BETTER.

140
00:07:34,990 --> 00:07:36,319
THEY ALSO REQUIRED MORE POWER.

141

00:07:36,319 --> 00:07:39,749
IN ORDER TO REQUIRE MORE POWER,
WE HAD TO CHANGE THE SOLO RAYS

142
00:07:39,749 --> 00:07:41,509
TO SOMETHING MORE EFFICIENT.

143
00:07:41,509 --> 00:07:47,120
UP HERE, HUBBLE SOLO RAYS USED
TO BE VERY GOOD POWER CELL

144
00:07:47,120 --> 00:07:49,800
GENERATING CAPABILITY.

145
00:07:49,800 --> 00:07:55,789
WE HAD TO UPGRADE THE SOLAR CELL
TO BECOME MORE EFFICIENT AND

146
00:07:55,789 --> 00:07:58,479
HELP US TO DISCOVER THINGS IN
THE FUTURE.

147
00:07:58,479 --> 00:08:02,889
NEXT SLIDE, PLEASE.

148
00:08:02,889 --> 00:08:05,979
HERE'S A LITTLE CHART I KEPT TO
HELP ME UNDERSTAND AND TRACK

149
00:08:05,979 --> 00:08:07,779
WHAT WAS HAPPENING OVER THE
YEARS.

150
00:08:07,779 --> 00:08:11,879
SO IN THE LEFT-HAND COLUMN WHAT
YOU WOULD SEE IS ALL THE DEPLOY

151
00:08:11,879 --> 00:08:16,699
INSTRUMENTS AND OTA IS THE
OPTICAL TELESCOPE ASSEMBLY AND

152
00:08:16,699 --> 00:08:19,400
THEY ALL HAVE DIFFERENT NUMBERS.

153
00:08:19,400 --> 00:08:22,490
IT GIVES THE ABILITY TO TRACK
HOW LONG AN INSTRUMENT WAS IN

154
00:08:22,490 --> 00:08:25,550
PLACE, WHAT WAS LEAVING AND WHAT
THE NEW INSTRUMENT WAS.

155
00:08:25,550 --> 00:08:28,509
THIS IS A SNAPSHOT OF WHERE WE
WERE WHEN WE STARTED HUBBLE TO

156
00:08:28,509 --> 00:08:30,949
WHERE WE ARE TODAY WITH HUBBLE'S
FINE INSTRUMENTS.

157
00:08:30,949 --> 00:08:33,040
NEXT SLIDE, PLEASE.

158
00:08:33,040 --> 00:08:36,979
WALK US THROUGH THE NEXT FEW
CHARTS?

159
00:08:36,979 --> 00:08:37,979
>> SURE.

160
00:08:37,979 --> 00:08:45,940
AGAIN MY NAME IS ED REZAK FROM
THE SPACE CENTER UP THE ROAD.

161
00:08:45,940 --> 00:08:52,540
THE REALLY NEAT THING ABOUT
HUBBLE FOR ME IS SHE LAUNCHED IN

162
00:08:52,540 --> 00:08:58,090

APRIL OF '90, 1990, HAD A LIFE
EXPECTANCY OF WHAT, 12 YEARS,

163
00:08:58,090 --> 00:09:00,460
APPROXIMATELY, 10 OR 12 YEARS.

164
00:09:00,460 --> 00:09:05,510
THIS YEAR WE'RE CELEBRATING 25
YEARS OF ON-ORBIT OPERATIONS.

165
00:09:05,510 --> 00:09:10,200
IT'S BECAUSE WE HAVE BEEN ABLE
TO SEND WOMEN AND MEN INTO SPACE

166
00:09:10,200 --> 00:09:11,570
TO SERVICE THE TELESCOPE.

167
00:09:11,570 --> 00:09:17,460
AS A RESULT, WE HAVE ENDED UP
WITH PROBABLY ONE OF THE MOST

168
00:09:17,460 --> 00:09:25,100
ARGUABLY MOST IMPORTANT MACHINE
EVER BUILT BY HUMANS.

169
00:09:25,100 --> 00:09:30,210
OVER THE 25 YEARS, I'VE GOT THE
RED LASER.

170
00:09:30,210 --> 00:09:35,020
OVER THE 25 YEARS, WE HAVE TAKEN
MORE THAN A MILLION EXPOSURES

171
00:09:35,020 --> 00:09:39,840
AND HAVE FOUND OVER 22,000 NEW
OBJECTS.

172
00:09:39,840 --> 00:09:47,430
THE GREATEST DISCOVERIES ARE
BECAUSE WE HAVE BEEN ABLE TO GO

173
00:09:47,430 --> 00:09:52,850
AND UPGRADE THOSE SCIENCE
INSTRUMENTS ONBOARD AND REPAIR

174
00:09:52,850 --> 00:09:55,650
THEM.

175
00:09:55,650 --> 00:10:00,650
JUSTIN WILL GET INTO THE ACS
REPAIRS A LITTLE BIT FARTHER ON.

176
00:10:00,650 --> 00:10:03,540
NEXT SLIDE, PLEASE.

177
00:10:03,540 --> 00:10:10,560
OUR STS-125 CREW, THIS IS THE
LAST HUMAN CREW THAT VISITED THE

178
00:10:10,560 --> 00:10:15,660
SPACE TELESCOPE IN MAY OF 2009.

179
00:10:15,660 --> 00:10:21,190
WE HAVE ONBOARD TWO TEAMS OF EVA
OR EXTRA VEHICULAR ACTIVITY

180
00:10:21,190 --> 00:10:23,840
SPACE WALKERS.

181
00:10:23,840 --> 00:10:29,930
THE FIRST TEAM WAS JOHN AND DREW
AND THEN THE OTHER PAIR WERE

182
00:10:29,930 --> 00:10:32,910
MIKE AND MIKE GOOD.

183
00:10:32,910 --> 00:10:34,710
TWO MIKES OUT THERE AT THE SAME
TIME.

184
00:10:34,710 --> 00:10:41,980
SO THIS IS MATT AND THIS IS
BUENO.

185
00:10:41,980 --> 00:10:46,810
TRAINING THE ASTRONAUTS IS QUITE
A CHALLENGE.

186
00:10:46,810 --> 00:10:50,430
THE PROJECT IDENTIFIES THE
PRIORITIES FOR THE SERVICING

187
00:10:50,430 --> 00:10:51,430
MISSION.

188
00:10:51,430 --> 00:10:55,870
AND THEN WE HAVE TO WORK WITH
THE FOLKS AT JSE.

189
00:10:55,870 --> 00:11:00,180
THE JOHNSON SPACE CENTER TO
CHOREOGRAPH AND PLAN ALL THE

190
00:11:00,180 --> 00:11:01,180
SPACE WALKS.

191
00:11:01,180 --> 00:11:05,080
WHEN THEY GO OUT THEY GO OUT FOR
APPROXIMATELY SIX HOURS AT A

192
00:11:05,080 --> 00:11:06,080
TIME.

193
00:11:06,080 --> 00:11:12,000
SO NO MOTION, NO TRANSLATION, NO
MANEUVER IS WASTED.

194
00:11:12,000 --> 00:11:17,670

TO TRAIN THEM TO DO THAT, WE
HAVE A NUMBER OF FACILITIES, TWO

195
00:11:17,670 --> 00:11:21,230
BIG FACILITIES, ONE RIGHT UP
HERE THE ROAD, THE GODARD SPACE

196
00:11:21,230 --> 00:11:27,450
CENTER AND THE JOHNSON SPACE
FLIGHT CENTER.

197
00:11:27,450 --> 00:11:32,770
WHERE DID MY FLAG GO?

198
00:11:32,770 --> 00:11:37,450
IN PLANNING FOR THE SERVICING
MISSION, ONE OF THE NEAT THINGS

199
00:11:37,450 --> 00:11:40,500
WE DID, IF YOU LOOK AT THE FIVE
SERVICING MISSIONS, THERE'S

200
00:11:40,500 --> 00:11:41,500
ALWAYS A LEGACY.

201
00:11:41,500 --> 00:11:44,930
WE ALWAYS TOOK A CREW MEMBER
FROM THE PREVIOUS SERVICING

202
00:11:44,930 --> 00:11:47,570
MISSION SO THEY HAD THAT
CORPORATE KNOWLEDGE BROUGHT WITH

203
00:11:47,570 --> 00:11:49,630
THEM AT THE NEXT VISIT.

204
00:11:49,630 --> 00:11:56,850
THIS WAS KIND OF A NEAT TRIP
BECAUSE WE HAD NOT ONE BUT TWO

205
00:11:56,850 --> 00:12:03,120
AND THREE RETURNING HUBBLE
HOVERS TO THE MISSION.

206
00:12:03,120 --> 00:12:11,330
OUR COMMANDER WAS SCOTT ALTMAN
AND PILOT, GREG JOHNSON AND

207
00:12:11,330 --> 00:12:18,940
MEGAN McARTHUR WAS OUR ENGINEER
RMS OPERATOR.

208
00:12:18,940 --> 00:12:22,440
THE OTHER FOUR WERE THE ONES WHO
SUITED UP AND WENT OUTSIDE.

209
00:12:22,440 --> 00:12:26,350
WHEN THE ASTRONAUTS GO OUTSIDE,
IT IS TRULY A TEAM EFFORT

210
00:12:26,350 --> 00:12:29,770
BECAUSE THE FOLKS INSIDE ARE
HELPING THEM WITH THEIR

211
00:12:29,770 --> 00:12:33,010
PROCEDURES AND TELLING†--
REMINDING THEM WHAT THEIR NEXT

212
00:12:33,010 --> 00:12:34,010
IS.

213
00:12:34,010 --> 00:12:37,990
FOR EVERY HOUR THAT THESE
FELLOWS SPENT OUT WALKING IN

214
00:12:37,990 --> 00:12:43,330
SPACE OR DOING AN EVA, WE HAVE
TRAINED THEM ANYWHERE FROM 10 TO

215

00:12:43,330 --> 00:12:47,640
16 HOURS ON EARTH DEPENDING ON
THE COMPLEXITY OF THE TASK.

216
00:12:47,640 --> 00:12:51,300
NEXT SLIDE, PLEASE.

217
00:12:51,300 --> 00:12:57,000
I MENTIONED THE FACILITIES AT
THE JOHNSON SPACE FLIGHT CENTER.

218
00:12:57,000 --> 00:13:03,920
THE NBL, WOW, FIGURED
PREDOMINANTLY IN A LOT OF OUR

219
00:13:03,920 --> 00:13:05,350
TRAINING.

220
00:13:05,350 --> 00:13:08,040
WE TRAIN THE ASTRONAUTS AND
SPACE WALKING ASTRONAUTS IN

221
00:13:08,040 --> 00:13:11,570
WATER BECAUSE IT'S AS CLOSE AS
WE CAN GET TO TRAINING THEM TO

222
00:13:11,570 --> 00:13:15,230
WORK IN THE MICRO-GRAVITY
ENVIRONMENT OF SPACE WHILE

223
00:13:15,230 --> 00:13:17,790
WEARING A SPACE SUIT AND
HANDLING LARGE PIECES OF

224
00:13:17,790 --> 00:13:21,130
HARDWARE.

225
00:13:21,130 --> 00:13:24,310
THE NBL IS A LARGE POOL.

226
00:13:24,310 --> 00:13:28,450
IT'S 60.2 BILLION GALLONS OF
WATER.

227
00:13:28,450 --> 00:13:33,470
IT'S 102 FEET WIDE, 202 FEET
LONG AND 40 FEET DEEP.

228
00:13:33,470 --> 00:13:38,600
THE NEAT PART ABOUT IT IS ONLY
20 FEET OF THAT DEPTH IS BELOW

229
00:13:38,600 --> 00:13:39,860
SEA LEVEL.

230
00:13:39,860 --> 00:13:42,790
IT'S ACTUALLY 20 FEET ABOVE SEA
LEVEL.

231
00:13:42,790 --> 00:13:47,610
ANY DIVERS, SCUBA DIVERS IN THE
CROWD?

232
00:13:47,610 --> 00:13:51,170
SCUBA DIVERS HAVE TO PAY
ATTENTION TO HOW DEEP THEY GO

233
00:13:51,170 --> 00:13:54,450
AND HOW LONG THEY SPEND DOWN
THERE BECAUSE OF THE EFFECTS OF

234
00:13:54,450 --> 00:13:55,450
THE HUMAN BODY.

235
00:13:55,450 --> 00:13:58,100
WE DIDN'T HAVE TO WORRY ABOUT
THAT IN THE POOL.

236
00:13:58,100 --> 00:14:01,680

JUSTIN HERE WAS ONE OF THE
DIVERS AND ACTUALLY GOT INTO THE

237
00:14:01,680 --> 00:14:05,930
WATER WITH THE ASTRONAUTS TO
TRAIN.

238
00:14:05,930 --> 00:14:11,760
THE PHOTOS YOU SEE HERE IS A
REPRESENTATION OF THE HUBBLE

239
00:14:11,760 --> 00:14:13,930
SPACE TELESCOPE.

240
00:14:13,930 --> 00:14:18,620
BUT NOT THE ENTIRE TELESCOPE
BECAUSE EVEN THOUGH THIS POOL IS

241
00:14:18,620 --> 00:14:23,780
40 FOOT DEEP, WE WOULD NOT BE
ABLE TO STAND THE TELESCOPE UP

242
00:14:23,780 --> 00:14:27,090
COMPLETELY BECAUSE PART OF IT
WOULD STICK OUT OF THE WATER AND

243
00:14:27,090 --> 00:14:29,070
OUR CREW WOULDN'T BE ABLE TO GET
TO IT.

244
00:14:29,070 --> 00:14:31,190
WE CUT THE TELESCOPE IN HALF.

245
00:14:31,190 --> 00:14:37,510
PUT THE TOP HALF DOWN ON THE
FLOOR OF THE POOL AND THEN IT

246
00:14:37,510 --> 00:14:41,880
WAS SITUATED IN A MOCKUP
REPRESENTATION OF THE BAY OF THE

247
00:14:41,880 --> 00:14:43,890
SPACE SHUTTLE.

248
00:14:43,890 --> 00:14:47,980
EACH CREW MEMBER, MY RED LASER
JUST WENT OUT.

249
00:14:47,980 --> 00:14:54,100
EACH CREW MEMBER WAS†-- I GOT TO
USE THE GREEN ONE.

250
00:14:54,100 --> 00:14:57,940
HAD SUPPORT DIVERS AND SAFETY
DIVERS ASSIGNED TO THEM IN

251
00:14:57,940 --> 00:15:01,160
ADDITION WHILE THEY'RE IN THE
WATER THERE IS ALWAYS A CAMERA

252
00:15:01,160 --> 00:15:04,980
ON THAT CREW MEMBER FOR SAFETY
REASONS.

253
00:15:04,980 --> 00:15:11,000
IN THE NBL WE USE THE
OPPORTUNITY, USE THE IN-WATER

254
00:15:11,000 --> 00:15:15,800
OPPORTUNITY NOT ONLY TO PRACTICE
BUT TO DRIVE DESIGN FOR SOME OF

255
00:15:15,800 --> 00:15:19,290
THE TOOLS YOU'RE GOING TO HEAR
JUSTIN TALK ABOUT.

256
00:15:19,290 --> 00:15:22,030
WE BRING CONCEPTS DOWN TO THE
CREW.

257
00:15:22,030 --> 00:15:26,060
PUT THEM IN THE WATER WITH THE
ASTRONAUTS, THEY EVALUATE IT,

258
00:15:26,060 --> 00:15:30,350
COME BACK WITH IDEAS, LIKES AND
DISLIKES AND THEN JUSTIN'S TEAM

259
00:15:30,350 --> 00:15:33,790
BRINGS THEM BACK HOME AND GOES
OVER THE COMMENTS WITH THE

260
00:15:33,790 --> 00:15:39,350
ENGINEERS AND THEY DO VERY GOOD
JOB OF TURNING THOSE AROUND WITH

261
00:15:39,350 --> 00:15:46,320
ANOTHER REVISION OF THE TOOL FOR
THE ASTRONAUTS TO EVALUATE.

262
00:15:46,320 --> 00:15:47,850
NEXT SLIDE.

263
00:15:47,850 --> 00:15:53,410
I MENTIONED THE GODARD SPACE
FLIGHT CENTER.

264
00:15:53,410 --> 00:15:55,470
WOW.

265
00:15:55,470 --> 00:15:59,590
THIS IS A PHOTO OF THE WORLD'S
LARGEST CLEAN ROOM.

266
00:15:59,590 --> 00:16:02,630
IN FACT, AT GODARD IT IS
CURRENTLY OCCUPIED BY THE

267
00:16:02,630 --> 00:16:08,760

TELESCOPE TEAM BUT YEARS THE
HUBBLE DEVELOPMENT PROJECT

268
00:16:08,760 --> 00:16:09,760
RESIDED THERE.

269
00:16:09,760 --> 00:16:14,050
THERE IT IS.

270
00:16:14,050 --> 00:16:20,870
WE HAVE A†-- AGAIN, A HIGH
FIDELITY MECHANICAL SIMULATOR OF

271
00:16:20,870 --> 00:16:22,350
THE TELESCOPE.

272
00:16:22,350 --> 00:16:26,191
INSIDE IS WHERE THE FOUR AXIAL
INSTRUMENTS ARE.

273
00:16:26,191 --> 00:16:31,110
THEY ARE ABOUT THE SIZE OF A
TELEPHONE BOOTH IF ANYBODY CAN

274
00:16:31,110 --> 00:16:35,650
REMEMBER TELEPHONE BOOTHS.

275
00:16:35,650 --> 00:16:42,500
AND WE BRING THE CREW UP TO
GODARD AND DO TRAINING AND

276
00:16:42,500 --> 00:16:46,750
PROCEDURE DEVELOPMENT THERE AS
WELL AS HARDWARE DESIGN.

277
00:16:46,750 --> 00:16:51,790
NOW, IN THIS PHOTO YOU CAN SEE
MOST OF THE PEOPLE ARE WEARING

278

00:16:51,790 --> 00:16:56,040
WHITE BUNNY HATS YOU CALL THEM.

279
00:16:56,040 --> 00:17:00,310
IT'S HARD TO PICK OUT THE CREW
IN A CROWD OF ENGINEERS LIKE

280
00:17:00,310 --> 00:17:05,780
THIS SO WE HAVE THE CREW WHERE
BLUE HOODIES SO WE CAN TELL THEM

281
00:17:05,780 --> 00:17:06,780
APART.

282
00:17:06,780 --> 00:17:14,240
WE SPENT A LOT OF TIME HERE AT
THE HIGH FIDELITY MECHANICAL

283
00:17:14,240 --> 00:17:18,800
SIMULATOR AT GODARD BRINGING THE
CREW UP, THEY'RE ABLE TO

284
00:17:18,800 --> 00:17:26,140
ACTUALLY GET INTO POSITION, WE
USE AS MUCH OF THE EMU OR THE

285
00:17:26,140 --> 00:17:29,720
SPACE SUIT AS WE CAN, GLOVES
BECAUSE THAT HELPS US DETERMINE

286
00:17:29,720 --> 00:17:35,690
REACH AND ACCESS AND THEY ALSO
LEARN WHAT PARTS OF THE

287
00:17:35,690 --> 00:17:38,570
TELESCOPE THEY HAVE TO STAY AWAY
FROM.

288
00:17:38,570 --> 00:17:43,350
JOHN, OUR PAY LOAD COMMANDER FOR

THE LAST MISSION, IN FACT, FLEW

289
00:17:43,350 --> 00:17:47,560
THREE SERVICING MISSIONS FOR US,
REMINDED US CONSTANTLY THAT THE

290
00:17:47,560 --> 00:17:50,910
NUMBER ONE RULE OF SERVICING THE
TELESCOPE WAS DON'T BREAK THE

291
00:17:50,910 --> 00:17:51,910
TELESCOPE.

292
00:17:51,910 --> 00:17:56,610
SO THE CREW WAS ABLE TO BECOME
VERY, VERY FAMILIAR WITH WHAT

293
00:17:56,610 --> 00:17:59,070
THE TELESCOPE LOOKED LIKE,
THINGS THAT WE COULD NOT

294
00:17:59,070 --> 00:18:04,380
REPRESENT IN THE NBL MOCKUP.

295
00:18:04,380 --> 00:18:09,100
NEXT SLIDE, PLEASE.

296
00:18:09,100 --> 00:18:13,330
AND JUSTIN, THIS IS WHERE YOU
TAKE IT OVER.

297
00:18:13,330 --> 00:18:14,330
>> GREAT.

298
00:18:14,330 --> 00:18:15,330
THANKS.

299
00:18:15,330 --> 00:18:16,330
>> YOU'RE GREEN, SIR.

300
00:18:16,330 --> 00:18:17,330
>> OKAY.

301
00:18:17,330 --> 00:18:19,770
FOLKS, OVER THE MANY SERVICING
MISSIONS WE HAD WE BROUGHT

302
00:18:19,770 --> 00:18:20,770
TOOLS.

303
00:18:20,770 --> 00:18:23,230
SOME TOOLS WERE EASY AND SOME
WERE HARDER.

304
00:18:23,230 --> 00:18:26,600
OVER TIME BECAUSE OUR CHANGEOUTS
OF THE EQUIPMENT ON HUBBLE

305
00:18:26,600 --> 00:18:30,530
BECAME SO COMPLICATED WE NEEDED
TO DEVELOP MORE TOOLS.

306
00:18:30,530 --> 00:18:33,280
HERE'S A LONGER LIST OF ALL THE
DIFFERENT TOOLS ALL THROUGH THE

307
00:18:33,280 --> 00:18:36,420
SERVICING MISSIONS ON WHAT WE
HAD TO FLY UP TO SPACE.

308
00:18:36,420 --> 00:18:39,250
SOME WE WERE ABLE TO REUSE
BECAUSE SOMETIMES ONE INSTRUMENT

309
00:18:39,250 --> 00:18:42,150
HAD TO REPLACE FOR ANOTHER.

310
00:18:42,150 --> 00:18:45,160

THIS IS ONE OF THE SOCKETS THAT
WE WOULD USE TO RELEASE ONE OF

311
00:18:45,160 --> 00:18:46,160
THE INSTRUMENTS.

312
00:18:46,160 --> 00:18:47,270
THERE'S NO REASON BUILDING A NEW
TOOL.

313
00:18:47,270 --> 00:18:48,270
WE WOULD JUST RESEND IT.

314
00:18:48,270 --> 00:18:52,780
SO THAT'S WHAT THE LINE THAT
READS REFLOWN MEANS.

315
00:18:52,780 --> 00:18:56,250
NEXT SLIDE.

316
00:18:56,250 --> 00:19:00,210
THE PISTOL GRIP TOOL IS
BASICALLY YOUR HOME POWER TOOL

317
00:19:00,210 --> 00:19:01,690
BUT MADE FOR SPACE.

318
00:19:01,690 --> 00:19:04,480
SPACE IS VERY TOUGH FOR A TOOL
TO WORK IN.

319
00:19:04,480 --> 00:19:08,670
IT'S VERY COLD, IT'S IN A
VACUUM.

320
00:19:08,670 --> 00:19:12,500
THIS IS A SOPHISTICATED
COMPUTER-AIDED TOOL THAT ALLOWS

321

00:19:12,500 --> 00:19:19,840
US TO PROVIDE THE TORQUE FOR OUR
DIFFERENT FASTENERS.

322
00:19:19,840 --> 00:19:24,010
THIS WAS DEVELOPED AT GODARD AND
USED ON ALL THE SERVICES

323
00:19:24,010 --> 00:19:26,540
MISSIONS AND TODAY IT'S USED UP
ON SPACE STATION.

324
00:19:26,540 --> 00:19:29,800
WE'RE AWARE IT IS USED TO
SUPPORT THE EVS CREW DURING

325
00:19:29,800 --> 00:19:32,390
THEIR CHANGEOUTS.

326
00:19:32,390 --> 00:19:36,259
NEXT SLIDE.

327
00:19:36,259 --> 00:19:38,480
A COLLECTION OF ALL THE SOCKETS.

328
00:19:38,480 --> 00:19:39,500
WHY DO WE NEED SO MANY?

329
00:19:39,500 --> 00:19:41,720
WE HAVE MANY DIFFERENT
FUNCTIONS.

330
00:19:41,720 --> 00:19:46,180
ALL 716th AT THE FRONT END OF
THE NOSE.

331
00:19:46,180 --> 00:19:47,510
THEY'RE ALL SOCKET TOOLS.

332

00:19:47,510 --> 00:19:51,521
THE END OF THE SOCKETS BOBBLE,
FOR EXAMPLE, THIS IS WHAT WE

333
00:19:51,521 --> 00:19:53,480
CALL A WOBBLE SOCKET.

334
00:19:53,480 --> 00:19:57,010
IT'S ABLE TO BEND TO COMPLY AND
ALLOW THE ASTRONAUT TO GET ON TO

335
00:19:57,010 --> 00:19:59,930
THE INTERFACE YOU'RE TURNING.

336
00:19:59,930 --> 00:20:04,600
IT EXTENDS IF NEEDED.

337
00:20:04,600 --> 00:20:07,520
SOME OF THEM ARE SMALLER AND
RIGID AND THAT ALLOWS US TO GET

338
00:20:07,520 --> 00:20:09,980
ON A SHORT INNER FACE BASED ON
THE REQUIREMENT.

339
00:20:09,980 --> 00:20:13,790
NEXT SLIDE.

340
00:20:13,790 --> 00:20:19,630
ED WAS MENTIONING THE HIGH-FI
MECHANICAL STIMULATOR.

341
00:20:19,630 --> 00:20:23,010
IT'S WHAT WE HAVE HERE ON THE
HUBBLE SPACE TELESCOPE.

342
00:20:23,010 --> 00:20:26,480
IT'S THE BACK END OF THE SCHOOL
BUS AND THAT'S WHERE THE

343
00:20:26,480 --> 00:20:29,210
SCIENTIFIC INSTRUMENTS ARE
STORED.

344
00:20:29,210 --> 00:20:34,540
THEY ARE SOMETHING THAT LOOKS
LIKE A PHONE BOOTH OR KIND OF

345
00:20:34,540 --> 00:20:36,750
LIKE A PIZZA PIE SHAPE.

346
00:20:36,750 --> 00:20:42,110
ONE OF OUR INSTRUMENTS AS WELL
AS OUR GUIDANCE CENSORS.

347
00:20:42,110 --> 00:20:43,750
THE YELLOW REPRESENTS THE DOOR.

348
00:20:43,750 --> 00:20:50,091
ONLY THREE SETS OF DOORS WHERE
AS THE PIZZA PIE SHAPE, THERE

349
00:20:50,091 --> 00:20:51,750
ARE THREE DOORS AS WELL.

350
00:20:51,750 --> 00:20:56,160
THE ONE INSTRUMENT OFF TO THE
SIDE DOESN'T REQUIRE A DOOR.

351
00:20:56,160 --> 00:20:58,550
IF I WANT TO GET IN HERE AND
CHANGE AN INSTRUMENT I HAVE TO

352
00:20:58,550 --> 00:21:02,990
GO THROUGH FOUR LATCHES.

353
00:21:02,990 --> 00:21:05,080
WHY DOES THAT MEAN SOMETHING?

354
00:21:05,080 --> 00:21:07,880
WE NEED TO WORK WITH OUR TOOLS
AND THEY NEED TO BE SET TO A

355
00:21:07,880 --> 00:21:11,570
CERTAIN VALUE TO ALLOW US TO
RELEASE THE BOLTS AND ALLOW US

356
00:21:11,570 --> 00:21:13,030
TO GET INSIDE THE DOOR.

357
00:21:13,030 --> 00:21:16,220
IT IS VERY COMPLEX TO DO THIS.

358
00:21:16,220 --> 00:21:21,380
IT BECAME SO COMPLEX, WE MADE A
DOOR SIMULATOR SENT DOWN TO THE

359
00:21:21,380 --> 00:21:25,110
SPACE CENTER SO ASTRONAUTS CAN
PRACTICE CLOSING THESE DOORS.

360
00:21:25,110 --> 00:21:30,910
THEY'RE FIN ICKY AND IT BECAME
AN ISSUE THAT WE HAD TO ADDRESS

361
00:21:30,910 --> 00:21:34,480
TO MAKE SURE OUR CREWS WERE
PROFICIENT AND USING THEIR TIME

362
00:21:34,480 --> 00:21:38,640
MOST EFFICIENTLY TO LEARN TO
PROPERLY CLOSE THE DOORS.

363
00:21:38,640 --> 00:21:43,140
NEXT SLIDE, PLEASE.

364
00:21:43,140 --> 00:21:46,690
WHAT WE'RE GOING TO FOCUS ON

TODAY IS HUBBLE MISSION FOUR.

365
00:21:46,690 --> 00:21:49,240
THERE ARE FIVE EVA DAYS.

366
00:21:49,240 --> 00:21:52,170
EVA DAYS, APPROXIMATELY EIGHT
HOURS LET'S SAY.

367
00:21:52,170 --> 00:21:56,970
I WANT TO FOCUS ON DAYS THREE
AND FOUR.

368
00:21:56,970 --> 00:21:59,640
THOSE ARE IMPORTANT BECAUSE THEY
WERE DOING SOMETHING WE DID NOT

369
00:21:59,640 --> 00:22:01,370
INTEND TO DO IN THE FIRST PLACE.

370
00:22:01,370 --> 00:22:03,290
THE FIRST ONE WAS EASY.

371
00:22:03,290 --> 00:22:09,720
HERE'S THE DOORS THAT WERE OPEN
AND ONE EMPTY BAY THERE AND THIS

372
00:22:09,720 --> 00:22:13,220
IS THE INSTRUMENT THAT WAS IN
THAT BAY AND THAT INSTRUMENT IS

373
00:22:13,220 --> 00:22:16,410
CALLED COSTAR AND JENNIFER, THAT
IS HERE AT THE MUSEUM.

374
00:22:16,410 --> 00:22:17,470
>> IT IS?

375
00:22:17,470 --> 00:22:18,640

>> PLEASE TAKE A LOOK AT THAT.

376
00:22:18,640 --> 00:22:21,510
THIS INSTRUMENT IS VERY
IMPORTANT WHEN HUBBLE WAS FIRST

377
00:22:21,510 --> 00:22:25,870
LAUNCHED THERE WAS AN ISSUE WITH
THE PRIMARY MIRROR AND THIS IS

378
00:22:25,870 --> 00:22:30,150
THE INSTRUMENT THAT ALLOWED TO
PROVIDE CONTACT LENSES IN FRONT

379
00:22:30,150 --> 00:22:32,470
OF THE OTHER INSTRUMENTS TO
ALLOW AND CORRECT FOR THE

380
00:22:32,470 --> 00:22:36,370
ABERRATION OF THE ORIGINAL
MIRROR.

381
00:22:36,370 --> 00:22:41,110
NEW INSTRUMENTS HAVE IT BUILT
INTO THEM, THEREFORE, COSTAR

382
00:22:41,110 --> 00:22:44,000
BECAME OBSOLETE AND WERE ABLE TO
REMOVE THAT.

383
00:22:44,000 --> 00:22:48,090
THE NEW ONE IN ITS PLACE IS
CALLED THE COSMIC SPECTOGRAPH.

384
00:22:48,090 --> 00:22:49,610
THE OTHER TWO INSTRUMENTS
FAILED.

385
00:22:49,610 --> 00:22:59,700
IN THE TIME THEY FAILED THERE

WAS NOT ENOUGH TIME TO BUILD A

386
00:22:59,700 --> 00:23:02,470
NEW INSTRUMENT AND TRAIN THE
CREW AND THEN GET THE

387
00:23:02,470 --> 00:23:03,670
INSTRUMENTS UP INTO SPACE.

388
00:23:03,670 --> 00:23:05,320
THERE WAS NOT ENOUGH TIME.

389
00:23:05,320 --> 00:23:08,630
SO WE WERE DIRECTED FIX THEM IN
SPACE.

390
00:23:08,630 --> 00:23:10,500
SO INSTEAD OF DOING BOX LEVEL
CHANGE OUT.

391
00:23:10,500 --> 00:23:16,310
WE DECIDED TO OPEN UP THE BOX,
PULL THE CARD OUT AND REPLACE

392
00:23:16,310 --> 00:23:17,920
THE COMPONENT.

393
00:23:17,920 --> 00:23:21,380
WE DID THAT ON BOTH INSTRUMENTS.

394
00:23:21,380 --> 00:23:24,860
WE'RE GOING TO GO INTO DETAIL
ABOUT THE TOOL IT TOOK TO DO

395
00:23:24,860 --> 00:23:26,140
THOSE.

396
00:23:26,140 --> 00:23:28,700
NEXT SLIDE.

397
00:23:28,700 --> 00:23:31,660
HERE'S THE CREW MEMBER HERE.

398
00:23:31,660 --> 00:23:34,210
NOT ONLY DID THE RMS GRAPPLE
HUBBLE AND BRING IT IN TO

399
00:23:34,210 --> 00:23:38,080
SHUTTLE BAY, YOU CAN ATTACH A
FOOT RESTRAINT.

400
00:23:38,080 --> 00:23:40,500
JENNIFER IT'S ALSO HERE AS WELL.

401
00:23:40,500 --> 00:23:42,990
PLEASE TAKE A LOOK AT THAT.

402
00:23:42,990 --> 00:23:45,900
THIS ATTACHES ON TO THE ARM.

403
00:23:45,900 --> 00:23:48,330
THE CREW MEMBER PUTS THEIR FEET
IN THERE AND THEY'RE MANEUVERED

404
00:23:48,330 --> 00:23:53,320
AROUND THE CARGO BAY TO ASSIST
THE FREE FLOATER DOING THE TASK.

405
00:23:53,320 --> 00:23:56,860
IT'S A TWO PERSON TASK DOING
THESE CHANGEOUTS.

406
00:23:56,860 --> 00:24:01,010
YOU GOT A LOT OF HARDWARE AND
TOOLS ASSOCIATED ALONG WITH THE

407
00:24:01,010 --> 00:24:02,010
ASTRONAUT.

408
00:24:02,010 --> 00:24:06,110
THE ASTRONAUT HAS A TOOL BELT
BUT THERE'S SO MUCH MORE THEY'RE

409
00:24:06,110 --> 00:24:09,900
ABLE TO PUT ON AND THAT GOES TO
THE WORK SITE TO ASSIST THEM TO

410
00:24:09,900 --> 00:24:12,270
MAKE THEIR JOSH EASIER AND
FASTER.

411
00:24:12,270 --> 00:24:14,690
NEXT SLIDE.

412
00:24:14,690 --> 00:24:16,900
SO THIS IS GETTING REALLY INTO
THE DETAILS.

413
00:24:16,900 --> 00:24:18,860
THE INSTRUMENT THAT FAILED WAS
THIS.

414
00:24:18,860 --> 00:24:23,970
IT HAS AN ELECTRONICS BOX CALLED
THE MAIN ELECTRONIC BOX.

415
00:24:23,970 --> 00:24:26,310
IT'S GOT 13 ELECTRICAL CARDS IN
THERE.

416
00:24:26,310 --> 00:24:28,000
THEY GENERATE HEAT.

417
00:24:28,000 --> 00:24:29,690
IT GETS HOT.

418
00:24:29,690 --> 00:24:32,500

SO THIS IS BASICALLY THE BIG
RADIATOR PLATE.

419
00:24:32,500 --> 00:24:35,890
IT RADIATED SO MUCH HEAT, THERE
WASN'T ENOUGH SURFACE AREA SO

420
00:24:35,890 --> 00:24:39,600
THEY CREATED AN EXTENSION, LIKE
A DIVING BOARD IN ORDER TO

421
00:24:39,600 --> 00:24:43,760
RADIATE MORE HEAT TO MAKE IT
WORK MORE OPTIMAL.

422
00:24:43,760 --> 00:24:46,940
BECAUSE IT WAS A DIVING BOARD
THEY PUT THE CLAMP TO CINCH IT

423
00:24:46,940 --> 00:24:56,010
DOWN SO DURING LAUNCH IT WOULD
NOT DISTURB THE INSTRUMENT.

424
00:24:56,010 --> 00:25:00,480
I NEED TO TAKE THE HANDRAIL OFF.

425
00:25:00,480 --> 00:25:03,950
I HAVE OTHER OBSTACLES AROUND
HERE, I THINK I COULD WORK

426
00:25:03,950 --> 00:25:07,730
AROUND THEM BUT I HAVE TO DEAL
WITH THE CLAMP AND HANDRAIL.

427
00:25:07,730 --> 00:25:10,980
NEXT SLIDE.

428
00:25:10,980 --> 00:25:13,050
THIS COVER HAS GOT A LOT OF
SCREWS.

429
00:25:13,050 --> 00:25:16,220
THESE SCREWS ALSO HAVE WASHERS.

430
00:25:16,220 --> 00:25:18,600
THIS IS A TORQUE SET FASTENER.

431
00:25:18,600 --> 00:25:22,640
THERE ARE 39 OF THESE AND THESE
ARE IN YOUR RED ZONES.

432
00:25:22,640 --> 00:25:25,670
THE ONES THAT ACTUALLY
PHYSICALLY CONNECT TO EACH ONE

433
00:25:25,670 --> 00:25:27,350
OF THE 13 ELECTRONIC CARDS.

434
00:25:27,350 --> 00:25:31,470
EVEN THOUGH WE ARE REMOVING ONE
BOARD THE ENTIRE COVER HAS TO

435
00:25:31,470 --> 00:25:32,620
COME OFF.

436
00:25:32,620 --> 00:25:37,210
NEXT UP IS THE BLUE ONE IN THESE
REGIONS AND HERE'S A SOCKET HEAD

437
00:25:37,210 --> 00:25:41,381
CAP SCREW AND THE LARGER ONES ON
THE RIGHT-HAND SIDE AND

438
00:25:41,381 --> 00:25:43,630
LEFT-HAND SIDE ARE THE NUMBER
8s.

439
00:25:43,630 --> 00:25:47,240
SO WHEN I ADD ALL THESE NUMBERS

UP, JUST FOR THE SCREWS ALONE,

440
00:25:47,240 --> 00:25:48,920
IT'S 111 OF SCREWS.

441
00:25:48,920 --> 00:25:53,210
WHEN THEY ADD THE COMPONENTS UP,
THAT'S 183 DIFFERENT INDIVIDUAL

442
00:25:53,210 --> 00:25:54,990
COMPONENTS I NEED TO CONTROL.

443
00:25:54,990 --> 00:25:57,190
THE PROBLEM IS THE CHANGEOUT IS
OCCURRING.

444
00:25:57,190 --> 00:25:58,580
A HUGE CHALLENGE.

445
00:25:58,580 --> 00:26:04,390
IN THE OPTICAL TELESCOPE ANY ONE
LITTLE ITEM LOOSE COULD FLY AND

446
00:26:04,390 --> 00:26:09,010
FLOAT INTO THE MOST WORSE PLACE
AND IT WOULD JUST DISRUPT

447
00:26:09,010 --> 00:26:10,010
SCIENCE.

448
00:26:10,010 --> 00:26:14,481
WE HAD TO BE CONCERNED ABOUT
CONTROLLING ALL THE LOOSE

449
00:26:14,481 --> 00:26:15,481
HARDWARE.

450
00:26:15,481 --> 00:26:19,550
NEXT SLIDE, PLEASE.

451
00:26:19,550 --> 00:26:22,570
SO THIS IS A VERY FLAT PLATE.

452
00:26:22,570 --> 00:26:27,440
THERE ARE NO HAND-HOLD FEATURES
TO GRAB AHOLD OF.

453
00:26:27,440 --> 00:26:29,740
WE HAD TO REMOVE THAT LOWER
CLAMP IN THE CORNER, THIS IS THE

454
00:26:29,740 --> 00:26:31,200
TOOL WE CAME UP WITH.

455
00:26:31,200 --> 00:26:35,480
I HAD TO REMOVE THIS HANDRAIL
THAT WAS IN THE WAY AND I PUT ON

456
00:26:35,480 --> 00:26:39,830
THESE DEVICES CALLED HANDRAIL
REMOVAL TOOLS UP AND BOTTOM.

457
00:26:39,830 --> 00:26:43,140
I PUT THEM ON, I TOOK THE TOOL
AND RELEASED THE SCREWS AND

458
00:26:43,140 --> 00:26:45,140
EVERYTHING IS CAPTURED AND
NOTHING WOULD FLOAT AWAY.

459
00:26:45,140 --> 00:26:50,460
I'M ABLE TO PUT THAT INTO A
DISPOSABLE BAG IF YOU WILL.

460
00:26:50,460 --> 00:26:54,240
HOW AM I GOING TO CONTROL THE
SCREWS THAT BECOME FREE-FLOATING

461

00:26:54,240 --> 00:26:57,600
AND RUIN SCIENCE FOR THE FUTURE
OF HUBBLE?

462
00:26:57,600 --> 00:26:59,500
WE CREATED A FASTENER CAPTURE
PLATE.

463
00:26:59,500 --> 00:27:02,240
A MEANS OF CONTAINING THE
FASTENERS.

464
00:27:02,240 --> 00:27:05,110
HOW AM I GOING TO ATTACH TO
SOMETHING FEATURELESS?

465
00:27:05,110 --> 00:27:08,850
WE DECIDED TO INSTALL ANCHOR
GUIDE STUDS.

466
00:27:08,850 --> 00:27:16,929
OUT OF THE 111 FASTENERS I'M
GOING TO PUT THE GUIDE STUDS

467
00:27:16,929 --> 00:27:21,980
INTO THE PLATE AND WE'RE GOING
TO GO TO THE NEXT SLIDE.

468
00:27:21,980 --> 00:27:23,570
SO HERE'S MY CHALLENGE.

469
00:27:23,570 --> 00:27:24,570
HERE'S THE ELECTRONIC BOX.

470
00:27:24,570 --> 00:27:28,270
HERE IN LIGHT BLUE IS THE COVER
AND THE FLOATING FASTENERS THAT

471
00:27:28,270 --> 00:27:30,040
I NEED TO CONTROL.

472
00:27:30,040 --> 00:27:32,400
IT DOESN'T MATTER THAT THEY'RE
FLOATING AROUND, AS LONG AS I

473
00:27:32,400 --> 00:27:34,970
HAVE CONTROL OVER THEM AND THEY
DON'T FLOAT AWAY.

474
00:27:34,970 --> 00:27:39,429
I NEED TO PUT MY SHIELD ON TOP
OF THESE MAKING USE OF THESE

475
00:27:39,429 --> 00:27:40,980
GUIDE STUDS.

476
00:27:40,980 --> 00:27:42,490
NEXT SLIDE.

477
00:27:42,490 --> 00:27:50,570
I DID THAT WITH THAT THIS CALLED
THE FASTENER CAPTURE PLATE.

478
00:27:50,570 --> 00:27:59,970
I PUT IT ON TO THE PLATE AND
CINCH DOWN THE GUIDE STUDIES AND

479
00:27:59,970 --> 00:28:04,100
THIS PLATE IS THE SIXTH SIDE TO
A BOX.

480
00:28:04,100 --> 00:28:07,890
I CREATED A COMPARTMENT FOR
RELEASING THE FASTENERS TO KEEP

481
00:28:07,890 --> 00:28:10,070
THEM UNDER CONTROL.

482
00:28:10,070 --> 00:28:12,070

NEXT SLIDE, PLEASE.

483
00:28:12,070 --> 00:28:17,880
WHAT YOU CAN'T SEE UNDERNEATH
THE WINDOW HERE IS THE PISTOL

484
00:28:17,880 --> 00:28:18,880
GRIP TOOL.

485
00:28:18,880 --> 00:28:26,260
I HAVE ONE RIGHT HERE THAT WE
USE IN THE POOL.

486
00:28:26,260 --> 00:28:27,950
THIS IS A GREAT TOOL.

487
00:28:27,950 --> 00:28:30,822
IT CAN GO 10, 20 AND 64 RPMs.

488
00:28:30,822 --> 00:28:34,920
SO IT'S PRETTY FAST AND IT'S
STRONG IN THAT IT CAN BREAK

489
00:28:34,920 --> 00:28:36,720
TORQUE AND SET TORQUE.

490
00:28:36,720 --> 00:28:39,880
IT'S A VERY STRONG TOOL.

491
00:28:39,880 --> 00:28:44,740
THE PROBLEM IS WHEN I'M DOING
111 FASTENERS, IT'S REALLY NOT

492
00:28:44,740 --> 00:28:46,620
FAST ENOUGH FOR US.

493
00:28:46,620 --> 00:28:49,190
SO WE CREATED THIS TOOL CALLED
THE MINI POWER TOOL.

494
00:28:49,190 --> 00:28:51,750
THE SPEED IS 180.

495
00:28:51,750 --> 00:28:55,090
THREE TIMES FASTER THAN THE
PISTOL GRIP TOOL.

496
00:28:55,090 --> 00:28:58,760
NOW, JUST TO GIVE YOU AN EXAMPLE
OF TIME.

497
00:28:58,760 --> 00:29:04,080
IF I HAD 100 FASTENERS AND I HAD
TO RELEASE EACH ONE OF THOSE TEN

498
00:29:04,080 --> 00:29:10,090
TIMES, 100 FASTENERS USING THE
PGT, IT WOULD TAKE ME 18 MINUTES

499
00:29:10,090 --> 00:29:13,410
OF TIME JUST RELEASING THE
FASTENERS AND THAT'S NOT

500
00:29:13,410 --> 00:29:16,760
INCLUDING TAKING IT OUT, PUTTING
IT IN AND LINING IT UP.

501
00:29:16,760 --> 00:29:19,690
IT WOULD TAKE US A VERY, VERY
LONG TIME TO RELEASE ALL THE

502
00:29:19,690 --> 00:29:22,110
FASTENERS WITH THIS PISTOL GRIP
TOOL.

503
00:29:22,110 --> 00:29:23,890
THAT'S WHY WE CREATED THIS MINI
POWER TOOL.

504
00:29:23,890 --> 00:29:28,090
IT'S THREE TIMES FASTER AND
DOESN'T HAVE THE TORQUE BECAUSE

505
00:29:28,090 --> 00:29:29,450
THE SCREWS ARE SO SMALL.

506
00:29:29,450 --> 00:29:34,630
WE DIDN'T HAVE THE REQUIREMENT
FOR A LARGE TOOL TO USE.

507
00:29:34,630 --> 00:29:36,180
MINI POWER TOOL.

508
00:29:36,180 --> 00:29:38,780
NEXT SLIDE.

509
00:29:38,780 --> 00:29:41,750
SO WE ALSO NEEDED THESE
DIFFERENT BITS FOR THE DIFFERENT

510
00:29:41,750 --> 00:29:45,740
TYPE OF SCREWS INSTALLED ON A
FASTENER PLATE TO RELEASE THEM.

511
00:29:45,740 --> 00:29:48,440
WE CREATED THESE BITS THAT ARE
COLOR CODED.

512
00:29:48,440 --> 00:29:53,799
TO HELP THE ASTRONAUT IDENTIFY.

513
00:29:53,799 --> 00:29:57,050
WE ARRANGE THESE IN A BIT CADDY.

514
00:29:57,050 --> 00:30:00,570
WE EQUATE THIS TO THE INDY PIT
CREW WHEN THE RACE CAR COMES IN,

515
00:30:00,570 --> 00:30:01,640
TIME IS OF THE ESSENCE.

516
00:30:01,640 --> 00:30:06,280
WE WANT THE CAR TURNED RIGHT
BACK OUT IN THE RACETRACK.

517
00:30:06,280 --> 00:30:07,850
SAME THING FOR US.

518
00:30:07,850 --> 00:30:10,490
WE WANT TO MAKE BEST USE OF
ASTRONAUT TIME.

519
00:30:10,490 --> 00:30:17,790
HOW CAN WE MAKE THIS CHANGEOUT
QUICKER?

520
00:30:17,790 --> 00:30:20,220
WHATEVER TIME WE COULD SAVE
WOULD BE GREAT.

521
00:30:20,220 --> 00:30:24,500
SO WE CREATED THIS BIT CADDY FOR
EACH ONE OF THE FASTENERS TO BE

522
00:30:24,500 --> 00:30:26,890
RELEASED BY A BIT.

523
00:30:26,890 --> 00:30:30,560
NEXT SLIDE, PLEASE.

524
00:30:30,560 --> 00:30:33,010
SO HERE'S SOME CREW
EVALUATION/TRAINING.

525
00:30:33,010 --> 00:30:37,690
MORE LIKE ED WAS TALKING ABOUT
AT GODARD AND DOWN AT JSC.

526
00:30:37,690 --> 00:30:39,400
THE MINI POWER TOOL.

527
00:30:39,400 --> 00:30:47,540
WE DECIDED TO TAKE SOMETHING
LIKE THE PISTOL GRIP TOOL ANDY

528
00:30:47,540 --> 00:30:52,570
†-- AND DIVIDE IT IN HALF.

529
00:30:52,570 --> 00:30:58,180
DOWN THE LEFT HAND CORNER THERE
ARE FOUR YELLOW TOOLS.

530
00:30:58,180 --> 00:31:01,040
WE TRAVELED TO HOUSTON, MET UP
WITH A COUPLE OF ASTRONAUTS AND

531
00:31:01,040 --> 00:31:02,970
BROUGHT THESE FOUR TOOLS.

532
00:31:02,970 --> 00:31:06,501
INSIDE THOSE TOOLS WE PRESET
THEM TO A DIFFERENT SPEED SO WE

533
00:31:06,501 --> 00:31:08,530
ASKED ALL THE DIFFERENT
ASTRONAUTS WHAT DO YOU THINK OF

534
00:31:08,530 --> 00:31:09,530
THIS SPEED?

535
00:31:09,530 --> 00:31:11,630
WE WERE TRYING TO FIND OUT WHAT
WAS THE OPTIMAL SPEED AND THAT'S

536
00:31:11,630 --> 00:31:15,200
HOW WE GOT TO 180.

537
00:31:15,200 --> 00:31:19,169
UP ON THE TOP IS MIKE WITH THE
PISTOL GRIP TOOL ON THE FIRST

538
00:31:19,169 --> 00:31:23,840
VERSION, FIRST TIME HE EVER SAW
THE PLATE BEFORE RELEASING THE

539
00:31:23,840 --> 00:31:24,840
SCREW.

540
00:31:24,840 --> 00:31:28,920
AND THIS IS BEFORE WE DECIDED TO
CREATE THE MINI POWER TOOL.

541
00:31:28,920 --> 00:31:33,200
NOW YOU SEE MIKE WEARING SOME
ASTRONAUT GLOVES WITH THE MINI

542
00:31:33,200 --> 00:31:38,549
POWER TOOL AND A TRAINER TO
ALLOW THEM TO PRACTICE AND TRAIN

543
00:31:38,549 --> 00:31:41,570
WHENEVER HE HAD TIME TO PRACTICE
AND TRAIN.

544
00:31:41,570 --> 00:31:45,040
SO THIS IS A CUSTOM INTERFACE
MADE FOR HIM AS A TRAINING UNIT.

545
00:31:45,040 --> 00:31:47,910
ON THE RIGHT-HAND SIDE IS A
PICTURE OF ONE OF THE CREW

546
00:31:47,910 --> 00:31:50,200
MEMBERS USING THE PISTOL GRIP
TOOL.

547
00:31:50,200 --> 00:31:53,650
RELEASING THE YELLOW HANDRAIL IN
THE WAY TO REMOVE THE CARD.

548
00:31:53,650 --> 00:31:55,820
WHY ARE WE USING THAT?

549
00:31:55,820 --> 00:31:59,500
THOSE BOLTS ARE REALLY BIG AND
REQUIRE MORE TORQUE.

550
00:31:59,500 --> 00:32:01,830
THIS IS THE TOOL RIGHT THERE.

551
00:32:01,830 --> 00:32:03,820
THIS IS OUR NBL TRAINING TOOL.

552
00:32:03,820 --> 00:32:08,610
NEXT SLIDE, PLEASE.

553
00:32:08,610 --> 00:32:13,380
THIS SHOULD BE A MOVIE.

554
00:32:13,380 --> 00:32:17,200
SO THIS IS AT NBL AND THIS IS A
CREW MEMBER RELEASING A

555
00:32:17,200 --> 00:32:18,200
FASTENER.

556
00:32:18,200 --> 00:32:20,660
I'M SORRY IF IT'S A LITTLE DARK.

557
00:32:20,660 --> 00:32:23,259
SO HE'S LINING THE TOOL UP.

558
00:32:23,259 --> 00:32:24,259
STABILIZING HIMSELF.

559
00:32:24,259 --> 00:32:31,330
AND THERE HE GOES TO RELEASE IT.

560
00:32:31,330 --> 00:32:35,179
SO I APOLOGIZE BECAUSE THIS
VIDEO IS DARK BUT YOU GOT TO

561
00:32:35,179 --> 00:32:38,700
REMEMBER, THIS IS SUPPOSED TO
OCCUR INSIDE THE HUBBLE SPACE

562
00:32:38,700 --> 00:32:42,030
TELESCOPE WHICH IS LIKE A
PHOTOGRAPHY DARK ROOM.

563
00:32:42,030 --> 00:32:44,640
IT IS SUPPOSED TO BE DARK.

564
00:32:44,640 --> 00:32:48,330
THE CREW MEMBER BRINGS LIGHTS ON
THEIR HELMETS AND WE HAVE A

565
00:32:48,330 --> 00:32:50,640
LIGHT UP AT THE FRONT END OF THE
TOOL TO ALLOW THEM TO LIGHT UP

566
00:32:50,640 --> 00:32:54,870
THE WORK SITE THEY'RE TRYING TO
WORK ON.

567
00:32:54,870 --> 00:32:58,980
SO HERE'S A SUMMARY OF STEP-WISE
OF FILLING THE FASTENER PLATE

568
00:32:58,980 --> 00:33:04,290
AND HOW WE USE THE MINI POWER
TOOL WITH THE BIG CADDY

569

00:33:04,290 --> 00:33:06,760
OPTIMALLY TO CHANGE OUT BITS
QUICK AND DO THE CHANGEOUT

570
00:33:06,760 --> 00:33:11,070
EASIER AND THE CREW MEMBER DOING
THE DIFFERENT STEPS TO RELEASE

571
00:33:11,070 --> 00:33:14,309
EACH ONE OF THE 111 FASTENERS.

572
00:33:14,309 --> 00:33:17,049
NEXT SLIDE.

573
00:33:17,049 --> 00:33:21,710
THIS IS WHAT HAPPENS WHEN I GET
TO LOOK AT HARDWARE THAT CAME

574
00:33:21,710 --> 00:33:23,360
BACK FROM SPACE.

575
00:33:23,360 --> 00:33:26,330
WHEN THE FASTENER PLATE CAME
BACK, WE TOOK IT OFF OUR

576
00:33:26,330 --> 00:33:27,330
HARDWARE.

577
00:33:27,330 --> 00:33:28,330
IT CAME BACK TO GODARD.

578
00:33:28,330 --> 00:33:29,821
I OPENED UP THE BOX AND THIS IS
WHAT I SAW.

579
00:33:29,821 --> 00:33:35,780
I SAW THE PLATE INDEED CAPTURING
THESE SMALL FASTENERS THAT MIKE

580

00:33:35,780 --> 00:33:37,800
RELEASED.

581
00:33:37,800 --> 00:33:41,370
AND YOU CAN SEE HERE'S THE HOLE
THAT THE BIT OF THE TOOL WOULD

582
00:33:41,370 --> 00:33:45,549
GO INTO TO GET ON TO THE
FASTENER BUT THE FASTENER HEAD

583
00:33:45,549 --> 00:33:46,980
CAN'T COME BACK OUT THE HOLE.

584
00:33:46,980 --> 00:33:50,450
WE WERE SUCCESSFUL IN CAPTURING
FASTENERS.

585
00:33:50,450 --> 00:33:54,990
NEXT SLIDE, PLEASE.

586
00:33:54,990 --> 00:33:57,690
THAT CLAMP I WAS MENTIONING, THE
SMALL CLAMP THAT HELD A DIVING

587
00:33:57,690 --> 00:34:02,960
BOARD, HERE'S A HAND SKETCH I
DID BACK IN 2006 OF SOMETHING I

588
00:34:02,960 --> 00:34:08,060
THOUGHT WOULD BE A GOOD IDEA,
SOMETHING TO GRAB ON TO IT.

589
00:34:08,060 --> 00:34:11,069
YOU SEE HERE SOMETHING THAT†-- A
CONCEPT OR PROTOCOL TYPE THAT

590
00:34:11,069 --> 00:34:14,839
WE'RE TRAINING IN THE POOL AND
THE FLIGHT UNIT.

591
00:34:14,839 --> 00:34:17,409
IT'S NOT TOO FAR OFF FROM
ORIGINAL CONCEPT OF WHAT THIS

592
00:34:17,409 --> 00:34:21,049
TOOL COULD LOOK LIKE FROM THE
START TO THE END.

593
00:34:21,049 --> 00:34:24,229
DOWN ON THE BOTTOM IS MIKE
REMOVING THE PLATE.

594
00:34:24,229 --> 00:34:28,269
THIS IS THE FIRST TIME AT GODARD
HE ACTUALLY REMOVED IT.

595
00:34:28,269 --> 00:34:34,269
HERE HE IS AT TRAINING REMOVING
IT AS WELL AS THIS IS THE†--

596
00:34:34,269 --> 00:34:37,119
DURING FLIGHT THIS IS THE
FASTENER CAPTURE PLATE ATTACHED

597
00:34:37,119 --> 00:34:40,039
TO THE COVER REMOVED BEING
TRANSLATED TO SPACE.

598
00:34:40,039 --> 00:34:44,230
IT'S HARD TO SEE BUT THERE ARE
TINY WIRES ON THE BACK.

599
00:34:44,230 --> 00:34:45,230
WHY?

600
00:34:45,230 --> 00:34:47,319
THIS IS A INSTRUMENT.

601

00:34:47,319 --> 00:34:52,499
THE THERMAL PEOPLE WANT TO KNOW
WHAT THE TEMPERATURE WAS OF THE

602
00:34:52,499 --> 00:34:55,470
RADIATOR DURING THE OPERATION OF
THE INSTRUMENT.

603
00:34:55,470 --> 00:34:58,920
IF WE'RE REMOVING THE COVER THE
WIRE IS STILL THERE.

604
00:34:58,920 --> 00:35:00,049
WE HAD TO CUT THAT WIRE.

605
00:35:00,049 --> 00:35:04,680
GO TO THE NEXT SLIDE, PLEASE.

606
00:35:04,680 --> 00:35:06,289
WE USED THE WIRE CUTTER TOOL.

607
00:35:06,289 --> 00:35:10,059
IT'S BASICALLY A SURGICAL TOOL
WE MADE EVA FRIENDLY.

608
00:35:10,059 --> 00:35:15,229
WE PUT A COVER TO PROTECT THE
ASTRONAUT.

609
00:35:15,229 --> 00:35:16,229
THERE WAS A PITCH POINT.

610
00:35:16,229 --> 00:35:19,150
SO WE PUT CLOTH TO PREVENT THE
ASTRONAUT FROM PINCHING HIS

611
00:35:19,150 --> 00:35:24,690
FINGER AND A CREW HOOK ON IT SO
IT WOULDN'T FLOAT AWAY FROM HIM.

612
00:35:24,690 --> 00:35:27,700
NEXT SLIDE.

613
00:35:27,700 --> 00:35:29,700
AND HIT PLAY.

614
00:35:29,700 --> 00:35:31,700
I'M SORRY.

615
00:35:31,700 --> 00:35:35,690
DID WE MISS ONE?

616
00:35:35,690 --> 00:35:39,759
SO THIS IS ON ORBIT VIDEO OF
MIKE RELEASING THE FASTENER

617
00:35:39,759 --> 00:35:42,819
CAPTURE PLATE AND YOU SEE A HAND
HERE.

618
00:35:42,819 --> 00:35:48,309
THIS IS MIKE GOOD BUENO WITH THE
WIRE CUTTING TOOL CUTTING THAT

619
00:35:48,309 --> 00:35:52,479
LITTLE TINY WIRE BEHIND THE
PLATE.

620
00:35:52,479 --> 00:35:56,840
AND AS YOU CAN SEE THE FASTENERS
ARE FLOATING AROUND IN THEIR

621
00:35:56,840 --> 00:36:00,440
LITTLE POCKETS.

622
00:36:00,440 --> 00:36:06,950
NEXT SLIDE.

623

00:36:06,950 --> 00:36:09,849
SO WHEN IT CAME TO THE COVER
BEING REMOVED WE HAD TO PULL OUT

624
00:36:09,849 --> 00:36:10,980
THE CARD.

625
00:36:10,980 --> 00:36:14,619
WE HAD TO USE WHAT WE CALL A
CARD EXTRACTION TOOL AND I HAVE

626
00:36:14,619 --> 00:36:18,920
OUR NBL VERSION HERE OF THE CARD
EXTRACTION TOOL.

627
00:36:18,920 --> 00:36:21,739
IF ANYONE HAS SEEN THE MOVIE
"GRAVITY," THIS TOOL AND THE

628
00:36:21,739 --> 00:36:26,259
WIRE CUTTER TOOL ARE USED BY
SANDRA BULLOCK IN THE MOVIE.

629
00:36:26,259 --> 00:36:30,880
THIS TOOL IS FAMOUS.

630
00:36:30,880 --> 00:36:33,519
SO WE HAD TO USE A CARD
EXTRACTION TOOL BECAUSE THE CARD

631
00:36:33,519 --> 00:36:37,160
IS HELD IN THERE AND THIS IS
WHAT A TYPICAL ELECTRONIC CARD

632
00:36:37,160 --> 00:36:38,690
LOOKS LIKE.

633
00:36:38,690 --> 00:36:42,890
IT'S NOT POPULATED WITH A LOT OF
COMPONENTS BUT IT'S THE SIZE OF

634
00:36:42,890 --> 00:36:43,950
THE ELECTRONIC BOARD.

635
00:36:43,950 --> 00:36:50,849
THE FAILED ONE THAT WE HAD TO
REMOVE.

636
00:36:50,849 --> 00:36:53,440
NEXT SLIDE.

637
00:36:53,440 --> 00:36:57,670
HERE IS MIKE REMOVING THE NEW
CARD, THE NEW CARD AND ITS OWN

638
00:36:57,670 --> 00:37:00,319
BRAND NEW SPECIAL SAFE BOX.

639
00:37:00,319 --> 00:37:07,549
WHEN I WAS AT THE WORK SITE HE
WOULD REMOVE IT AND PLUG IT BACK

640
00:37:07,549 --> 00:37:12,539
INTO THE INSTRUMENT AND IT IS
USED IN THE INSERTION.

641
00:37:12,539 --> 00:37:15,059
NEXT SLIDE.

642
00:37:15,059 --> 00:37:18,700
SO WHEN IT CAME DOWN TO IT, THE
CARD WAS†-- BAD CARD WAS REMOVE

643
00:37:18,700 --> 00:37:22,489
AND NEW PUT BACK IN ITS PLACE.

644
00:37:22,489 --> 00:37:26,400
WE'RE NOT GOING TO SPEND THE
TIME PUTTING 111 SCREWS BACK.

645
00:37:26,400 --> 00:37:31,630
WE WORK TO BE VERY EFFICIENT
CREATING NEW WAYS TO DO THINGS.

646
00:37:31,630 --> 00:37:37,490
WE CREATED A NEW MEB COVER THAT
SIMPLY WAS PUT INTO PLACE, A

647
00:37:37,490 --> 00:37:41,970
LATCH HERE AND HERE, SWUNG
OUTSIDE AND WE HAD THE TINY PINS

648
00:37:41,970 --> 00:37:45,569
THAT YOU WOULD LOCK IN PLACE AND
IT WAS FULLY INSTALLED AND WE

649
00:37:45,569 --> 00:37:50,220
SHOWED THE CREW MEMBER DOWN HERE
PRACTICING WITH ASTRONAUT GLOVES

650
00:37:50,220 --> 00:37:52,640
PERFORMING THAT TASK.

651
00:37:52,640 --> 00:37:56,589
WHEN MACK TOOK ABOUT 35 MINUTES
RELEASING ALL THE FASTENERS JUST

652
00:37:56,589 --> 00:38:01,800
TO TAKE THE COVER OFF THIS COVER
WENT ON IN MERE SECONDS.

653
00:38:01,800 --> 00:38:02,930
VERY EFFICIENT.

654
00:38:02,930 --> 00:38:04,680
NEXT SLIDE.

655
00:38:04,680 --> 00:38:06,670

SO NOW WE'RE GOING TO MOVE INTO
ANOTHER INSTRUMENT.

656
00:38:06,670 --> 00:38:08,079
THE ACS INSTRUMENT.

657
00:38:08,079 --> 00:38:09,460
HERE IT IS.

658
00:38:09,460 --> 00:38:11,739
IT ALSO HAD AN MEB BOX.

659
00:38:11,739 --> 00:38:13,970
THAT'S WHERE THE FAILURE OF THE
CARD OCCURRED.

660
00:38:13,970 --> 00:38:19,180
THE PROBLEM IS THAT INSTRUMENT,
ACS, AS IT SITS INSIDE THE

661
00:38:19,180 --> 00:38:22,579
HUBBLE SPACE TELESCOPE, THERE'S
A BIG ELECTRONIC COOLER BOX IN

662
00:38:22,579 --> 00:38:23,579
THE WAY.

663
00:38:23,579 --> 00:38:26,519
THERE'S NORWAY FOR US TO
PHYSICALLY ACCESS THAT BOX.

664
00:38:26,519 --> 00:38:31,499
THE SMART FIGURED OUT A WAY THAT
IF I GO INTO THIS BOX RIGHT

665
00:38:31,499 --> 00:38:35,999
HERE, IF IF I GO INTO THERE, I
COULD BACK-POWER THE INSTRUMENT.

666

00:38:35,999 --> 00:38:37,819
THEY FIGURED OUT A WAY.

667
00:38:37,819 --> 00:38:40,380
WE HAD TO GO AFTER A WAY OF HOW
ARE WE GOING TO GET INSIDE OF

668
00:38:40,380 --> 00:38:45,839
THIS INSTRUMENT.

669
00:38:45,839 --> 00:38:49,710
AROUND THE PERIMETER HERE ARE 16
FASTENERS WITH WASHERS THAT IS

670
00:38:49,710 --> 00:38:51,619
YOU SEE A SECTION RIGHT HERE.

671
00:38:51,619 --> 00:38:53,160
UNDERNEATH ARE 32 SPACERS.

672
00:38:53,160 --> 00:38:57,099
THAT'S A LOT OF FASTENERS AND
COMPONENTS WE NEED TO CONTROL.

673
00:38:57,099 --> 00:38:59,410
THEN ONCE THAT IS DONE WE'RE
TRYING TO REMOVE THE BLACK

674
00:38:59,410 --> 00:39:02,109
COVER, 32 FASTENERS IN ALL.

675
00:39:02,109 --> 00:39:04,329
ANOTHER BIG NUMBER THING TO DO.

676
00:39:04,329 --> 00:39:07,509
WE DECIDED WELL, LET'S NOT
REMOVE THIS WHOLE THING.

677
00:39:07,509 --> 00:39:09,869

LET'S JUST GO RIGHT FOR THE
BLACK COVER, LET'S GO THROUGH

678
00:39:09,869 --> 00:39:11,940
THIS PLATE.

679
00:39:11,940 --> 00:39:15,559
AND ED PROVIDED ME THIS COVER
RIGHT HERE.

680
00:39:15,559 --> 00:39:19,130
THIS IS THE EXACT REPLICA OF THE
COVER WE HAD TO GO THROUGH.

681
00:39:19,130 --> 00:39:21,290
IT'S PRETTY THIN ALUMINUM.

682
00:39:21,290 --> 00:39:24,119
SO WE DEVISED A WAY TO GO
THROUGH INSTEAD OF RELEASING ALL

683
00:39:24,119 --> 00:39:28,160
THE HARDWARE TO GET AROUND IT.

684
00:39:28,160 --> 00:39:30,890
NEXT SLIDE, PLEASE.

685
00:39:30,890 --> 00:39:34,799
WE WANTED TO INSTALL JUST LIKE
THIS REPAIR ANCHOR GUIDE STUDIES

686
00:39:34,799 --> 00:39:41,190
OF MEANS OF ATTACHING DEVICES
THAT WILL BE ABLE TO HANDLE A

687
00:39:41,190 --> 00:39:42,190
LEVERAGE.

688
00:39:42,190 --> 00:39:47,430

WE WANT TO REMOVE FOUR
FASTENERS, NOT ALL 16.

689
00:39:47,430 --> 00:39:51,759
WE DID THIS WITH THIS PARTICULAR
SCREWDRIVER WITH A TIP ON IT AND

690
00:39:51,759 --> 00:39:53,779
THE CAPTURE HOOK AND A BLOCK.

691
00:39:53,779 --> 00:39:56,729
ONCE THE FASTENER WAS RELEASED
IT WOULD BE PRESSED INTO THIS

692
00:39:56,729 --> 00:40:00,270
BLOCK AND NO LONGER WOULD BE
RELEASED OR COULD AFFECT THE

693
00:40:00,270 --> 00:40:03,119
TELESCOPE BY FLYING INTO THE
PLACES WE DON'T WANT IT TO.

694
00:40:03,119 --> 00:40:05,940
I HAVE A VIDEO ON THE NEXT
SLIDE, PLEASE.

695
00:40:05,940 --> 00:40:06,940
OKAY.

696
00:40:06,940 --> 00:40:07,940
I DON'T.

697
00:40:07,940 --> 00:40:09,609
HERE'S A CREW MEMBER.

698
00:40:09,609 --> 00:40:12,510
REMOVING ONE OF FOUR FASTENERS.

699
00:40:12,510 --> 00:40:15,410

WE CAN GO RIGHT TO THE VIDEO AND
YOU CAN SEE THE CREW MEMBER

700
00:40:15,410 --> 00:40:20,420
TRAINING IN THE NBL POOL.

701
00:40:20,420 --> 00:40:30,229
BUT FIRST UP, ASTRONAUT PUTS ON
HIS GLOVES.

702
00:40:30,229 --> 00:40:34,660
HE GRABS THE TOOL.

703
00:40:34,660 --> 00:40:36,589
THERE WE GO.

704
00:40:36,589 --> 00:40:43,849
SO NOW YOU SEE HIM RELEASING A
COUPLE TURNS ON THE FASTENER.

705
00:40:43,849 --> 00:40:45,210
THE FASTENER IS RELEASED.

706
00:40:45,210 --> 00:40:46,859
HE EXTENDS THE FORK.

707
00:40:46,859 --> 00:40:50,300
IT CAPTURES BEHIND THE WASHER
AND GETS THE SCREW.

708
00:40:50,300 --> 00:40:54,319
HE CONTINUES TO BACK OFF THE
SCREW.

709
00:40:54,319 --> 00:41:03,140
THERE HE GOES.

710
00:41:03,140 --> 00:41:05,779
AND THE SCREW IS RELEASED AN

WOULD GO BACK INTO THE FASTENER

711
00:41:05,779 --> 00:41:09,079
CAPTURE BLOCK FOR RETENTION.

712
00:41:09,079 --> 00:41:11,950
SO ONCE WE HAD THE FOUR
FASTENERS REMOVED, ONE, TWO,

713
00:41:11,950 --> 00:41:15,910
THREE, FOUR, WE PUT THE ANCHOR
GUIDE STUDS JUST LIKE THIS, ACS

714
00:41:15,910 --> 00:41:18,039
HAS ITS OWN.

715
00:41:18,039 --> 00:41:20,910
WE CREATED A CADDY FOR THESE
GUYS TO MAKE SURE THEY WERE IN

716
00:41:20,910 --> 00:41:24,469
THE KIT AND ALL TOGETHER AND
WOULDN'T FLOAT AWAY.

717
00:41:24,469 --> 00:41:27,499
THEN WE HAD A HANDLE TO ALLOW
THEM TO PUT THE GUIDE STUDS IN.

718
00:41:27,499 --> 00:41:30,799
IF WE GO TO NEXT SLIDE, WE HAVE
A SHORT CLIP OF THE ASTRONAUT

719
00:41:30,799 --> 00:41:33,029
PERFORMING ONE OF THOSE
INSTALLS.

720
00:41:33,029 --> 00:41:37,369
SCREWING IT IN.

721

00:41:37,369 --> 00:41:38,920
HE'S RELEASING IT AND IT'S I
STALLED.

722
00:41:38,920 --> 00:41:40,390
VERY, VERY QUICK AND EASY.

723
00:41:40,390 --> 00:41:43,369
NEXT SLIDE.

724
00:41:43,369 --> 00:41:47,589
SO AS FAR AS PROTECTIVE GRID IS
CONCERNED, HERE'S A GRID WE

725
00:41:47,589 --> 00:41:48,589
NEEDED TO GO THROUGH.

726
00:41:48,589 --> 00:41:50,460
WE DEVELOPED SOMETHING CALLED A
GRID CUTTER.

727
00:41:50,460 --> 00:41:53,550
THAT'S WHAT YOU SEE ON THE LEFT
HAND CORNER OF THE WINDOW.

728
00:41:53,550 --> 00:41:57,319
THE GRID CUTTER ALLOWED US TO
INSTALL A DEVICE THAT BECAME A

729
00:41:57,319 --> 00:42:01,789
GUILLOTINE FOR EACH ONE OF THE
SPOKES OF THE FRAME.

730
00:42:01,789 --> 00:42:06,739
AND BECAUSE IT HAD SHARP EDGES
IT HAD ITS OWN BAG TO GO UP IN.

731
00:42:06,739 --> 00:42:11,420
SO HERE'S A CREW MEMBER, JOHN,
INSTALLING THIS PLATE AND THEN

732
00:42:11,420 --> 00:42:15,779
HE USES THE PGT, WE NEED A PGT
BECAUSE WE WANT HIGH TORQUE.

733
00:42:15,779 --> 00:42:21,450
IT TAKES A LOT OF FORCE TO SNAP
EACH ONE OF THOSE GRIDS.

734
00:42:21,450 --> 00:42:25,740
AND BECAUSE OF A STRUT RIGHT
HERE, THESE FASTENERS COULDN'T

735
00:42:25,740 --> 00:42:28,950
BE HIT NOT EVEN WITH THE WOBBLE
SOCKET.

736
00:42:28,950 --> 00:42:32,239
SO WE HAD TO ANGLE TOWARDS THE
SIDE.

737
00:42:32,239 --> 00:42:36,670
WHEN IT WAS DONE WE HAD A BAG
RIGHT HERE.

738
00:42:36,670 --> 00:42:40,289
YOU'RE REMOVING THE GRID THAT
YOU CUT AND THE TOOL AND IT GOES

739
00:42:40,289 --> 00:42:44,299
BACK INTO THE SAME BAG IT FLEW
UP IN JUST LIKE THIS BAG RIGHT

740
00:42:44,299 --> 00:42:45,299
HERE.

741
00:42:45,299 --> 00:42:46,789
YOU INTRODUCE A SHARP EDGE.

742

00:42:46,789 --> 00:42:49,839
YOU HAVE BEEN ABLE TO CONTROL
AND LIMIT THE AMOUNT OF CREW

743
00:42:49,839 --> 00:42:53,440
TIME THEY HAVE INTO THIS
EXPOSURE.

744
00:42:53,440 --> 00:42:57,249
DOWN HERE IS A PICTURE OF THAT
RETURN TOOL AND THE GRID THAT I

745
00:42:57,249 --> 00:43:01,210
SAW AND TOOK THIS PICTURE WHEN
THE HARDWARE CAME BACK DOWN ON

746
00:43:01,210 --> 00:43:03,210
TO EARTH.

747
00:43:03,210 --> 00:43:05,210
NEXT SLIDE.

748
00:43:05,210 --> 00:43:06,219
OKAY.

749
00:43:06,219 --> 00:43:10,309
SO NEXT UP IS THE FASTENER
EXTRACTION TOOL.

750
00:43:10,309 --> 00:43:13,900
I BELIEVE THIS IS ON DISPLAY ON
THE WEBSITE I BELIEVE.

751
00:43:13,900 --> 00:43:14,900
>> YES.

752
00:43:14,900 --> 00:43:17,479
>> SO IF ANYONE HAS WORKED ON
ANYTHING IN THIS THEIR HOME THAT

753
00:43:17,479 --> 00:43:20,529
INVOLVES A SCREW AND THERE ARE A
NUMBER OF SCREWS IT'S ALWAYS

754
00:43:20,529 --> 00:43:25,279
THAT LAST SCREW THAT BECOMES
DIFFICULT.

755
00:43:25,279 --> 00:43:28,930
SO WE DECIDED IS WE'RE GOING TO
TAKE THE TOOLS AND HERE YOU SEE

756
00:43:28,930 --> 00:43:31,460
THE CREW MEMBER IN THE POOL
DOING THE SAME.

757
00:43:31,460 --> 00:43:34,150
WE'RE GOING TO GET ON TO EACH
ONE OF THOSE LITTLE TINY 32

758
00:43:34,150 --> 00:43:37,160
SCREWS AND BREAK THE TORQUE OF
EVERY SINGLE ONE OF THEM.

759
00:43:37,160 --> 00:43:38,160
WHY?

760
00:43:38,160 --> 00:43:40,180
BECAUSE WE WANT TO MAKE SURE WE
CAN RELEASE EVERY ONE OF THEM

761
00:43:40,180 --> 00:43:43,880
BEFORE WE GET MORE INVOLVED IN
THE PROGRAM.

762
00:43:43,880 --> 00:43:46,130
ANOTHER PICTURE IS SHOWING THE
STRUT I WAS TALKING TO YOU

763

00:43:46,130 --> 00:43:47,130
ABOUT.

764
00:43:47,130 --> 00:43:49,249
THE ACCESS TO THE BOX IS REALLY
DIFFICULT.

765
00:43:49,249 --> 00:43:51,940
WE HAVE TWO OF THESE FASTENER
TOOLS.

766
00:43:51,940 --> 00:43:53,259
A LONG ONE AND SHORT ONE.

767
00:43:53,259 --> 00:43:56,319
WE'RE ABLE TO GIVE THE CREW
MEMBER THE ABILITY TO CHOOSE A

768
00:43:56,319 --> 00:44:01,050
LONG OR SHORT BASED ON WHERE
THEY WERE RELEASING THE SCREWS.

769
00:44:01,050 --> 00:44:02,050
WHEN THAT WAS DONE.

770
00:44:02,050 --> 00:44:06,759
WE HAVE ACS, A SMALLER VERSION
OF THE FASTENER CAPTURE PLATE

771
00:44:06,759 --> 00:44:07,950
THAT DID THE SAME FUNCTION.

772
00:44:07,950 --> 00:44:12,359
ALLOWS US TO CAPTURE A FASTENER
SO THEY FLOAT AWAY AND RUIN THE

773
00:44:12,359 --> 00:44:13,359
OPTICS.

774

00:44:13,359 --> 00:44:16,359
THEN WE SEE THE POWER TOOL
REACHING THROUGH AND RELEASING

775
00:44:16,359 --> 00:44:17,359
THE SCREWS.

776
00:44:17,359 --> 00:44:19,339
WE CAN GO TO THE NEXT SLIDE.

777
00:44:19,339 --> 00:44:22,819
HERE'S A DIFFERENT VIEW OF THE
FASTENER CAPTURE PLATE BY

778
00:44:22,819 --> 00:44:23,819
ITSELF.

779
00:44:23,819 --> 00:44:27,359
HERE IT IS CAPTURED THE BLACK
PLATES OF ACS.

780
00:44:27,359 --> 00:44:28,910
HERE IT IS WITHOUT THE BLACK
PLATE.

781
00:44:28,910 --> 00:44:31,150
DOWN HERE IS A FLIGHT RETURN
PICTURE.

782
00:44:31,150 --> 00:44:34,650
THIS IS WHAT I TOOK WHEN I FOUND
THIS WHEN I OPENED UP THE BOX.

783
00:44:34,650 --> 00:44:39,160
I SAW THE FASTENERS THAT HAD
RETAINED DURING THE FLIGHT.

784
00:44:39,160 --> 00:44:41,029
NEXT SLIDE.

785
00:44:41,029 --> 00:44:42,539
OKAY.

786
00:44:42,539 --> 00:44:47,079
WE CAN VIDEO.

787
00:44:47,079 --> 00:44:52,559
HERE'S A CREW MEMBER IN THE DARK
WITH THE FASTENER EXTENSION TOOL

788
00:44:52,559 --> 00:44:56,180
RELEASING EACH ONE OF THOSE
FASTENERS BEFORE YOU PUT THE

789
00:44:56,180 --> 00:44:57,369
PLATE ON.

790
00:44:57,369 --> 00:45:00,519
NOW WITH THE PLATE, EVEN WITH
THE MINI POWER TOOL BEING AS

791
00:45:00,519 --> 00:45:03,509
SMALL AS IT WAS, IT STILL HAD
PROBLEMS BEING NEXT TO

792
00:45:03,509 --> 00:45:06,400
STRUCTURE, SO HE WOULD USE THE
HAND TOOL TO GET THE REALLY

793
00:45:06,400 --> 00:45:08,049
TOUGH PLACES.

794
00:45:08,049 --> 00:45:15,420
WE'LL LET THIS PLAY OUT.

795
00:45:15,420 --> 00:45:26,380
SO THIS IS BACK AT GODARD WITH
THE MINI POWER TOOL.

796
00:45:26,380 --> 00:45:30,190
RELEASING THE DIFFERENT
FASTENERS.

797
00:45:30,190 --> 00:45:34,089
SO WE'RE ABLE TO DELIVER TO ONE
OF THE ASTRONAUTS, MIKE, A

798
00:45:34,089 --> 00:45:36,729
TRAINER IN ORDER FOR HIM TO
TRAIN.

799
00:45:36,729 --> 00:45:40,190
WE COULDN'T DO THAT FOR JOHN
BECAUSE WE DIDN'T†-- IT WOULD BE

800
00:45:40,190 --> 00:45:42,400
A LARGE STRUCTURE IN ORDER TO
ACCOMMODATE THAT TRAINING

801
00:45:42,400 --> 00:45:43,400
FACILITY.

802
00:45:43,400 --> 00:45:46,400
SO JOHN HAD TO COME UP TO GODARD
OFTEN TO PERFORM HIS TRAINING

803
00:45:46,400 --> 00:45:52,329
ACTIVITIES WHERE MIKE HAD TO DO
IT BASICALLY AT HIS LEISURE.

804
00:45:52,329 --> 00:45:55,970
SO JUST LIKE WE HAD THIS CARD
EXTRACTION TOOL THAT I SHOWED

805
00:45:55,970 --> 00:45:59,039
YOU FOR PULLING A CARD OUT, WE
NEEDED TO DO THE SAME THING FOR

806

00:45:59,039 --> 00:46:01,130
ACS.

807
00:46:01,130 --> 00:46:06,180
WE'RE REMOVING FOUR BOARDS, NOT
ONE.

808
00:46:06,180 --> 00:46:09,119
SO WE DECIDED TO PUT THE TOOL
TOGETHER.

809
00:46:09,119 --> 00:46:11,680
SO WE CALLED IT THE INDEXING
CARD EXTRACTION TOOL.

810
00:46:11,680 --> 00:46:14,029
ED, WE THOUGHT WE WERE REALLY
COOL BECAUSE WE CALLED IT THE

811
00:46:14,029 --> 00:46:20,420
ICE T.
SO IT'S RIGHT HERE.

812
00:46:20,420 --> 00:46:25,289
HERE'S THE ICE T AND THE ICE T
HAD TO ATTACH SOMEHOW ON TO THE

813
00:46:25,289 --> 00:46:26,289
ACS INSTRUMENT.

814
00:46:26,289 --> 00:46:29,450
IF YOU RECALL, WE PUT THE ANCHOR
GUIDE STUDS ON BEFORE.

815
00:46:29,450 --> 00:46:33,829
THE ANCHOR GUIDE STUDS, WE HAD
AN ADAPTER DOWN HERE THAT WOULD

816
00:46:33,829 --> 00:46:36,380
MECHANICALLY ATTACH ON TO THE

STUDS.

817
00:46:36,380 --> 00:46:39,450
THAT GAVE US ANOTHER FOUNDATION
WHERE THE ICE T WOULD THEN

818
00:46:39,450 --> 00:46:43,700
ATTACH AS YOU SEE HERE ON TO THE
BOX AND ALLOW US TO INDEX EACH

819
00:46:43,700 --> 00:46:46,789
ONE OF THE EXTRACTION POINTS TO
REMOVE THE CARD.

820
00:46:46,789 --> 00:46:50,440
WHEN THE CARD WAS REMOVED, VERY,
VERY SHARP, DIDN'T WANT THE

821
00:46:50,440 --> 00:46:53,969
ASTRONAUT ANYWHERE NEAR IT, WE
WOULD PUT IT IMMEDIATELY INTO A

822
00:46:53,969 --> 00:46:55,670
BAG THAT WOULD HOLD ALL FOUR
BOARDS.

823
00:46:55,670 --> 00:46:59,440
THAT'S WHAT YOU SEE RIGHT HERE.

824
00:46:59,440 --> 00:47:02,040
NEXT SLIDE, PLEASE.

825
00:47:02,040 --> 00:47:05,230
SO WHEN THE ACS TASK WAS
COMPLETED IT BECAME EASIER TO

826
00:47:05,230 --> 00:47:10,980
PUT THINGS BACK TOGETHER AGAIN.

827

00:47:10,980 --> 00:47:15,750
WE'VE GOT A MODULE, ELECTRONIC
BOX CAVITY.

828
00:47:15,750 --> 00:47:18,549
WE REMOVED FOUR BOARDS AND HAD
TO PUT SOMETHING BACK IN.

829
00:47:18,549 --> 00:47:21,480
WE'RE TRYING TO BACK-POWER THE
INSTRUMENT.

830
00:47:21,480 --> 00:47:24,619
WE PUT THE MODULE INTO THERE.

831
00:47:24,619 --> 00:47:29,940
YOU SEE THE CREW MEMBER IN THE
POOL PERFORMING THE SAME

832
00:47:29,940 --> 00:47:34,400
ACTIVITY AND PUT A ELECTRONIC
BOX ON THE HANDRAIL AND RUN THE

833
00:47:34,400 --> 00:47:38,690
HARNESS INTO THE POWER SUPPLY.

834
00:47:38,690 --> 00:47:44,559
WE'RE ABLE TO RESTORE THE
INSTRUMENT AND POWER IT BACK UP.

835
00:47:44,559 --> 00:47:46,339
A COUPLE SLIDES IN CONCLUSION.

836
00:47:46,339 --> 00:47:51,690
HERE'S THE START OF THE HUBBLE
MISSION ON THE LAUNCH PAD.

837
00:47:51,690 --> 00:47:53,950
NEXT SLIDE.

838
00:47:53,950 --> 00:47:56,319
HERE'S THE BEAUTIFUL LAUNCH THAT
ED AND I GOT TO WITNESS

839
00:47:56,319 --> 00:47:57,869
FIRSTHAND.

840
00:47:57,869 --> 00:48:02,680
NEXT SLIDE.

841
00:48:02,680 --> 00:48:08,109
THE NEXT SLIDE SHOWS INTO THE
CARGO BAY.

842
00:48:08,109 --> 00:48:11,039
YOU NOTICE THE COOLING SYSTEM
HERE.

843
00:48:11,039 --> 00:48:13,380
THIS IS ONE OF THE NEW
INSTRUMENTS.

844
00:48:13,380 --> 00:48:16,130
AND THEN YOU SEE THE RMS IN THE
DISTANCE.

845
00:48:16,130 --> 00:48:17,559
NEXT SLIDE.

846
00:48:17,559 --> 00:48:19,520
WE RELEASED HUBBLE.

847
00:48:19,520 --> 00:48:21,349
THIS IS THE RELEASE PICTURE.

848
00:48:21,349 --> 00:48:24,660
A NICE ONE OF OUR PINS
COMMEMORATING THE 25th

849
00:48:24,660 --> 00:48:28,170
ANNIVERSARY OF HUBBLE PERFORMING
DIFFERENT OPERATIONS FOR US.

850
00:48:28,170 --> 00:48:34,280
LASTLY, NEXT SLIDE, WE BROUGHT
SAFELY THE 125 CREW HOME AND

851
00:48:34,280 --> 00:48:37,249
ABLE TO SHARE ALL THE DIFFERENT
EXPERIENCES THAT OUR TEAM

852
00:48:37,249 --> 00:48:41,029
EXPERIENCED WITH THE ASTRONAUT
TEAM AND THE SERVICING TEAMS AND

853
00:48:41,029 --> 00:48:42,240
EVERYONE TOGETHER.

854
00:48:42,240 --> 00:48:45,339
OUR GREAT OPPORTUNITY TO SERVICE
THE HUBBLE SPACE TELESCOPE.

855
00:48:45,339 --> 00:48:47,809
JENNIFER, THAT'S THE END OF THE
PRESENTATION.

856
00:48:47,809 --> 00:48:48,809
>> THANK YOU SO MUCH.

857
00:48:48,809 --> 00:48:51,210
I THINK WE'RE GOING TO TAKE
QUESTIONS RIGHT NOW.

858
00:48:51,210 --> 00:48:54,710
IF ANY OF YOU HAVE QUESTIONS IN
THE AUDIENCE, FEEL FREE TO STEP

859
00:48:54,710 --> 00:48:57,029

UP TO THE MICROPHONE HERE.

860
00:48:57,029 --> 00:49:02,779
WE MAY HAVE QUESTIONS FROM
ONLINE.

861
00:49:02,779 --> 00:49:04,940
>> WE'RE GOING TO START WITH AN
ONLINE QUESTION.

862
00:49:04,940 --> 00:49:13,559
WHAT ARE THE POSSIBILITIES FOR
3D PRINTING TOOLS IN SPACE AND

863
00:49:13,559 --> 00:49:14,949
WHAT ARE THE CHALLENGES?

864
00:49:14,949 --> 00:49:16,150
>> WHAT ARE THE CHALLENGES.

865
00:49:16,150 --> 00:49:17,670
I'LL TELL YOU ABOUT 3D PRINTING
IN SPACE.

866
00:49:17,670 --> 00:49:21,219
RIGHT NOW THERE'S A COMPANY THAT
HAS PROVIDED TO THE SPACE

867
00:49:21,219 --> 00:49:23,210
STATION THE PRINTING CAPABILITY.

868
00:49:23,210 --> 00:49:25,430
SO THE ABILITY EXISTS RIGHT NOW.

869
00:49:25,430 --> 00:49:27,789
I BELIEVE IN THE FALL TIME FRAME
THEY'RE GOING TO DELIVER AN

870
00:49:27,789 --> 00:49:31,869

UPGRADED PRINTER WITH MORE
CAPABILITIES AND BOTH ED AND

871
00:49:31,869 --> 00:49:36,049
MYSELF, WE ARE NOW WORKING ON
NOT ONLY WORKING ON ASTRONAUT

872
00:49:36,049 --> 00:49:38,450
SERVICES BUT ROBOTIC SERVICING.

873
00:49:38,450 --> 00:49:42,729
THERE'S A GREAT ROBOTIC SPACE
STATION THAT WE HAVE SENT PAY

874
00:49:42,729 --> 00:49:46,969
LOADS UP SHOWING A ROBOT CAN
TAKE THINGS APART AND WE WOULD

875
00:49:46,969 --> 00:49:49,329
LIKE TO SHOW WE CAN PUT THINGS
TOGETHER.

876
00:49:49,329 --> 00:49:51,930
BECAUSE OF THAT, WE HAVE SOME
REQUIREMENTS THAT ARE GOING TO

877
00:49:51,930 --> 00:49:56,739
MAKE USE OF 3D PRINTING TO
DEMONSTRATE THAT WE CAN DO

878
00:49:56,739 --> 00:50:00,680
IN-SPACE MANUFACTURING AND
SUPPORT, NOT ONLY IVA WORK BUT

879
00:50:00,680 --> 00:50:03,750
ROBOTIC WORK.

880
00:50:03,750 --> 00:50:06,609
>> DAVID.

881
00:50:06,609 --> 00:50:09,380
>> DURING THE SERVICING MISSIONS
WHAT WAS YOUR LIFE LIKE?

882
00:50:09,380 --> 00:50:12,140
DID YOU GET ANY SLEEP?

883
00:50:12,140 --> 00:50:14,349
>> ED, THAT'S FOR YOU.

884
00:50:14,349 --> 00:50:16,000
>> I'LL TAKE THAT.

885
00:50:16,000 --> 00:50:18,430
YEAH, SURE, WE GOT SOME SLEEP.

886
00:50:18,430 --> 00:50:21,859
NOT AS MUCH AS WE COULD HAVE
USED.

887
00:50:21,859 --> 00:50:23,450
BUT IT'S VERY HECTIC.

888
00:50:23,450 --> 00:50:25,300
YOU HAVE GOT A DEADLINE.

889
00:50:25,300 --> 00:50:28,890
YOU'RE WORKING AROUND A WHOLE
BUNCH OF DIFFERENT SCHEDULES

890
00:50:28,890 --> 00:50:34,890
INCLUDING THE CREW AVAILABILITY,
THE TOOL ENGINEERS RESPONDING TO

891
00:50:34,890 --> 00:50:40,719
INPUT, TO TURN THINGS AROUND FOR
THE NEXT EVALUATION.

892

00:50:40,719 --> 00:50:43,450
I GOT TO TELL YOU THOUGH, I
DON'T THINK†-- I THINK IT'S FAIR

893
00:50:43,450 --> 00:50:47,549
TO SAY THAT NOBODY REALLY
COMPLAINS.

894
00:50:47,549 --> 00:50:52,130
BECAUSE WE ARE FORTUNATE TO BE
DOING SOMETHING THAT WE REALLY

895
00:50:52,130 --> 00:50:55,970
ARE ENJOYING AND NOT A WHOLE LOT
OF PEOPLE GET AN OPPORTUNITY TO

896
00:50:55,970 --> 00:50:56,970
DO.

897
00:50:56,970 --> 00:50:57,970
AND WE'RE MAKING HISTORY.

898
00:50:57,970 --> 00:51:01,289
>> I MEAN IT'S ALMOST LIKE THE
SUPER BOWL OR THE WORLD SERIES

899
00:51:01,289 --> 00:51:02,289
FOR US.

900
00:51:02,289 --> 00:51:05,339
IT'S SOMETHING WE HAVE BEEN
TRAINING AND WORKING WITH FOR

901
00:51:05,339 --> 00:51:06,829
THESE YEARS.

902
00:51:06,829 --> 00:51:07,829
>> YES.

903

00:51:07,829 --> 00:51:08,829
>> OKAY.

904
00:51:08,829 --> 00:51:12,069
WE HAVE ANOTHER ONLINE QUESTION.

905
00:51:12,069 --> 00:51:15,749
WHAT WAS THE MOST DIFFICULT
HUBBLE SERVICING MISSION?

906
00:51:15,749 --> 00:51:23,410
>> I'LL TELL YOU†-- DIFFICULT.

907
00:51:23,410 --> 00:51:27,859
I'LL TELL YOU WHICH ONE WAS THE
MOST AMBITIOUS AND IT'S THE ONE

908
00:51:27,859 --> 00:51:30,450
WE HAVE BEEN TALKING ABOUT.

909
00:51:30,450 --> 00:51:31,450
THE 125 MISSION.

910
00:51:31,450 --> 00:51:33,200
WE MENTIONED HUBBLE IS MODULAR
IN DESIGN.

911
00:51:33,200 --> 00:51:38,410
YOU KNOW, AS TECHNOLOGY CATCHES
UP OR PARTS WEAR OUTS ON ORBIT,

912
00:51:38,410 --> 00:51:43,460
YOU PULL OUT ONE BOX AND PUT IN
ANOTHER BUT IN ADDITION TO THAT,

913
00:51:43,460 --> 00:51:51,869
WE HAD TWO MAJOR INSTRUMENTS
THAT HAD TO BE FIXED ON SITE.

914

00:51:51,869 --> 00:51:56,029
SO IT PRESENTED SOME CHALLENGES.

915
00:51:56,029 --> 00:51:58,839
SOME OF THE TASKS WE THOUGHT
WOULD BE MORE DIFFICULT, TURNED

916
00:51:58,839 --> 00:52:04,290
OUT TO BE PERFORMED VERY, VERY
SMOOTHLY AND THEN SOME ONES WE

917
00:52:04,290 --> 00:52:06,549
DIDN'T EXPECT THROUGH SOME
SURPRISES.

918
00:52:06,549 --> 00:52:12,359
BUT THE NEAT THING ABOUT STS-125
IS GOING INTO IT, WE KNEW THIS

919
00:52:12,359 --> 00:52:14,809
WAS GOING TO BE OUR LAST
OPPORTUNITY TO SERVICE THE

920
00:52:14,809 --> 00:52:18,430
HUBBLE SPACE TELESCOPE USING A
SPACE SHUTTLE.

921
00:52:18,430 --> 00:52:25,549
WE WANTED TO LEAVE HER IN AS
BEST OPERATING CONDITION AS WE

922
00:52:25,549 --> 00:52:30,609
POSSIBLY COULD AND THROUGH THE
TRAINING, THROUGH DEVELOPING OF

923
00:52:30,609 --> 00:52:35,319
SOME AWESOME ONE OF A KIND
TOOLS, WE WERE ABLE TO DO THAT.

924
00:52:35,319 --> 00:52:39,680

EVERY MISSION GOES UP WITH A
LIST OF PRIORITIES, A LIST OF

925
00:52:39,680 --> 00:52:42,519
OBJECTIVES AND THEN YOU HAVE
ALWAYS GOT THE BACK POCKET WISH

926
00:52:42,519 --> 00:52:43,519
LIST.

927
00:52:43,519 --> 00:52:47,549
WE WERE ABLE TO GET EVERYTHING
DONE ON STS-125.

928
00:52:47,549 --> 00:52:51,309
>> AND THE HUBBLE SPACE
TELESCOPE WILL CONTINUE TO

929
00:52:51,309 --> 00:52:54,300
FUNCTION HOPEFULLY WITH NO
FAILURES FOR AT LEAST A FEW

930
00:52:54,300 --> 00:52:59,069
YEARS TO COME AND RETURN SOME
GREAT IMAGES FOR ALL OF US TO

931
00:52:59,069 --> 00:53:00,069
ENJOY.

932
00:53:00,069 --> 00:53:02,119
I WANT TO THANK OUR SPEAKERS FOR
JOINING US TODAY.

933
00:53:02,119 --> 00:53:06,369
AND FOR ALL OF YOU IN THE
AUDIENCE HERE IN THE EXHIBITION

934
00:53:06,369 --> 00:53:12,219
AND ONLINE AND TV AS WELL FOR
PARTICIPATING AND ENJOYING THE

935
00:53:12,219 --> 00:53:13,219
SHOW TODAY.

936
00:53:13,219 --> 00:53:16,719
WE THANK OUR SPEAKERS AND
HOPEFULLY YOU CAN JOIN US NEXT