1
00:00:05,670 --> 00:00:03,030
okay thanks everybody for uh for

2
00:00:07,510 --> 00:00:05,680
rejoining our session um first thing i'd

3
00:00:09,750 --> 00:00:07,520
like to do is just

4
00:00:11,749 --> 00:00:09,760
i think we had a fabulous session with

5
00:00:14,390 --> 00:00:11,759
our presenters i'd like to

6
00:00:17,029 --> 00:00:14,400
really thank everybody who submitted an

7
00:00:18,870 --> 00:00:17,039
rfi input and presented today

8
00:00:20,630 --> 00:00:18,880
um i think we had a so congratulations

9
00:00:22,550 --> 00:00:20,640
to all i know it takes a lot of time and

10
00:00:24,310 --> 00:00:22,560
energy to put these together

11
00:00:25,670 --> 00:00:24,320
to write the paper and submit them but

12
00:00:27,589 --> 00:00:25,680
there's some really good ideas that we

13
00:00:32,709 --> 00:00:27,599

can use so thank you very much for

14
00:00:36,950 --> 00:00:34,870
i'd also like to thank before we get

15
00:00:39,110 --> 00:00:36,960
into talking about uh the different

16
00:00:40,549 --> 00:00:39,120
topics that we'll kind of cover i'd

17
00:00:42,630 --> 00:00:40,559
really like to thank a few people that

18
00:00:45,990 --> 00:00:42,640
made this session possible like to thank

19
00:00:48,709 --> 00:00:46,000
mark mcdonald who led our cat team

20
00:00:50,709 --> 00:00:48,719
joe gard who helped look at all the rfi

21
00:00:51,830 --> 00:00:50,719
submittals and pedro lopez who isn't

22
00:00:54,069 --> 00:00:51,840
here today

23
00:00:55,189 --> 00:00:54,079
wendy watkins for helping support the

24
00:00:58,310 --> 00:00:55,199
session

25
00:00:59,910 --> 00:00:58,320
alma stephanie tapia who's kept me

26
00:01:01,349 --> 00:00:59,920
trying to keep me straight

27
00:01:02,869 --> 00:01:01,359
for this whole

28
00:01:04,469 --> 00:01:02,879
this whole workshop and for many other

29
00:01:05,590 --> 00:01:04,479
things she's helped organize our session

30
00:01:07,590 --> 00:01:05,600
today

31
00:01:08,630 --> 00:01:07,600
carlos westell who's helped build the

32
00:01:09,990 --> 00:01:08,640
charts

33
00:01:12,310 --> 00:01:10,000
and

34
00:01:13,990 --> 00:01:12,320
all our other team members back in

35
00:01:15,190 --> 00:01:14,000
houston that really helped make this

36
00:01:16,710 --> 00:01:15,200
possible

37
00:01:18,149 --> 00:01:16,720
so what we're going to do is hopefully

38
00:01:20,149 --> 00:01:18,159

we'll make this a little interactive but

39
00:01:21,830 --> 00:01:20,159
we'll try to talk about

40
00:01:23,350 --> 00:01:21,840
a few of the different topics coming out

41
00:01:24,870 --> 00:01:23,360
of today's session and where we go

42
00:01:26,710 --> 00:01:24,880
forward from here

43
00:01:28,070 --> 00:01:26,720
we really see this in in a couple of

44
00:01:29,830 --> 00:01:28,080
different uh

45
00:01:31,510 --> 00:01:29,840
a couple different frameworks these are

46
00:01:33,990 --> 00:01:31,520
the building blocks that we use that i

47
00:01:35,990 --> 00:01:34,000
talked about we were really trying to to

48
00:01:37,590 --> 00:01:36,000
make this mission very affordable very

49
00:01:39,270 --> 00:01:37,600
lean and just use the bare bones

50
00:01:40,950 --> 00:01:39,280
capabilities for orion

51
00:01:42,550 --> 00:01:40,960
today

52
00:01:46,310 --> 00:01:42,560
you guys have presented some amazing

53
00:01:48,149 --> 00:01:46,320
ideas of how we can move forward

54
00:01:49,670 --> 00:01:48,159
we'll talk about things under four

55
00:01:51,109 --> 00:01:49,680
different areas extensibility for

56
00:01:52,630 --> 00:01:51,119
exploration

57
00:01:54,870 --> 00:01:52,640
anchoring techniques

58
00:01:56,310 --> 00:01:54,880
translation and tools robotics and

59
00:01:58,550 --> 00:01:56,320
additional mass

60
00:02:00,870 --> 00:01:58,560
delivery for utilization

61
00:02:02,149 --> 00:02:00,880
the way we kind of see the mission

62
00:02:05,670 --> 00:02:02,159
for those of you that are familiar with

63
00:02:08,869 --> 00:02:07,270

you know today we have the international

64
00:02:11,029 --> 00:02:08,879
space station at the top row and we're

65
00:02:12,949 --> 00:02:11,039
doing amazing exploration

66
00:02:14,390 --> 00:02:12,959
work onboard the space station closed

67
00:02:15,910 --> 00:02:14,400
loop life support

68
00:02:17,190 --> 00:02:15,920
habitability human health and

69
00:02:19,190 --> 00:02:17,200
performance

70
00:02:20,869 --> 00:02:19,200
the next phase is this asteroid redirect

71
00:02:22,710 --> 00:02:20,879
mission in the next row where we'll do

72
00:02:25,190 --> 00:02:22,720
some exploration of that

73
00:02:27,270 --> 00:02:25,200
that asteroid in one or two missions is

74
00:02:29,270 --> 00:02:27,280
kind of the concept those sort of feed

75
00:02:30,949 --> 00:02:29,280
into an extended duration time frame in

76
00:02:32,550 --> 00:02:30,959
cis lunar space and many of the ideas

77
00:02:35,670 --> 00:02:32,560
that we've talked about

78
00:02:38,309 --> 00:02:35,680
with enhanced robotics uh with modules

79
00:02:40,550 --> 00:02:38,319
to extend our duration and cis lunar

80
00:02:42,470 --> 00:02:40,560
space beyond what orion provides those

81
00:02:44,550 --> 00:02:42,480
are the things that feed into that into

82
00:02:46,390 --> 00:02:44,560
that kind of realm that lunar vicinity

83
00:02:48,830 --> 00:02:46,400
cis lunar space

84
00:02:51,670 --> 00:02:48,840
will sort of use this as a staging point

85
00:02:52,790 --> 00:02:51,680
for sort of building up for exploration

86
00:02:55,030 --> 00:02:52,800
and then

87
00:02:57,750 --> 00:02:55,040
the the global exploration roadmap shows

88
00:03:00,149 --> 00:02:57,760

the next phase of of other partners who

89
00:03:02,949 --> 00:03:00,159
are interested very much in the lunar

90
00:03:04,949 --> 00:03:02,959
operations it shows a path there that

91
00:03:06,710 --> 00:03:04,959
nasa would support those operations

92
00:03:08,390 --> 00:03:06,720
should another partner decide

93
00:03:09,990 --> 00:03:08,400
to pursue that and then of course our

94
00:03:13,110 --> 00:03:10,000
ultimate destination on the bottom row

95
00:03:14,869 --> 00:03:13,120
is sustainability toward mars and so the

96
00:03:16,550 --> 00:03:14,879
things when we talk about what

97
00:03:19,190 --> 00:03:16,560
capabilities to pursue

98
00:03:20,949 --> 00:03:19,200
we need to keep in mind the end goal of

99
00:03:22,710 --> 00:03:20,959
mars is the destination

100
00:03:24,229 --> 00:03:22,720
and also these these other paths in

101
00:03:25,910 --> 00:03:24,239
system or space

102
00:03:27,589 --> 00:03:25,920
so what we want to do is take the

103
00:03:30,229 --> 00:03:27,599
initial mission which is

104
00:03:32,390 --> 00:03:30,239
we agree is a very uh capable mission

105
00:03:34,309 --> 00:03:32,400
but very very simplistic and sort of

106
00:03:36,710 --> 00:03:34,319
build upon that with the things we've

107
00:03:38,630 --> 00:03:36,720
talked about today

108
00:03:39,990 --> 00:03:38,640
so here's kind of a notional path that

109
00:03:42,309 --> 00:03:40,000
we might uh

110
00:03:45,589 --> 00:03:42,319
we might be on this is our concept of

111
00:03:47,030 --> 00:03:45,599
extensibility sort of in the near term

112
00:03:48,949 --> 00:03:47,040
you know we would fly a couple of

113
00:03:50,949 --> 00:03:48,959

missions testing out the orion

114
00:03:53,509 --> 00:03:50,959
capabilities then we would fly maybe

115
00:03:55,190 --> 00:03:53,519
this arm mission to the asteroid you can

116
00:03:56,710 --> 00:03:55,200
see the robotic spacecraft in the upper

117
00:03:58,949 --> 00:03:56,720
left and then we would bring orion up

118
00:04:00,630 --> 00:03:58,959
and then we sort of see this next phase

119
00:04:02,149 --> 00:04:00,640
is extended operations in cis-lunar

120
00:04:04,550 --> 00:04:02,159
space

121
00:04:07,509 --> 00:04:04,560
where we might have a habitation module

122
00:04:09,350 --> 00:04:07,519
of sorts we show a node-like module but

123
00:04:11,350 --> 00:04:09,360
but boeing and lockheed had really good

124
00:04:12,710 --> 00:04:11,360
ideas as well on how to how to extend

125
00:04:13,589 --> 00:04:12,720
that capability how to do different

126
00:04:15,429 --> 00:04:13,599
things

127
00:04:17,110 --> 00:04:15,439
perhaps that module is an international

128
00:04:19,110 --> 00:04:17,120
module as mike

129
00:04:20,629 --> 00:04:19,120
rafferty showed in his presentation and

130
00:04:22,150 --> 00:04:20,639
then we showed you know maybe there's

131
00:04:23,189 --> 00:04:22,160
some resupply

132
00:04:25,350 --> 00:04:23,199
vehicle

133
00:04:28,550 --> 00:04:25,360
on there as well and then there's sort

134
00:04:30,150 --> 00:04:28,560
of a path as we build in cis-lunar space

135
00:04:32,070 --> 00:04:30,160
then we can build toward a mars deep

136
00:04:34,710 --> 00:04:32,080
exploration capability or

137
00:04:37,110 --> 00:04:34,720
maybe some uh some lunar excursions to

138
00:04:38,550 --> 00:04:37,120

to work telerobotics with with the with

139
00:04:40,310 --> 00:04:38,560
the lunar surface so there's sort of a

140
00:04:41,909 --> 00:04:40,320
path that supports the global

141
00:04:43,189 --> 00:04:41,919
exploration roadmap we've had to work

142
00:04:44,710 --> 00:04:43,199
hand-in-hand with our partners through

143
00:04:46,629 --> 00:04:44,720
this process

144
00:04:48,950 --> 00:04:46,639
so this is just sort of notional of how

145
00:04:50,870 --> 00:04:48,960
how we sort of see it

146
00:04:52,629 --> 00:04:50,880
in the workshop today we've had a lot of

147
00:04:54,390 --> 00:04:52,639
really good ideas on extending orion

148
00:04:55,990 --> 00:04:54,400
capability beyond

149
00:04:57,350 --> 00:04:56,000
what it's designed for which is for crew

150
00:04:59,110 --> 00:04:57,360
21 days

151
00:05:01,029 --> 00:04:59,120
you know we thought that the pantry idea

152
00:05:01,909 --> 00:05:01,039
was a really great idea by lockheed to

153
00:05:05,350 --> 00:05:01,919
try to

154
00:05:07,670 --> 00:05:05,360
extend that capability uh and

155
00:05:10,629 --> 00:05:07,680
in a relatively simplistic approach i

156
00:05:12,390 --> 00:05:10,639
think we would have to to work on

157
00:05:14,870 --> 00:05:12,400
launch mass and how that mission would

158
00:05:17,189 --> 00:05:14,880
be executed to social interspace

159
00:05:18,790 --> 00:05:17,199
with our early block one

160
00:05:20,230 --> 00:05:18,800
we we have

161
00:05:21,990 --> 00:05:20,240
very good capability but we'd have to

162
00:05:23,510 --> 00:05:22,000
look at that carefully

163
00:05:25,189 --> 00:05:23,520

the pantry is pretty unique and

164
00:05:27,830 --> 00:05:25,199
innovative and that you know we could

165
00:05:29,830 --> 00:05:27,840
stow with some additional uh

166
00:05:32,150 --> 00:05:29,840
eva hardware additional food to extend

167
00:05:33,430 --> 00:05:32,160
that duration and just use orion so it's

168
00:05:35,749 --> 00:05:33,440
looks like it would be something we

169
00:05:38,629 --> 00:05:35,759
could study and be pretty affordable

170
00:05:40,710 --> 00:05:38,639
then on the lower left we see you know

171
00:05:42,550 --> 00:05:40,720
the boeing approach which

172
00:05:45,510 --> 00:05:42,560
shows maybe more extended capability

173
00:05:47,270 --> 00:05:45,520
using using a node attached to the arv

174
00:05:49,029 --> 00:05:47,280
which is a very similar concept to what

175
00:05:51,510 --> 00:05:49,039
what we've looked at as well and trying

176
00:05:52,870 --> 00:05:51,520
to extend that operations in in cisco

177
00:05:53,990 --> 00:05:52,880
interspace so we think that feeds

178
00:05:54,790 --> 00:05:54,000
forward very well and something that

179
00:05:59,830 --> 00:05:54,800
we'll

180
00:06:01,990 --> 00:05:59,840
and then you know beyond that there was

181
00:06:03,590 --> 00:06:02,000
some really good ideas relative to

182
00:06:05,270 --> 00:06:03,600
robotics and how

183
00:06:06,950 --> 00:06:05,280
we could extend the capability and

184
00:06:10,710 --> 00:06:06,960
provide more capability

185
00:06:12,710 --> 00:06:10,720
from from mda from goddard from atk and

186
00:06:15,189 --> 00:06:12,720
from several others on how we could we

187
00:06:17,189 --> 00:06:15,199
could maybe extend that capability

188
00:06:18,790 --> 00:06:17,199

that really augments the asteroid

189
00:06:20,230 --> 00:06:18,800
mission it provides

190
00:06:22,550 --> 00:06:20,240
you know extended capability we'd have

191
00:06:24,550 --> 00:06:22,560
to mature the suits along with that

192
00:06:26,710 --> 00:06:24,560
today that the suits as i talked about

193
00:06:28,870 --> 00:06:26,720
earlier and talked about yesterday

194
00:06:29,909 --> 00:06:28,880
the early suit capability that we're

195
00:06:31,830 --> 00:06:29,919
employing

196
00:06:34,390 --> 00:06:31,840
is a very limited capability and so we'd

197
00:06:36,070 --> 00:06:34,400
have to expand our eva capability to

198
00:06:38,150 --> 00:06:36,080
to utilize some of these robotics and

199
00:06:41,270 --> 00:06:38,160
then at the bottom again

200
00:06:42,950 --> 00:06:41,280
we see a nice concept with another

201
00:06:45,430 --> 00:06:42,960
perhaps international partner module

202
00:06:47,430 --> 00:06:45,440
extending operations in cisco interspace

203
00:06:48,550 --> 00:06:47,440
so we really see this as a series of

204
00:06:50,710 --> 00:06:48,560
missions

205
00:06:53,990 --> 00:06:50,720
not just one initial mission we've

206
00:06:55,830 --> 00:06:54,000
talked openly about the first mission

207
00:06:57,830 --> 00:06:55,840
a lot and we've worked on that at the

208
00:07:00,070 --> 00:06:57,840
conceptual level we really need to kind

209
00:07:01,110 --> 00:07:00,080
of string together some some sequence of

210
00:07:02,710 --> 00:07:01,120
missions

211
00:07:05,110 --> 00:07:02,720
and i think i'll pause here to see if

212
00:07:06,469 --> 00:07:05,120
there's any comments from anybody

213
00:07:08,150 --> 00:07:06,479

in the audience

214
00:07:09,670 --> 00:07:08,160
in our panel today relative to

215
00:07:12,469 --> 00:07:09,680
extensibility

216
00:07:18,629 --> 00:07:12,479
um whether mike or somebody wants to

217
00:07:21,749 --> 00:07:20,230
if we can talk a little bit about the

218
00:07:23,909 --> 00:07:21,759
sequence of missions

219
00:07:28,230 --> 00:07:23,919
concept um that seems like a really

220
00:07:31,430 --> 00:07:28,240
important concept and it's difficult

221
00:07:34,550 --> 00:07:31,440
not having a firm destination set for

222
00:07:36,230 --> 00:07:34,560
after asteroid but maybe there's ways to

223
00:07:37,909 --> 00:07:36,240
look at

224
00:07:40,469 --> 00:07:37,919
capabilities in a sequence of missions

225
00:07:42,390 --> 00:07:40,479
that feed forward directly to mars and

226
00:07:44,629 --> 00:07:42,400
have

227
00:07:47,670 --> 00:07:44,639
direct applicability to that kind of

228
00:07:48,869 --> 00:07:47,680
mission has been maybe emphasized

229
00:07:50,230 --> 00:07:48,879
um

230
00:07:51,589 --> 00:07:50,240
and it seems like that would tie in with

231
00:07:52,869 --> 00:07:51,599
the ger what are your thoughts about

232
00:07:54,550 --> 00:07:52,879
that steve

233
00:07:57,510 --> 00:07:54,560
yeah i think we're sort of looking at

234
00:07:59,350 --> 00:07:57,520
you know how do we tie together uh

235
00:08:01,270 --> 00:07:59,360
how do we start with this mission and

236
00:08:03,589 --> 00:08:01,280
then build upon that and the sequence of

237
00:08:05,589 --> 00:08:03,599
missions that gets us to mars and what

238
00:08:07,430 --> 00:08:05,599

would those missions look like

239
00:08:08,869 --> 00:08:07,440
what would the propulsion system look

240
00:08:10,710 --> 00:08:08,879
like how does the solar electric

241
00:08:12,150 --> 00:08:10,720
propulsion feed forward

242
00:08:14,230 --> 00:08:12,160
um how do the solar array technology

243
00:08:16,150 --> 00:08:14,240
feed forward all that we think you know

244
00:08:18,550 --> 00:08:16,160
lines up very well with with cargo

245
00:08:20,390 --> 00:08:18,560
delivery to mars and so some sequence of

246
00:08:22,790 --> 00:08:20,400
of launches we think system of space

247
00:08:24,309 --> 00:08:22,800
will be an area will operate in for some

248
00:08:25,430 --> 00:08:24,319
period of time as we do the build up

249
00:08:27,270 --> 00:08:25,440
just like for international space

250
00:08:29,029 --> 00:08:27,280
station there was some sequence of time

251
00:08:31,430 --> 00:08:29,039
where you're building up

252
00:08:32,790 --> 00:08:31,440
but we agree mike that there's some

253
00:08:34,630 --> 00:08:32,800
period of time where we're going to be

254
00:08:36,870 --> 00:08:34,640
building up a capability

255
00:08:39,990 --> 00:08:36,880
in cisco inner space and as we begin to

256
00:08:47,670 --> 00:08:40,000
move out toward mars

257
00:08:53,590 --> 00:08:51,269
i think you you said it well steve um

258
00:08:56,310 --> 00:08:53,600
by looking forward

259
00:08:59,910 --> 00:08:56,320
that's really the focus of where human

260
00:09:02,150 --> 00:08:59,920
exploration is going on to mars and and

261
00:09:03,750 --> 00:09:02,160
i think we kind of although the asteroid

262
00:09:05,590 --> 00:09:03,760
mission is very important we think of

263
00:09:06,870 --> 00:09:05,600

that as a stepping stone to going

264
00:09:08,630 --> 00:09:06,880
further so

265
00:09:10,470 --> 00:09:08,640
keeping that in mind and making sure

266
00:09:13,910 --> 00:09:10,480
that things for the asteroid mission are

267
00:09:15,829 --> 00:09:13,920
proving out that next step is crucial in

268
00:09:17,829 --> 00:09:15,839
doing things that are extensive

269
00:09:20,550 --> 00:09:17,839
extensible in that regard

270
00:09:21,910 --> 00:09:20,560
i agree we see the asteroid mission as a

271
00:09:23,990 --> 00:09:21,920
a nice foundation where we get those

272
00:09:25,590 --> 00:09:24,000
early capabilities docking

273
00:09:27,110 --> 00:09:25,600
um eva

274
00:09:29,110 --> 00:09:27,120
and then the solar array insular

275
00:09:31,430 --> 00:09:29,120
electric propulsion and we can operate

276
00:09:33,990 --> 00:09:31,440
relatively close to the earth it's much

277
00:09:35,350 --> 00:09:34,000
further 10 days or 12 days away relative

278
00:09:38,710 --> 00:09:35,360
to where we're at with space station but

279
00:09:40,550 --> 00:09:38,720
it's a kind of a stepping stone approach

280
00:09:42,630 --> 00:09:40,560
i think ben has a comment

281
00:09:44,710 --> 00:09:42,640
yeah

282
00:09:46,150 --> 00:09:44,720
i would say that uh and i know you're

283
00:09:48,230 --> 00:09:46,160
doing this as well but just to let the

284
00:09:50,150 --> 00:09:48,240
public know that not only

285
00:09:51,750 --> 00:09:50,160
destinations you know where are we going

286
00:09:53,269 --> 00:09:51,760
to go next but

287
00:09:55,990 --> 00:09:53,279
just sticking around there's still lots

288
00:09:58,710 --> 00:09:56,000

of very meaningful work that the crew

289
00:10:01,590 --> 00:09:58,720
can do in orbit that robots can't do by

290
00:10:03,190 --> 00:10:01,600
themselves like assemble very large

291
00:10:04,870 --> 00:10:03,200
observatories

292
00:10:06,550 --> 00:10:04,880
so i think as we develop the

293
00:10:09,910 --> 00:10:06,560
capabilities here to stay out there

294
00:10:11,990 --> 00:10:09,920
longer to have advanced

295
00:10:15,190 --> 00:10:12,000
techniques for evas and robotics

296
00:10:18,069 --> 00:10:15,200
assembly and and manipulation of goods

297
00:10:19,670 --> 00:10:18,079
that that lends itself extremely well

298
00:10:21,910 --> 00:10:19,680
towards

299
00:10:23,190 --> 00:10:21,920
a meaningful goal for the public

300
00:10:26,870 --> 00:10:23,200
and

301
00:10:29,670 --> 00:10:26,880
science missions that could not

302
00:10:31,590 --> 00:10:29,680
otherwise be done right it is enabling

303
00:10:32,949 --> 00:10:31,600
to science

304
00:10:34,870 --> 00:10:32,959
and i think that's one of the things

305
00:10:36,150 --> 00:10:34,880
that made the hubble mission so

306
00:10:38,870 --> 00:10:36,160
successful

307
00:10:41,829 --> 00:10:38,880
for everyone is not just that we did

308
00:10:44,150 --> 00:10:41,839
neato engineering things but we rewrote

309
00:10:45,829 --> 00:10:44,160
the textbook two or three and four times

310
00:10:48,069 --> 00:10:45,839
over with the science that hubble did

311
00:10:49,910 --> 00:10:48,079
afterwards that was only possible

312
00:10:51,829 --> 00:10:49,920
because of the crew

313
00:10:53,829 --> 00:10:51,839

the crew and robots working together to

314
00:10:56,630 --> 00:10:53,839
change out those instruments and to to

315
00:10:59,590 --> 00:10:56,640
do the repairs the unplanned tasks

316
00:11:02,069 --> 00:10:59,600
that i think is is one way that nasa can

317
00:11:04,310 --> 00:11:02,079
you know recapture the american spirit

318
00:11:06,150 --> 00:11:04,320
and and support is by doing meaningful

319
00:11:07,350 --> 00:11:06,160
missions like that

320
00:11:09,350 --> 00:11:07,360
thanks ben

321
00:11:10,710 --> 00:11:09,360
and we think too you know

322
00:11:12,069 --> 00:11:10,720
i think chris moore said it best

323
00:11:14,470 --> 00:11:12,079
probably last night when he talked about

324
00:11:16,389 --> 00:11:14,480
the asteroid mission being unique i

325
00:11:18,550 --> 00:11:16,399
think we in human spaceflight think of

326
00:11:21,190 --> 00:11:18,560
the piece parts about

327
00:11:23,269 --> 00:11:21,200
robotics and eva

328
00:11:25,350 --> 00:11:23,279
how we would collect the samples how we

329
00:11:27,910 --> 00:11:25,360
would dock and rendezvous but

330
00:11:30,069 --> 00:11:27,920
the the power of moving a heavenly body

331
00:11:32,470 --> 00:11:30,079
from an orbit that it's been in

332
00:11:36,389 --> 00:11:32,480
from its inception

333
00:11:38,310 --> 00:11:36,399
four billion years ago to a location

334
00:11:40,550 --> 00:11:38,320
is very very powerful as well so we

335
00:11:41,910 --> 00:11:40,560
think that is is a

336
00:11:42,949 --> 00:11:41,920
big selling point for the mission as

337
00:11:49,990 --> 00:11:42,959
well

338
00:11:54,150 --> 00:11:51,190

so they were just wondering if you

339
00:11:56,150 --> 00:11:54,160
wanted to comment on um how the asteroid

340
00:11:58,389 --> 00:11:56,160
mission actually extends into other

341
00:11:59,269 --> 00:11:58,399
destinations i think i'll let mark do

342
00:12:00,629 --> 00:11:59,279
this

343
00:12:01,590 --> 00:12:00,639
okay

344
00:12:03,269 --> 00:12:01,600
um

345
00:12:05,030 --> 00:12:03,279
there's actually several ways that the

346
00:12:07,750 --> 00:12:05,040
technologies that we're investing in

347
00:12:10,550 --> 00:12:07,760
today directly apply to future missions

348
00:12:12,310 --> 00:12:10,560
uh easily the most easy example is orion

349
00:12:13,750 --> 00:12:12,320
the re-entry speeds that we demonstrate

350
00:12:15,670 --> 00:12:13,760
on this mission are the same re-entry

351
00:12:17,430 --> 00:12:15,680
speeds we would need for any lunar

352
00:12:19,590 --> 00:12:17,440
mission that you would want to support

353
00:12:21,030 --> 00:12:19,600
international desires but based on your

354
00:12:23,110 --> 00:12:21,040
mission design it can also support

355
00:12:24,870 --> 00:12:23,120
missions further into deep space

356
00:12:26,470 --> 00:12:24,880
and is a stepping stone in proving out

357
00:12:28,629 --> 00:12:26,480
the technologies necessary for mars

358
00:12:29,750 --> 00:12:28,639
entries additional technology developed

359
00:12:31,190 --> 00:12:29,760
would need to be done on the heat shield

360
00:12:34,069 --> 00:12:31,200
for that but this is would be the

361
00:12:34,870 --> 00:12:34,079
fastest re-entry that we had ever done

362
00:12:36,710 --> 00:12:34,880
so

363
00:12:38,870 --> 00:12:36,720

the second thing is the uva suits which

364
00:12:40,710 --> 00:12:38,880
steve mentioned earlier the plus suits

365
00:12:42,949 --> 00:12:40,720
the portable life support systems for

366
00:12:45,509 --> 00:12:42,959
the for the cva would be exactly

367
00:12:48,310 --> 00:12:45,519
applicable to a lunar surface eva or any

368
00:12:49,910 --> 00:12:48,320
deep space eva with minor modifications

369
00:12:52,389 --> 00:12:49,920
the same life support system could work

370
00:12:53,990 --> 00:12:52,399
for a mars surface surfacing so that

371
00:12:56,629 --> 00:12:54,000
that would apply as well

372
00:12:58,470 --> 00:12:56,639
microgravity suits for for all of the

373
00:13:01,110 --> 00:12:58,480
robotic crew interactions

374
00:13:03,430 --> 00:13:01,120
in a second step for logistics we could

375
00:13:05,590 --> 00:13:03,440
bring up additional microgravity suits

376
00:13:07,750 --> 00:13:05,600
to augment our initial capability and

377
00:13:09,670 --> 00:13:07,760
this would be a stepping stone for that

378
00:13:10,790 --> 00:13:09,680
solar electric propulsion on the robotic

379
00:13:12,310 --> 00:13:10,800
side

380
00:13:15,190 --> 00:13:12,320
when you look at the efficiencies of

381
00:13:17,750 --> 00:13:15,200
solar electric propulsion compared to

382
00:13:20,550 --> 00:13:17,760
chemical propulsion it's dramatic

383
00:13:21,670 --> 00:13:20,560
so having a 40 kilowatt class

384
00:13:23,829 --> 00:13:21,680
sep

385
00:13:25,590 --> 00:13:23,839
tug it's not only applicable for

386
00:13:28,150 --> 00:13:25,600
reorganizing the solar system as steve

387
00:13:30,389 --> 00:13:28,160
describes but is an extremely effective

388
00:13:34,069 --> 00:13:30,399

way of delivering cargo

389
00:13:35,990 --> 00:13:34,079
to a cis lunar base all right for

390
00:13:38,389 --> 00:13:36,000
observations or whatever science you

391
00:13:39,990 --> 00:13:38,399
chose to do if you wanted to support an

392
00:13:41,269 --> 00:13:40,000
international mission to the moon that

393
00:13:43,269 --> 00:13:41,279
could be a tug to support an

394
00:13:46,389 --> 00:13:43,279
international mission and for mars

395
00:13:48,150 --> 00:13:46,399
staging to deliver mars elements to mars

396
00:13:49,990 --> 00:13:48,160
it's a technology stepping stone of

397
00:13:52,230 --> 00:13:50,000
increasing our solar array efficiencies

398
00:13:54,069 --> 00:13:52,240
and the ability to do large-scale solar

399
00:13:56,230 --> 00:13:54,079
stepping towards the capabilities we

400
00:13:58,069 --> 00:13:56,240
would need for mars that's actually the

401
00:14:00,710 --> 00:13:58,079
beauty of this mission is that

402
00:14:02,470 --> 00:14:00,720
everything we're doing applies

403
00:14:05,110 --> 00:14:02,480
whether or not the asteroid mission's

404
00:14:07,590 --> 00:14:05,120
there it's a very flexible technology

405
00:14:09,030 --> 00:14:07,600
place that can support lots of missions

406
00:14:10,629 --> 00:14:09,040
going forward

407
00:14:12,310 --> 00:14:10,639
and i think i think mark said it very

408
00:14:14,389 --> 00:14:12,320
well and in terms of suits frank you

409
00:14:16,150 --> 00:14:14,399
know we we have traded umbilicals and

410
00:14:17,509 --> 00:14:16,160
when we looked at those not only are

411
00:14:18,629 --> 00:14:17,519
there technical challenges with long

412
00:14:19,990 --> 00:14:18,639
umbilicals

413
00:14:22,389 --> 00:14:20,000

you need more consumables actually

414
00:14:24,310 --> 00:14:22,399
because typically you're pumping that

415
00:14:26,389 --> 00:14:24,320
the oxygen at the crew breeze overboard

416
00:14:28,550 --> 00:14:26,399
but if you look at how does that feed

417
00:14:30,790 --> 00:14:28,560
forward to mars we need a

418
00:14:33,430 --> 00:14:30,800
suit that's independent of a vehicle to

419
00:14:35,030 --> 00:14:33,440
traverse the martian surface someday

420
00:14:36,069 --> 00:14:35,040
and then maybe as our structures grow

421
00:14:38,550 --> 00:14:36,079
bigger and bigger if we're doing a

422
00:14:40,629 --> 00:14:38,560
repair uh of some sort or some kind of a

423
00:14:42,150 --> 00:14:40,639
science experiment outside the vehicle

424
00:14:43,910 --> 00:14:42,160
those kind of things don't feed forward

425
00:14:45,189 --> 00:14:43,920
so when we look at eva technology we're

426
00:14:46,790 --> 00:14:45,199
trying to look for

427
00:14:49,269 --> 00:14:46,800
you know a suit that then takes us

428
00:14:51,750 --> 00:14:49,279
forward toward toward mars as an

429
00:14:53,990 --> 00:14:51,760
evolutionary path

430
00:14:56,470 --> 00:14:54,000
does anybody else have any comments that

431
00:14:58,069 --> 00:14:56,480
went from aaron yeah so on the on the

432
00:15:01,350 --> 00:14:58,079
topic of the extensibility i think the

433
00:15:03,590 --> 00:15:01,360
destination drivers are one uh axis to

434
00:15:05,430 --> 00:15:03,600
look at it but as mark was saying there

435
00:15:07,910 --> 00:15:05,440
you know there are sort of capabilities

436
00:15:09,030 --> 00:15:07,920
that you want to get into the portfolio

437
00:15:10,470 --> 00:15:09,040
and so

438
00:15:12,629 --> 00:15:10,480

maybe there can be a little bit more

439
00:15:14,550 --> 00:15:12,639
discussion uh you know the commercial

440
00:15:17,910 --> 00:15:14,560
interests seem to be

441
00:15:19,829 --> 00:15:17,920
focused on isru and and whether that's

442
00:15:20,870 --> 00:15:19,839
part of the capability suite that we

443
00:15:22,470 --> 00:15:20,880
need

444
00:15:25,509 --> 00:15:22,480
also a lot of the talk today was on

445
00:15:27,430 --> 00:15:25,519
human robot interaction and cooperation

446
00:15:29,430 --> 00:15:27,440
especially as you lose

447
00:15:30,629 --> 00:15:29,440
ground support as you move further away

448
00:15:32,550 --> 00:15:30,639
or at least the

449
00:15:34,629 --> 00:15:32,560
the sort of imminent or you know real

450
00:15:36,069 --> 00:15:34,639
time ground support

451
00:15:39,509 --> 00:15:36,079
maybe there are some more as well and

452
00:15:41,430 --> 00:15:39,519
then and this could prove kind of as a

453
00:15:44,949 --> 00:15:41,440
not only a destination but also a

454
00:15:47,990 --> 00:15:44,959
technology incubator of sorts

455
00:15:50,550 --> 00:15:48,000
certainly the asteroid is a potential uh

456
00:15:52,870 --> 00:15:50,560
for i in space resource utilization

457
00:15:55,110 --> 00:15:52,880
where we would learn to utilize

458
00:15:56,069 --> 00:15:55,120
today in human space flight we have

459
00:15:58,389 --> 00:15:56,079
taken

460
00:15:59,829 --> 00:15:58,399
every single pound of

461
00:16:02,310 --> 00:15:59,839
tulle or

462
00:16:05,189 --> 00:16:02,320
food or clothing water

463
00:16:06,790 --> 00:16:05,199

air with us on every single mission

464
00:16:08,790 --> 00:16:06,800
we've ever executed

465
00:16:10,550 --> 00:16:08,800
from the very beginning

466
00:16:12,870 --> 00:16:10,560
we need somehow to move away from that

467
00:16:14,550 --> 00:16:12,880
paradigm perhaps uh

468
00:16:16,069 --> 00:16:14,560
this asteroid would be

469
00:16:17,590 --> 00:16:16,079
one area where we could test those kind

470
00:16:20,230 --> 00:16:17,600
of things and i'll see if mark has

471
00:16:22,069 --> 00:16:20,240
anything to add

472
00:16:23,990 --> 00:16:22,079
so it's my job in the technical lead

473
00:16:25,749 --> 00:16:24,000
i've got to look at

474
00:16:27,030 --> 00:16:25,759
from a step back

475
00:16:29,670 --> 00:16:27,040
so when we talk about adding

476
00:16:31,509 --> 00:16:29,680
capabilities regretfully every

477
00:16:33,189 --> 00:16:31,519
capability comes with the mass penalty

478
00:16:35,189 --> 00:16:33,199
of delivering it there

479
00:16:37,030 --> 00:16:35,199
so when we look in this first mission as

480
00:16:39,430 --> 00:16:37,040
mike described you've really got to look

481
00:16:40,550 --> 00:16:39,440
at this in a series of missions so if we

482
00:16:43,269 --> 00:16:40,560
want to do

483
00:16:46,150 --> 00:16:43,279
isru greater science on the asteroid

484
00:16:48,550 --> 00:16:46,160
whatever capability you're talking about

485
00:16:51,030 --> 00:16:48,560
the first question i have to ask myself

486
00:16:53,269 --> 00:16:51,040
is how are we going to get it there

487
00:16:55,269 --> 00:16:53,279
so in the architecture the way it is now

488
00:16:56,550 --> 00:16:55,279

with the base performance of the sls and

489
00:16:58,870 --> 00:16:56,560
the orion

490
00:17:00,150 --> 00:16:58,880
very flexible platforms which enable

491
00:17:01,590 --> 00:17:00,160
this mission that they were never

492
00:17:04,150 --> 00:17:01,600
designed to do

493
00:17:07,029 --> 00:17:04,160
but we don't have significant extra mass

494
00:17:09,189 --> 00:17:07,039
to bring up the mass power resources

495
00:17:11,510 --> 00:17:09,199
necessary to do isru

496
00:17:14,309 --> 00:17:11,520
so that's where things like providing

497
00:17:15,909 --> 00:17:14,319
opportunities to commercial logistics to

498
00:17:18,390 --> 00:17:15,919
deliver extra mass

499
00:17:20,870 --> 00:17:18,400
things that point us to a node where you

500
00:17:23,029 --> 00:17:20,880
could dock a commercial logistics module

501
00:17:24,789 --> 00:17:23,039
in an orion to aggregate new

502
00:17:26,549 --> 00:17:24,799
capabilities

503
00:17:29,350 --> 00:17:26,559
long-term life support for mars

504
00:17:31,909 --> 00:17:29,360
closed-loop life support or isru

505
00:17:33,830 --> 00:17:31,919
so all of those capabilities lead to

506
00:17:36,470 --> 00:17:33,840
enabling commercial participation

507
00:17:37,270 --> 00:17:36,480
through logistics supply beyond leo

508
00:17:39,029 --> 00:17:37,280
and

509
00:17:40,870 --> 00:17:39,039
potential international or commercial

510
00:17:43,270 --> 00:17:40,880
development for

511
00:17:44,789 --> 00:17:43,280
node-like things to you know aggregate

512
00:17:46,390 --> 00:17:44,799
multiple elements

513
00:17:47,990 --> 00:17:46,400

those in themselves are techniques we

514
00:17:50,390 --> 00:17:48,000
need to go to mars we need to be able to

515
00:17:52,390 --> 00:17:50,400
assemble vehicles in deep space those

516
00:17:54,070 --> 00:17:52,400
types of things so all of those

517
00:17:56,470 --> 00:17:54,080
capabilities play together in an

518
00:17:58,630 --> 00:17:56,480
integrated architecture moving us as a

519
00:17:59,909 --> 00:17:58,640
stepping stone towards mars so all of

520
00:18:02,789 --> 00:17:59,919
those things will play out as we go

521
00:18:07,669 --> 00:18:04,950
stan did you have a comment or

522
00:18:12,549 --> 00:18:10,950
any other comments on extensibility

523
00:18:14,390 --> 00:18:12,559
i think i think we're in the community

524
00:18:15,909 --> 00:18:14,400
is in general agreement that we need

525
00:18:17,110 --> 00:18:15,919
sequence of missions

526
00:18:19,190 --> 00:18:17,120
i think the community is in general

527
00:18:20,390 --> 00:18:19,200
agreement that cis lunar space is the

528
00:18:22,470 --> 00:18:20,400
next

529
00:18:24,470 --> 00:18:22,480
logical destination

530
00:18:26,549 --> 00:18:24,480
i think the communities in general

531
00:18:28,230 --> 00:18:26,559
agreement that this aspect mission

532
00:18:30,070 --> 00:18:28,240
is the next best step for the different

533
00:18:31,190 --> 00:18:30,080
capabilities that that it brings to

534
00:18:34,789 --> 00:18:31,200
baron

535
00:18:35,990 --> 00:18:34,799
sort of our job uh across both nasa and

536
00:18:38,070 --> 00:18:36,000
industry to

537
00:18:40,710 --> 00:18:38,080
to build that plan of how then we feed

538
00:18:43,350 --> 00:18:40,720

this forward to mars and talk about it

539
00:18:45,430 --> 00:18:43,360
in a way that shows that this is indeed

540
00:18:46,789 --> 00:18:45,440
the right path to be on for the times

541
00:18:48,070 --> 00:18:46,799
that we're in for the capabilities that

542
00:18:49,350 --> 00:18:48,080
we're building

543
00:18:51,270 --> 00:18:49,360
i think it's a

544
00:18:53,190 --> 00:18:51,280
great mission from a sense that we it

545
00:18:55,029 --> 00:18:53,200
leverages a lot of the things that that

546
00:18:56,950 --> 00:18:55,039
we're doing today and then builds toward

547
00:18:59,110 --> 00:18:56,960
the future at the same time so

548
00:19:00,870 --> 00:18:59,120
we just got to explain that story put

549
00:19:02,470 --> 00:19:00,880
together the kind of the sequence of how

550
00:19:04,070 --> 00:19:02,480
that might work and then

551
00:19:05,909 --> 00:19:04,080
and then talk about it as a community to

552
00:19:07,029 --> 00:19:05,919
make sure that we're all sort of an

553
00:19:10,070 --> 00:19:07,039
agreement in the direction that we're

554
00:19:15,750 --> 00:19:12,230
okay the next topic is anchor techniques

555
00:19:19,190 --> 00:19:15,760
uh i think we saw a lot of innovative

556
00:19:21,190 --> 00:19:19,200
uh approaches to anchoring that

557
00:19:22,789 --> 00:19:21,200
that we really hadn't thought of and

558
00:19:25,590 --> 00:19:22,799
hadn't spent a lot of time of you know

559
00:19:26,870 --> 00:19:25,600
we have spent time

560
00:19:28,710 --> 00:19:26,880
using

561
00:19:30,150 --> 00:19:28,720
more traditional techniques of some

562
00:19:32,390 --> 00:19:30,160
simple booms

563
00:19:36,310 --> 00:19:32,400

on how we would anchor

564
00:19:40,390 --> 00:19:38,549
vehicle that anchors upside down was was

565
00:19:42,390 --> 00:19:40,400
pretty incredible i mean

566
00:19:43,990 --> 00:19:42,400
potentially this is something we could

567
00:19:45,669 --> 00:19:44,000
we could look at

568
00:19:47,590 --> 00:19:45,679
maybe as uh

569
00:19:48,950 --> 00:19:47,600
down the road after the first mission

570
00:19:51,029 --> 00:19:48,960
something we deploy that could then

571
00:19:53,110 --> 00:19:51,039
traverse around on an asteroid

572
00:19:55,270 --> 00:19:53,120
and then do some kind of experiments in

573
00:19:56,150 --> 00:19:55,280
between the human visits i think this is

574
00:19:57,830 --> 00:19:56,160
a great

575
00:19:59,510 --> 00:19:57,840
great capability

576
00:20:02,310 --> 00:19:59,520
all the other anchoring techniques are

577
00:20:04,470 --> 00:20:02,320
things that we i think need to look at

578
00:20:06,710 --> 00:20:04,480
you know most of what we had have been

579
00:20:09,190 --> 00:20:06,720
focused on is not necessarily having the

580
00:20:11,190 --> 00:20:09,200
crew since we're talking about a uh for

581
00:20:13,110 --> 00:20:11,200
the reference mission a 10 meter

582
00:20:15,590 --> 00:20:13,120
diameter asteroid we we hadn't really

583
00:20:18,710 --> 00:20:15,600
intended to to have the crew actually

584
00:20:20,630 --> 00:20:18,720
traverse on the asteroid so our our

585
00:20:23,909 --> 00:20:20,640
thought process was more of

586
00:20:25,669 --> 00:20:23,919
anchoring from a simple boom or you know

587
00:20:28,310 --> 00:20:25,679
in more evolved missions

588
00:20:29,990 --> 00:20:28,320

later on from a robotic platform but

589
00:20:32,070 --> 00:20:30,000
many of these anchoring techniques are

590
00:20:34,710 --> 00:20:32,080
very interesting and may feed forward

591
00:20:35,990 --> 00:20:34,720
to to the mars surface or or other

592
00:20:38,630 --> 00:20:36,000
destinations

593
00:20:40,950 --> 00:20:38,640
um someday so i thought there was a lot

594
00:20:42,710 --> 00:20:40,960
of really good innovative ideas

595
00:20:43,590 --> 00:20:42,720
um i think the

596
00:20:51,190 --> 00:20:43,600
the

597
00:20:53,669 --> 00:20:51,200
asteroid from a

598
00:20:54,950 --> 00:20:53,679
solid rock material to

599
00:20:57,909 --> 00:20:54,960
maybe a

600
00:20:59,350 --> 00:20:57,919
a looser material or even a rubble pile

601
00:21:00,630 --> 00:20:59,360
those that's when the anchoring

602
00:21:01,590 --> 00:21:00,640
techniques become problematic for

603
00:21:05,590 --> 00:21:01,600
smaller

604
00:21:07,909 --> 00:21:05,600
so so these there were some really good

605
00:21:09,190 --> 00:21:07,919
ideas does anybody have any more

606
00:21:12,470 --> 00:21:09,200
comments on

607
00:21:14,950 --> 00:21:13,590
i mean i think that's something we need

608
00:21:16,630 --> 00:21:14,960
to look at

609
00:21:18,310 --> 00:21:16,640
something we'll feed forward there's a

610
00:21:20,230 --> 00:21:18,320
question online

611
00:21:21,350 --> 00:21:20,240
go ahead joe joe

612
00:21:22,789 --> 00:21:21,360
yeah there are a couple of online

613
00:21:24,950 --> 00:21:22,799

questions the first one was actually to

614
00:21:26,710 --> 00:21:24,960
aaron parnis of jpl

615
00:21:28,549 --> 00:21:26,720
the question was any worries about the

616
00:21:30,789 --> 00:21:28,559
broken claws

617
00:21:33,590 --> 00:21:30,799
creating any kind of a sharp edge hazard

618
00:21:35,830 --> 00:21:33,600
to eva crew members could you get aaron

619
00:21:38,789 --> 00:21:35,840
the mic please thanks dan

620
00:21:41,590 --> 00:21:38,799
uh i i do think that is a potential

621
00:21:44,310 --> 00:21:41,600
concern uh i know that there's a lot of

622
00:21:45,430 --> 00:21:44,320
thought put into how tools are made to

623
00:21:47,510 --> 00:21:45,440
prevent

624
00:21:49,990 --> 00:21:47,520
you know

625
00:21:51,750 --> 00:21:50,000
tearing the suits and i'm sure that the

626
00:21:53,350 --> 00:21:51,760
asteroid itself presents somewhat of a

627
00:21:57,270 --> 00:21:53,360
hazard

628
00:21:58,870 --> 00:21:57,280
if it's a real sharp kind of rock

629
00:21:59,669 --> 00:21:58,880
so that that's something we would have

630
00:22:03,430 --> 00:21:59,679
to

631
00:22:07,830 --> 00:22:04,950
joe what else you got

632
00:22:09,190 --> 00:22:07,840
um i don't know if jonathan robill sorry

633
00:22:12,310 --> 00:22:09,200
i'm sure i'm saying that wrong of a

634
00:22:15,510 --> 00:22:12,320
honeybee robotics is still online

635
00:22:18,710 --> 00:22:16,630
yeah and i should have said earlier this

636
00:22:20,310 --> 00:22:18,720
is an opportunity to if if somebody had

637
00:22:21,590 --> 00:22:20,320
a question as we work through these

638
00:22:23,750 --> 00:22:21,600

different topics

639
00:22:26,390 --> 00:22:23,760
to go ahead and answer ask the question

640
00:22:29,110 --> 00:22:26,400
as well as we as we talk through go

641
00:22:30,870 --> 00:22:29,120
ahead john yeah the question was uh

642
00:22:33,270 --> 00:22:30,880
he mentioned the need to thoroughly test

643
00:22:36,070 --> 00:22:33,280
drilling in advance of the mission and

644
00:22:37,669 --> 00:22:36,080
the question is and and it perhaps could

645
00:22:40,390 --> 00:22:37,679
apply to aaron as well how would you go

646
00:22:42,310 --> 00:22:40,400
about doing uh that kind of testing on

647
00:22:44,870 --> 00:22:42,320
the ground

648
00:22:47,830 --> 00:22:44,880
you want to take a swing at that aaron

649
00:22:50,310 --> 00:22:47,840
sure so for our hundreds of k sort of

650
00:22:51,590 --> 00:22:50,320
development uh we test

651
00:22:54,230 --> 00:22:51,600
in the lab just at different

652
00:22:57,029 --> 00:22:54,240
gravitational orientations

653
00:22:59,430 --> 00:22:57,039
you know the iss is a great platform to

654
00:23:00,870 --> 00:22:59,440
try and test some of these at true zero

655
00:23:03,430 --> 00:23:00,880
gravity

656
00:23:05,909 --> 00:23:03,440
that would be one pathway

657
00:23:08,950 --> 00:23:05,919
you know some of the zero g flights and

658
00:23:11,590 --> 00:23:08,960
drop towers and things offer windows of

659
00:23:13,590 --> 00:23:11,600
of adequate testing but probably not

660
00:23:15,350 --> 00:23:13,600
enough to really do the

661
00:23:17,110 --> 00:23:15,360
the work you need well and that actually

662
00:23:19,350 --> 00:23:17,120
leads into the to another question

663
00:23:22,710 --> 00:23:19,360

related which would be um

664
00:23:23,830 --> 00:23:22,720
how do you manage the dust and debris

665
00:23:25,029 --> 00:23:23,840
make sure that you know when you're

666
00:23:28,310 --> 00:23:25,039
doing drilling and that kind of thing

667
00:23:30,710 --> 00:23:28,320
that you're not creating a a hazard for

668
00:23:31,590 --> 00:23:30,720
a test on iss for instance

669
00:23:33,990 --> 00:23:31,600
uh

670
00:23:35,669 --> 00:23:34,000
yeah i think you if you're up on iss you

671
00:23:38,149 --> 00:23:35,679
need to have sort of full containment

672
00:23:38,950 --> 00:23:38,159
you do it inside of a you know a fram or

673
00:24:08,230 --> 00:23:38,960
a

674
00:24:11,990 --> 00:24:08,240
of

675
00:24:14,070 --> 00:24:12,000
very hard you don't know from first

676
00:24:16,310 --> 00:24:14,080
principles whether an asteroid you go to

677
00:24:18,789 --> 00:24:16,320
is going to be as solid as a block a

678
00:24:20,710 --> 00:24:18,799
cast iron or as fluffy as a bunch of

679
00:24:22,870 --> 00:24:20,720
beanbag chair filler if you've ever

680
00:24:25,350 --> 00:24:22,880
opened up a beanbag chair you know

681
00:24:27,029 --> 00:24:25,360
how much you're dealing with there

682
00:24:29,750 --> 00:24:27,039
and you know your so your anchoring

683
00:24:31,830 --> 00:24:29,760
could be as simple as a magnet

684
00:24:33,350 --> 00:24:31,840
if you're talking to a block of nickel

685
00:24:34,870 --> 00:24:33,360
iron you can just use a magnet to hold

686
00:24:37,190 --> 00:24:34,880
yourself on or it could be that you

687
00:24:38,549 --> 00:24:37,200
cannot do anything with it mechanically

688
00:24:41,029 --> 00:24:38,559

and you have to put the thing in a bag

689
00:24:43,909 --> 00:24:41,039
so this is

690
00:24:45,190 --> 00:24:43,919
a very difficult series of problems but

691
00:24:46,630 --> 00:24:45,200
on the other hand it means that there's

692
00:24:48,310 --> 00:24:46,640
opportunities for a lot of valuable

693
00:24:50,230 --> 00:24:48,320
future work

694
00:24:52,870 --> 00:24:50,240
and i think maybe you know

695
00:24:54,310 --> 00:24:52,880
the the solid asteroid drill into that

696
00:24:55,909 --> 00:24:54,320
is probably not maybe the hardest case

697
00:24:57,590 --> 00:24:55,919
in some ways because you've got to

698
00:24:59,110 --> 00:24:57,600
penetrate a very hard object i think we

699
00:25:02,470 --> 00:24:59,120
have good ways to simulate that on the

700
00:25:03,830 --> 00:25:02,480
ground i th maybe getting into uh

701
00:25:06,870 --> 00:25:03,840
different consistencies of asteroids are

702
00:25:08,710 --> 00:25:06,880
maybe easier simpler tools

703
00:25:10,310 --> 00:25:08,720
the thing then is to keep the crew

704
00:25:11,830 --> 00:25:10,320
protected from liberation of material

705
00:25:13,669 --> 00:25:11,840
that's probably the biggest challenge

706
00:25:16,070 --> 00:25:13,679
and getting dust on the suit still as

707
00:25:19,669 --> 00:25:16,080
well so i have a comment to echo on that

708
00:25:21,029 --> 00:25:19,679
and and i share uh stan's frustration

709
00:25:22,630 --> 00:25:21,039
sometimes i keep asking all these

710
00:25:23,590 --> 00:25:22,640
scientists what's the surface like and

711
00:25:25,830 --> 00:25:23,600
you get

712
00:25:26,870 --> 00:25:25,840
every different answer um

713
00:25:28,630 --> 00:25:26,880

and

714
00:25:30,950 --> 00:25:28,640
the exciting thing is this is the sort

715
00:25:32,870 --> 00:25:30,960
of the beginning right and we have a

716
00:25:35,110 --> 00:25:32,880
sequence of missions already in line

717
00:25:37,110 --> 00:25:35,120
that are going to go to these bodies so

718
00:25:40,070 --> 00:25:37,120
we learned a lot when we got pictures

719
00:25:43,510 --> 00:25:40,080
from itakawa and we have osiris-rex uh

720
00:25:44,870 --> 00:25:43,520
on its way uh in the next uh uh you know

721
00:25:47,430 --> 00:25:44,880
cycle of missions and we have a

722
00:25:49,990 --> 00:25:47,440
hayabusa2 mission that may be going as

723
00:25:52,310 --> 00:25:50,000
well so uh we'll start to learn what

724
00:25:53,669 --> 00:25:52,320
these surface properties are so if you

725
00:25:55,750 --> 00:25:53,679
you know you're tying in the anchoring

726
00:25:58,149 --> 00:25:55,760
to some of the extensibility hopefully

727
00:26:01,190 --> 00:25:58,159
we won't be you know dealing with such a

728
00:26:03,029 --> 00:26:01,200
wide range of uncertainty uh in the

729
00:26:06,230 --> 00:26:03,039
future the one thing to keep in mind in

730
00:26:08,630 --> 00:26:06,240
this mission also is that the

731
00:26:10,470 --> 00:26:08,640
asteroid robotic vehicle is going to get

732
00:26:12,470 --> 00:26:10,480
detailed imaging and sensing of the

733
00:26:14,390 --> 00:26:12,480
asteroid when we capture it and then

734
00:26:16,789 --> 00:26:14,400
during the time it is towing it back to

735
00:26:17,669 --> 00:26:16,799
the dro we will have a few years to plan

736
00:26:19,510 --> 00:26:17,679
out our

737
00:26:22,789 --> 00:26:19,520
detailed dba and adjust our tool

738
00:26:26,390 --> 00:26:24,630

that makes good sense also the more we

739
00:26:27,990 --> 00:26:26,400
can get pictures of near earth asteroids

740
00:26:29,590 --> 00:26:28,000
and start building up a statistical

741
00:26:32,149 --> 00:26:29,600
understanding of what the population is

742
00:26:34,549 --> 00:26:32,159
like um that would be good i've heard

743
00:26:35,590 --> 00:26:34,559
discussions from some of the uh private

744
00:26:36,950 --> 00:26:35,600
companies that they want to go out and

745
00:26:40,230 --> 00:26:36,960
start prospecting asteroids that's all

746
00:26:42,549 --> 00:26:40,240
going to be very valuable information

747
00:26:43,909 --> 00:26:42,559
i think from a from the technical

748
00:26:46,149 --> 00:26:43,919
standpoint

749
00:26:48,310 --> 00:26:46,159
anchoring and drilling on a rubble pile

750
00:26:49,830 --> 00:26:48,320
is probably going to be our our biggest

751
00:26:51,029 --> 00:26:49,840
problem it's going to be very very hard

752
00:26:53,590 --> 00:26:51,039
to deal with

753
00:26:56,070 --> 00:26:53,600
what's what's essentially a cloud of

754
00:26:58,390 --> 00:26:56,080
stones where individually they're very

755
00:26:59,990 --> 00:26:58,400
hard but they have almost no cohesion

756
00:27:02,390 --> 00:27:00,000
with one another it's going to be

757
00:27:04,630 --> 00:27:02,400
a great technical challenge for us

758
00:27:06,070 --> 00:27:04,640
and i think you know as engineers we all

759
00:27:07,430 --> 00:27:06,080
like to have give me the design

760
00:27:08,470 --> 00:27:07,440
parameters and not build a perfect

761
00:27:10,070 --> 00:27:08,480
system and

762
00:27:12,310 --> 00:27:10,080
remember we're about exploring so

763
00:27:14,149 --> 00:27:12,320

sometimes we may have to have a couple

764
00:27:15,110 --> 00:27:14,159
of different approaches and

765
00:27:16,789 --> 00:27:15,120
we may

766
00:27:19,190 --> 00:27:16,799
have a little bit of the unexpected when

767
00:27:20,389 --> 00:27:19,200
we arrive and that's okay because

768
00:27:21,909 --> 00:27:20,399
the reason we're going there is because

769
00:27:23,750 --> 00:27:21,919
we really don't totally understand

770
00:27:26,630 --> 00:27:23,760
asteroids very well and we want to learn

771
00:27:31,909 --> 00:27:29,430
any more on anchoring techniques

772
00:27:33,830 --> 00:27:31,919
this is wonderful

773
00:27:35,430 --> 00:27:33,840
so translation and eva tools we've

774
00:27:37,190 --> 00:27:35,440
talked quite a bit about this and this

775
00:27:39,430 --> 00:27:37,200
kind of

776
00:27:41,110 --> 00:27:39,440
is a good segue from anchoring you know

777
00:27:43,029 --> 00:27:41,120
knowing the asteroid is important we've

778
00:27:44,950 --> 00:27:43,039
talked about that i think there were

779
00:27:46,310 --> 00:27:44,960
several promising

780
00:27:49,110 --> 00:27:46,320
drill

781
00:27:50,950 --> 00:27:49,120
kind of ideas that we will go look at

782
00:27:52,710 --> 00:27:50,960
you know the idea of taking something

783
00:27:55,590 --> 00:27:52,720
that works with our pistol

784
00:27:56,950 --> 00:27:55,600
grip tool that we use for eva is is very

785
00:27:58,630 --> 00:27:56,960
intriguing something that's fairly

786
00:28:01,190 --> 00:27:58,640
lightweight maybe we could

787
00:28:03,510 --> 00:28:01,200
modify and and uh and go take a core

788
00:28:05,590 --> 00:28:03,520

sample if it's a more solid asteroid

789
00:28:07,830 --> 00:28:05,600
um i think we have to

790
00:28:09,190 --> 00:28:07,840
think a little bit more about uh what we

791
00:28:11,190 --> 00:28:09,200
do for these

792
00:28:13,909 --> 00:28:11,200
rubble piles how do we

793
00:28:15,750 --> 00:28:13,919
get the sample but yet in enclosing in a

794
00:28:16,870 --> 00:28:15,760
way we get it a nut and have a bunch of

795
00:28:19,350 --> 00:28:16,880
debris

796
00:28:21,750 --> 00:28:19,360
on the crew and exposing it to orion

797
00:28:23,110 --> 00:28:21,760
and the hatches and so forth so we need

798
00:28:27,110 --> 00:28:23,120
to work on that i think we've got a lot

799
00:28:28,710 --> 00:28:27,120
of good ideas to to go choose from there

800
00:28:30,870 --> 00:28:28,720
i was very intrigued by the presentation

801
00:28:32,310 --> 00:28:30,880
from rob mueller who i don't think he

802
00:28:34,789 --> 00:28:32,320
may have departed

803
00:28:36,389 --> 00:28:34,799
early but um thinking about maybe some

804
00:28:38,870 --> 00:28:36,399
simple way to

805
00:28:39,990 --> 00:28:38,880
to keep get the dust off the suit

806
00:28:43,029 --> 00:28:40,000
maybe we need to do a little more

807
00:28:45,190 --> 00:28:43,039
testing with those materials

808
00:28:46,950 --> 00:28:45,200
and we can we can work with rob on doing

809
00:28:47,909 --> 00:28:46,960
that and maybe some shapes that are

810
00:28:50,470 --> 00:28:47,919
different than

811
00:28:52,230 --> 00:28:50,480
you know we do a lot of uh very simple

812
00:28:53,750 --> 00:28:52,240
tests in the lab on a very flat sample

813
00:28:55,430 --> 00:28:53,760

but the suit

814
00:28:57,510 --> 00:28:55,440
is not very flat there's a lot of curves

815
00:29:00,389 --> 00:28:57,520
and contours so how would that system

816
00:29:02,470 --> 00:29:00,399
work to to dust

817
00:29:03,190 --> 00:29:02,480
dust was a huge problem during apollo

818
00:29:04,149 --> 00:29:03,200
and

819
00:29:05,990 --> 00:29:04,159
uh

820
00:29:07,830 --> 00:29:06,000
for a for a solid asteroid i don't think

821
00:29:08,870 --> 00:29:07,840
the dust would be much of a problem but

822
00:29:11,190 --> 00:29:08,880
for these

823
00:29:13,830 --> 00:29:11,200
rubble piles as we talked those would be

824
00:29:15,669 --> 00:29:13,840
very very challenging

825
00:29:17,909 --> 00:29:15,679
and then

826
00:29:18,789 --> 00:29:17,919
the suits and tools

827
00:29:22,389 --> 00:29:18,799
great

828
00:29:25,110 --> 00:29:22,399
kinds of tools from

829
00:29:27,830 --> 00:29:25,120
from rrm the the

830
00:29:30,070 --> 00:29:27,840
wire cutter the tools that that atk

831
00:29:32,070 --> 00:29:30,080
talked about and then the drill

832
00:29:34,070 --> 00:29:32,080
we've got a lot of good things to build

833
00:29:35,590 --> 00:29:34,080
upon we've talked some about this but

834
00:29:37,029 --> 00:29:35,600
this is an area i think we can leverage

835
00:29:39,590 --> 00:29:37,039
this session

836
00:29:41,430 --> 00:29:39,600
pretty heavily on adapting and building

837
00:29:43,510 --> 00:29:41,440
different kinds of tools

838
00:29:45,029 --> 00:29:43,520

we've started some of that work

839
00:29:47,430 --> 00:29:45,039
in the neutral buoyancy lab but this is

840
00:29:48,950 --> 00:29:47,440
kind of a good time to have this session

841
00:29:50,549 --> 00:29:48,960
and get some input from the community on

842
00:29:53,190 --> 00:29:50,559
the kinds of things that we could go

843
00:29:53,200 --> 00:29:58,710
any discussion on tools michelle

844
00:30:06,310 --> 00:30:02,470
so just one thought is that there was

845
00:30:09,110 --> 00:30:06,320
um there were ideas presented

846
00:30:10,389 --> 00:30:09,120
with i would say some traditional tool

847
00:30:11,990 --> 00:30:10,399
concepts

848
00:30:14,230 --> 00:30:12,000
and then um

849
00:30:17,830 --> 00:30:14,240
a couple i saw that reminded me that

850
00:30:20,549 --> 00:30:17,840
there have been conversations about

851
00:30:23,110 --> 00:30:20,559
the low density asteroidal surface

852
00:30:24,470 --> 00:30:23,120
potentially requiring standoff distance

853
00:30:27,750 --> 00:30:24,480
with the crew

854
00:30:29,510 --> 00:30:27,760
and that there may be advances in some

855
00:30:31,269 --> 00:30:29,520
of the remote sensing techniques that

856
00:30:33,909 --> 00:30:31,279
actually could be used at a standoff

857
00:30:35,909 --> 00:30:33,919
distance that would both take advantage

858
00:30:38,710 --> 00:30:35,919
of what the crew brings to the table but

859
00:30:40,470 --> 00:30:38,720
also provide additional protection

860
00:30:42,389 --> 00:30:40,480
especially if there's a bag and you open

861
00:30:43,909 --> 00:30:42,399
it you don't really know exactly

862
00:30:46,070 --> 00:30:43,919
what's going to happen when you do that

863
00:30:47,750 --> 00:30:46,080

anyway so i mean that might that was

864
00:30:49,590 --> 00:30:47,760
kind of an interesting

865
00:30:51,110 --> 00:30:49,600
contrast in some of the ideas that were

866
00:30:53,909 --> 00:30:51,120
brought forward that might be something

867
00:30:56,389 --> 00:30:53,919
we need to look at a little bit

868
00:30:58,070 --> 00:30:56,399
then there was the one ksc concept as

869
00:30:59,669 --> 00:30:58,080
well that was kind of intriguing where

870
00:31:01,909 --> 00:30:59,679
we had the device put the pneumatic kind

871
00:31:03,269 --> 00:31:01,919
of sound device on the shovel maybe a

872
00:31:05,909 --> 00:31:03,279
shovel may not be quite right but

873
00:31:08,070 --> 00:31:05,919
something akin to that might be

874
00:31:10,470 --> 00:31:08,080
worth looking at

875
00:31:12,710 --> 00:31:10,480
one step back i'm sorry

876
00:31:16,310 --> 00:31:12,720
one step back from from the actual tool

877
00:31:18,630 --> 00:31:16,320
as end effector is the interface to

878
00:31:20,950 --> 00:31:18,640
the crew member or the robots that are

879
00:31:22,710 --> 00:31:20,960
manipulating those tools and i know

880
00:31:25,669 --> 00:31:22,720
there's work going on at darpa and

881
00:31:28,310 --> 00:31:25,679
things like this to to generate

882
00:31:29,909 --> 00:31:28,320
very effective designs for adaptable

883
00:31:31,750 --> 00:31:29,919
tool interfaces

884
00:31:33,430 --> 00:31:31,760
and you know as we look at the overall

885
00:31:35,750 --> 00:31:33,440
architecture we should be looking at the

886
00:31:37,830 --> 00:31:35,760
architecture of interfaces between

887
00:31:39,669 --> 00:31:37,840
interchangeable parts and make sure that

888
00:31:41,909 --> 00:31:39,679

we get all the functionality at those

889
00:31:43,830 --> 00:31:41,919
interfaces that we need so that they are

890
00:31:45,350 --> 00:31:43,840
extensible as well that's a good point

891
00:31:47,590 --> 00:31:45,360
frank

892
00:31:49,590 --> 00:31:47,600
i think uh stan has a

893
00:31:51,590 --> 00:31:49,600
so well that mike's transitioning to

894
00:31:53,269 --> 00:31:51,600
address one of michelle's comments

895
00:31:54,789 --> 00:31:53,279
one of the things we've discussed that

896
00:31:56,389 --> 00:31:54,799
didn't get out in the video so this

897
00:31:57,269 --> 00:31:56,399
audience hasn't seen it so i'll describe

898
00:31:58,950 --> 00:31:57,279
it is

899
00:32:01,509 --> 00:31:58,960
when you're worried about

900
00:32:03,029 --> 00:32:01,519
particulates coming out from a drill or

901
00:32:05,590 --> 00:32:03,039
you know contamination coming out to the

902
00:32:07,430 --> 00:32:05,600
crew so how do you contain that and you

903
00:32:09,190 --> 00:32:07,440
combine that with a bag

904
00:32:11,029 --> 00:32:09,200
one of the advantages the bag offers

905
00:32:12,789 --> 00:32:11,039
with a rubble pile is that instead of

906
00:32:15,430 --> 00:32:12,799
just cutting open the bag you could

907
00:32:16,630 --> 00:32:15,440
install effectively a portable glove box

908
00:32:18,149 --> 00:32:16,640
over the bag

909
00:32:19,669 --> 00:32:18,159
and then cut the hole in the bag to

910
00:32:22,710 --> 00:32:19,679
provide containment

911
00:32:23,750 --> 00:32:22,720
so we've talked about deployable

912
00:32:25,590 --> 00:32:23,760
tents

913
00:32:27,669 --> 00:32:25,600

you know to where you would affix those

914
00:32:30,470 --> 00:32:27,679
to the bag to provide a barrier between

915
00:32:32,470 --> 00:32:30,480
the crew and the particulates and then

916
00:32:34,470 --> 00:32:32,480
have your drill going inside that tent

917
00:32:35,990 --> 00:32:34,480
or inside that glove box to contain

918
00:32:37,430 --> 00:32:36,000
those types of things

919
00:32:39,029 --> 00:32:37,440
so some of those concepts have been

920
00:32:40,549 --> 00:32:39,039
discussed one of the things i was

921
00:32:42,549 --> 00:32:40,559
these and this is

922
00:32:44,789 --> 00:32:42,559
we've discussed tools and we've

923
00:32:47,350 --> 00:32:44,799
discussed getting the astronaut to the

924
00:32:49,590 --> 00:32:47,360
work site but how you set up the work

925
00:32:51,430 --> 00:32:49,600
site preparation in terms of a glove box

926
00:32:53,750 --> 00:32:51,440
or a tent or debris shields that type of

927
00:32:55,990 --> 00:32:53,760
thing is uh something that can mitigate

928
00:32:57,669 --> 00:32:56,000
some of these risks we're talking about

929
00:32:59,590 --> 00:32:57,679
and i think that's that's one area that

930
00:33:01,590 --> 00:32:59,600
we could use the community's help on if

931
00:33:05,269 --> 00:33:01,600
there's ideas about

932
00:33:07,750 --> 00:33:05,279
what's the best approach to actually

933
00:33:09,990 --> 00:33:07,760
you know get into the bag or get next to

934
00:33:12,549 --> 00:33:10,000
the asteroid we like the bag concept

935
00:33:14,789 --> 00:33:12,559
because it works for the wide range of

936
00:33:16,710 --> 00:33:14,799
potential kinds of asteroids that may be

937
00:33:18,149 --> 00:33:16,720
anywhere from robopile to

938
00:33:19,669 --> 00:33:18,159

to uh but those

939
00:33:21,190 --> 00:33:19,679
we're still in the process of figuring

940
00:33:22,950 --> 00:33:21,200
out what's the techniques and so the

941
00:33:24,789 --> 00:33:22,960
community

942
00:33:26,470 --> 00:33:24,799
he's got a lot of experience we showed a

943
00:33:27,669 --> 00:33:26,480
lot of pictures from shuttle flights

944
00:33:29,909 --> 00:33:27,679
that i remember where we came up with

945
00:33:33,269 --> 00:33:29,919
really innovative things to go repair

946
00:33:35,590 --> 00:33:33,279
blankets and other other things uh solar

947
00:33:37,509 --> 00:33:35,600
rays this community could probably help

948
00:33:38,950 --> 00:33:37,519
us think through some of those things as

949
00:33:40,950 --> 00:33:38,960
well

950
00:33:42,470 --> 00:33:40,960
we'll let stan and then we'll and uh

951
00:33:44,470 --> 00:33:42,480
steve mentioned the neutral buoyancy

952
00:33:46,310 --> 00:33:44,480
laboratory and i'd like to amplify that

953
00:33:49,590 --> 00:33:46,320
a little bit um

954
00:33:51,509 --> 00:33:49,600
the nbl the underwater environment works

955
00:33:53,029 --> 00:33:51,519
for training people and developing tools

956
00:33:57,750 --> 00:33:53,039
and techniques for working in zero

957
00:34:01,430 --> 00:33:59,909
the orbital environment zero gravity

958
00:34:03,110 --> 00:34:01,440
outside of spacecraft is probably about

959
00:34:05,830 --> 00:34:03,120
the most unnatural environment you can

960
00:34:07,590 --> 00:34:05,840
possibly imagine for a person to work in

961
00:34:09,909 --> 00:34:07,600
and the neutral buoyancy laboratory does

962
00:34:11,510 --> 00:34:09,919
a great job of preparing people to work

963
00:34:13,669 --> 00:34:11,520

in that environment effectively on their

964
00:34:17,349 --> 00:34:13,679
first time out the hatch so that's a

965
00:34:19,270 --> 00:34:17,359
resource that we should not overlook

966
00:34:20,869 --> 00:34:19,280
in addition to that

967
00:34:23,030 --> 00:34:20,879
tools and techniques that we tested in

968
00:34:24,710 --> 00:34:23,040
the nbl and then tested again

969
00:34:28,389 --> 00:34:24,720
underwater off the coast of florida in

970
00:34:31,109 --> 00:34:28,399
nemo looking at exploring asteroids

971
00:34:33,109 --> 00:34:31,119
in my opinion with the background in

972
00:34:35,270 --> 00:34:33,119
space flight and in asteroid science we

973
00:34:37,669 --> 00:34:35,280
went from not knowing how to do an eva

974
00:34:39,909 --> 00:34:37,679
on an asteroid to now knowing how to do

975
00:34:41,829 --> 00:34:39,919
an eva on an asteroid

976
00:34:43,909 --> 00:34:41,839
it's that valuable

977
00:34:45,829 --> 00:34:43,919
and all that's available at a pretty low

978
00:34:48,710 --> 00:34:45,839
cost and i think it's a it's a resource

979
00:34:50,550 --> 00:34:48,720
that we can make very good use of and be

980
00:34:52,629 --> 00:34:50,560
confident that what we develop is is

981
00:34:55,669 --> 00:34:52,639
going to work in space

982
00:34:57,589 --> 00:34:55,679
a shorter comment on containment

983
00:34:59,030 --> 00:34:57,599
we know that most near-earth asteroids

984
00:35:00,390 --> 00:34:59,040
are not too different from most

985
00:35:01,670 --> 00:35:00,400
meteorites

986
00:35:03,030 --> 00:35:01,680
and people are cutting those things

987
00:35:05,589 --> 00:35:03,040
apart in laboratories all the time

988
00:35:07,510 --> 00:35:05,599

without uh insane levels of containment

989
00:35:08,790 --> 00:35:07,520
they're basically rocks so i hope we

990
00:35:10,630 --> 00:35:08,800
don't frighten ourselves into thinking

991
00:35:12,470 --> 00:35:10,640
that we can't touch these things

992
00:35:16,069 --> 00:35:12,480
dust will be a problem but they're not

993
00:35:21,589 --> 00:35:18,069
doug has a comment i think

994
00:35:24,390 --> 00:35:21,599
yes uh one area that i i haven't seen

995
00:35:25,829 --> 00:35:24,400
talked about with related with regard to

996
00:35:28,470 --> 00:35:25,839
tools is

997
00:35:31,430 --> 00:35:28,480
uh actually getting into the containment

998
00:35:32,950 --> 00:35:31,440
bag the capture bag all the videos so

999
00:35:35,190 --> 00:35:32,960
far have just shown

1000
00:35:37,109 --> 00:35:35,200
the bag already open ready for the crew

1001
00:35:38,950 --> 00:35:37,119
member to show up and start working

1002
00:35:41,190 --> 00:35:38,960
there but i think there are some

1003
00:35:44,310 --> 00:35:41,200
competing design

1004
00:35:46,630 --> 00:35:44,320
principles on the one hand making that

1005
00:35:47,910 --> 00:35:46,640
bag very durable and tough and able to

1006
00:35:49,510 --> 00:35:47,920
withstand

1007
00:35:51,349 --> 00:35:49,520
anything that the asteroid can do to it

1008
00:35:53,589 --> 00:35:51,359
then the second is you need to be able

1009
00:35:56,150 --> 00:35:53,599
to get into it quickly and easily

1010
00:35:57,829 --> 00:35:56,160
so i could see a need for

1011
00:35:59,349 --> 00:35:57,839
some kind of tool development there

1012
00:36:01,109 --> 00:35:59,359
especially if there's reinforcement to

1013
00:36:02,710 --> 00:36:01,119

cut through that kind of thing

1014
00:36:04,390 --> 00:36:02,720
yeah i mean we've talked about the

1015
00:36:05,910 --> 00:36:04,400
concepts but we're still kind of working

1016
00:36:08,470 --> 00:36:05,920
through those i mean we've talked about

1017
00:36:10,550 --> 00:36:08,480
having slits positioned in the bag

1018
00:36:12,230 --> 00:36:10,560
of course the size of the asteroid will

1019
00:36:14,150 --> 00:36:12,240
determine the configuration you know

1020
00:36:16,550 --> 00:36:14,160
we're going to design the bag for

1021
00:36:19,109 --> 00:36:16,560
for a wide wide range of sizes maybe up

1022
00:36:20,550 --> 00:36:19,119
to 12 meters in diameter and so if it's

1023
00:36:22,150 --> 00:36:20,560
smaller then you've got folds to deal

1024
00:36:23,589 --> 00:36:22,160
with so we've got to work through that

1025
00:36:25,109 --> 00:36:23,599
if you knew it was solid you could i

1026
00:36:26,630 --> 00:36:25,119
think take a drill and drill right

1027
00:36:28,790 --> 00:36:26,640
through it and get the core you want and

1028
00:36:29,990 --> 00:36:28,800
then discard the material later

1029
00:36:32,470 --> 00:36:30,000
but if it's a rubble pile then we've got

1030
00:36:34,790 --> 00:36:32,480
to figure out how do i how do i open it

1031
00:36:36,230 --> 00:36:34,800
get inside access the sample and maybe

1032
00:36:38,550 --> 00:36:36,240
some of these tools

1033
00:36:40,950 --> 00:36:38,560
maybe some ideas about a telescoping

1034
00:36:43,829 --> 00:36:40,960
kind of tool that you get in and collect

1035
00:36:46,069 --> 00:36:43,839
not only the core sample but if it's

1036
00:36:47,589 --> 00:36:46,079
solid but then you know some rubble

1037
00:36:50,069 --> 00:36:47,599
out of it maybe there's some ideas here

1038
00:36:51,990 --> 00:36:50,079

that we can we can build upon

1039
00:36:53,270 --> 00:36:52,000
but that's forward work we know that's

1040
00:36:55,109 --> 00:36:53,280
that's probably the biggest challenge

1041
00:36:56,710 --> 00:36:55,119
and then making the suit

1042
00:36:58,310 --> 00:36:56,720
uh learning how to work in the suit with

1043
00:36:59,030 --> 00:36:58,320
the tools in the neutral buoyancy lab

1044
00:37:00,150 --> 00:36:59,040
which

1045
00:37:02,870 --> 00:37:00,160
is the way we've developed every

1046
00:37:04,950 --> 00:37:02,880
spacewalk in the history that at least

1047
00:37:07,109 --> 00:37:04,960
i've been a part of here at nasa's we go

1048
00:37:08,870 --> 00:37:07,119
in the nbl we work with the tools in the

1049
00:37:10,550 --> 00:37:08,880
suit that we're going to be in try to

1050
00:37:13,030 --> 00:37:10,560
design the tasks such that we can

1051
00:37:14,390 --> 00:37:13,040
position ourselves for success

1052
00:37:15,990 --> 00:37:14,400
the other thing i'll have to add to

1053
00:37:17,349 --> 00:37:16,000
steve's answer on i agree with all of

1054
00:37:19,349 --> 00:37:17,359
that is

1055
00:37:21,190 --> 00:37:19,359
when we go to collect a sample

1056
00:37:23,510 --> 00:37:21,200
it depends on what type of asteroid

1057
00:37:26,150 --> 00:37:23,520
we're going to on what art requirements

1058
00:37:28,790 --> 00:37:26,160
we would put on the sample container

1059
00:37:30,710 --> 00:37:28,800
if it is a rock as some people described

1060
00:37:32,710 --> 00:37:30,720
then putting it in a baggie and stowing

1061
00:37:34,710 --> 00:37:32,720
it you know would be okay

1062
00:37:36,470 --> 00:37:34,720
if it is a carbonaceous asteroid where

1063
00:37:38,310 --> 00:37:36,480

one of your primary primary things you

1064
00:37:40,790 --> 00:37:38,320
want to do is to capture the volatiles

1065
00:37:41,990 --> 00:37:40,800
in that rock and study the volatiles

1066
00:37:43,589 --> 00:37:42,000
you're going to want a hermetically

1067
00:37:44,710 --> 00:37:43,599
sealed container to contain those

1068
00:37:46,790 --> 00:37:44,720
volatiles

1069
00:37:49,190 --> 00:37:46,800
so there's some some differences there

1070
00:37:51,270 --> 00:37:49,200
that we'll take into account that's as

1071
00:37:52,790 --> 00:37:51,280
we peel the onion as we go deeper into

1072
00:37:54,230 --> 00:37:52,800
the study we'll investigate the

1073
00:37:58,230 --> 00:37:54,240
different different techniques and how

1074
00:38:04,710 --> 00:38:00,630
how about online any uh

1075
00:38:09,510 --> 00:38:07,190
yeah there was a question um it didn't

1076
00:38:11,430 --> 00:38:09,520
directly relate to tools but it was um

1077
00:38:13,510 --> 00:38:11,440
there was a question about

1078
00:38:15,589 --> 00:38:13,520
how the asus suit

1079
00:38:18,069 --> 00:38:15,599
was actually derived as the as the

1080
00:38:20,230 --> 00:38:18,079
asteroid suit and what mods and relevant

1081
00:38:21,270 --> 00:38:20,240
uh what mods were

1082
00:38:23,190 --> 00:38:21,280
would have to be made to make that

1083
00:38:27,430 --> 00:38:23,200
relevant for the asteroid mission so so

1084
00:38:31,670 --> 00:38:29,430
when we started looking at this mission

1085
00:38:33,349 --> 00:38:31,680
we looked at

1086
00:38:35,750 --> 00:38:33,359
all the suits in our inventory we looked

1087
00:38:38,150 --> 00:38:35,760
at the current emu that's

1088
00:38:39,109 --> 00:38:38,160

extra vehicular mobility unit that's on

1089
00:38:41,270 --> 00:38:39,119
station

1090
00:38:44,150 --> 00:38:41,280
we looked at the exploration suit

1091
00:38:47,349 --> 00:38:44,160
and we looked at at the modified aces as

1092
00:38:50,710 --> 00:38:47,359
a very bare-bones eva capability

1093
00:38:53,510 --> 00:38:50,720
we also traded uh an umbilical eva

1094
00:38:56,310 --> 00:38:53,520
versus versus a traditional what we've

1095
00:38:57,910 --> 00:38:56,320
done ever since skylab is a

1096
00:38:59,510 --> 00:38:57,920
plus or portable life support system

1097
00:39:01,750 --> 00:38:59,520
based dba

1098
00:39:04,390 --> 00:39:01,760
when we looked at all those

1099
00:39:06,390 --> 00:39:04,400
different suit capabilities

1100
00:39:07,750 --> 00:39:06,400
we knew

1101
00:39:09,670 --> 00:39:07,760
anytime you do an ebay you want the

1102
00:39:11,510 --> 00:39:09,680
absolute best suit and i would never

1103
00:39:12,950 --> 00:39:11,520
argue with that but when we looked at

1104
00:39:16,790 --> 00:39:12,960
the constraints of the mission and what

1105
00:39:18,790 --> 00:39:16,800
we could do using orion

1106
00:39:21,270 --> 00:39:18,800
as the eva platform from an

1107
00:39:23,270 --> 00:39:21,280
affordability perspective of trying to

1108
00:39:24,630 --> 00:39:23,280
minimize new developments in this time

1109
00:39:27,270 --> 00:39:24,640
frame

1110
00:39:29,829 --> 00:39:27,280
the modified asus suit traded best

1111
00:39:32,150 --> 00:39:29,839
because that suit had to be worn by the

1112
00:39:34,069 --> 00:39:32,160
crew anyway for launch and entry and we

1113
00:39:36,790 --> 00:39:34,079

went back and looked at the gemini time

1114
00:39:38,550 --> 00:39:36,800
frame and that suit that the modified

1115
00:39:40,470 --> 00:39:38,560
asus it's a full pressure suit it'll

1116
00:39:42,550 --> 00:39:40,480
protect you from the vacuum it has

1117
00:39:46,069 --> 00:39:42,560
heritage all the way back to gemini and

1118
00:39:48,470 --> 00:39:46,079
gemini did several tasks in that suit

1119
00:39:50,470 --> 00:39:48,480
so when we looked at the mass trade and

1120
00:39:51,990 --> 00:39:50,480
how we would stow the suits

1121
00:39:53,430 --> 00:39:52,000
in orion and the things we needed to

1122
00:39:55,589 --> 00:39:53,440
carry with us

1123
00:39:57,270 --> 00:39:55,599
that suit traded best from a mass and

1124
00:39:59,030 --> 00:39:57,280
performance perspective

1125
00:40:02,310 --> 00:39:59,040
orion has

1126
00:40:04,550 --> 00:40:02,320
launch mass constraints and it has abort

1127
00:40:06,230 --> 00:40:04,560
and nominal and emission

1128
00:40:08,069 --> 00:40:06,240
weight constraints it can only carry a

1129
00:40:09,750 --> 00:40:08,079
certain amount of weight as the system

1130
00:40:11,430 --> 00:40:09,760
is designed

1131
00:40:13,349 --> 00:40:11,440
so we made this trade of we're going to

1132
00:40:16,150 --> 00:40:13,359
go with a less capable suit

1133
00:40:17,430 --> 00:40:16,160
for the short term uh to execute this

1134
00:40:18,950 --> 00:40:17,440
early mission

1135
00:40:20,790 --> 00:40:18,960
and then for the long term we'll keep

1136
00:40:22,710 --> 00:40:20,800
evolving and go build the exploration

1137
00:40:24,150 --> 00:40:22,720
suit we really need for the future

1138
00:40:28,230 --> 00:40:24,160

that's kind of the trade hopefully that

1139
00:40:33,510 --> 00:40:30,550
any other questions online

1140
00:40:36,069 --> 00:40:33,520
any other comments for eva tools and so

1141
00:40:38,309 --> 00:40:36,079
let me in case the the other technical

1142
00:40:39,510 --> 00:40:38,319
modifications that were made to the suit

1143
00:40:41,030 --> 00:40:39,520
were

1144
00:40:44,069 --> 00:40:41,040
some biasing and the stitching to

1145
00:40:45,670 --> 00:40:44,079
encrypt to improve where the natural

1146
00:40:47,510 --> 00:40:45,680
work site is for the crew's hands to

1147
00:40:49,510 --> 00:40:47,520
reduce crew effort

1148
00:40:51,670 --> 00:40:49,520
adding a thermal protection over garment

1149
00:40:54,230 --> 00:40:51,680
to handle the difference of the thermal

1150
00:40:56,630 --> 00:40:54,240
environment from outside the cabin

1151
00:40:58,710 --> 00:40:56,640
modifications of including the

1152
00:41:00,710 --> 00:40:58,720
the phase six gloves that are currently

1153
00:41:03,109 --> 00:41:00,720
being used on stations so there were

1154
00:41:05,109 --> 00:41:03,119
basically mobility enhancements and

1155
00:41:07,670 --> 00:41:05,119
enhancements to handle the eva

1156
00:41:09,670 --> 00:41:07,680
environment different from the suit

1157
00:41:11,589 --> 00:41:09,680
those types of things the tmg for

1158
00:41:12,870 --> 00:41:11,599
example would those material

1159
00:41:15,910 --> 00:41:12,880
developments and everything else would

1160
00:41:17,430 --> 00:41:15,920
apply to a future suit as well

1161
00:41:20,790 --> 00:41:17,440
so we're about to make some of those

1162
00:41:23,270 --> 00:41:20,800
mods to the suit and get back in the nbl

1163
00:41:24,950 --> 00:41:23,280

as the calendar year turns over

1164
00:41:27,510 --> 00:41:24,960
and then try to test out

1165
00:41:29,829 --> 00:41:27,520
some modifications that the

1166
00:41:31,190 --> 00:41:29,839
asus suit the hands aren't necessarily

1167
00:41:33,030 --> 00:41:31,200
biased properly it was designed for

1168
00:41:35,670 --> 00:41:33,040
launch entry we think we can we can bias

1169
00:41:37,510 --> 00:41:35,680
those and do even more productive work

1170
00:41:38,950 --> 00:41:37,520
we know it's not the best suit but it's

1171
00:41:41,430 --> 00:41:38,960
it'll it'll work for this mission at

1172
00:41:43,190 --> 00:41:41,440
least we think for short evas

1173
00:41:46,309 --> 00:41:43,200
the next chart i have here is we there's

1174
00:41:48,950 --> 00:41:46,319
some pretty amazing things that that we

1175
00:41:50,630 --> 00:41:48,960
got out of this session relative to

1176
00:41:52,870 --> 00:41:50,640
how we would do translation and these

1177
00:41:54,309 --> 00:41:52,880
these telescoping booms

1178
00:41:56,630 --> 00:41:54,319
you saw in our animation and our

1179
00:41:58,950 --> 00:41:56,640
graphics we had a couple of booms but we

1180
00:41:59,829 --> 00:41:58,960
didn't we didn't really look at

1181
00:42:01,430 --> 00:41:59,839
um

1182
00:42:04,309 --> 00:42:01,440
you know we'd love to have a more

1183
00:42:05,670 --> 00:42:04,319
capable robotic arm but from a mass

1184
00:42:07,270 --> 00:42:05,680
perspective for the first mission it

1185
00:42:09,430 --> 00:42:07,280
just doesn't really work out

1186
00:42:11,030 --> 00:42:09,440
so some of these concepts of a

1187
00:42:13,030 --> 00:42:11,040
telescoping boom

1188
00:42:14,870 --> 00:42:13,040

kind of intrigue us a little bit

1189
00:42:15,750 --> 00:42:14,880
we've been struggling with how do we get

1190
00:42:19,030 --> 00:42:15,760
to

1191
00:42:20,950 --> 00:42:19,040
asteroid let's say

1192
00:42:22,630 --> 00:42:20,960
we think we can get to positions near

1193
00:42:24,470 --> 00:42:22,640
the the base if you saw in our graphic

1194
00:42:26,309 --> 00:42:24,480
pretty well but then if we want to go up

1195
00:42:27,750 --> 00:42:26,319
a little higher in the asteroid we're a

1196
00:42:29,990 --> 00:42:27,760
little challenged by our current

1197
00:42:32,790 --> 00:42:30,000
capability but these telescoping booms

1198
00:42:33,829 --> 00:42:32,800
are pretty simple they're pretty uh

1199
00:42:35,109 --> 00:42:33,839
pretty

1200
00:42:36,390 --> 00:42:35,119
we suspect they're relatively cost

1201
00:42:37,829 --> 00:42:36,400
effective and they may give us that

1202
00:42:38,630 --> 00:42:37,839
capability so this is something we want

1203
00:42:40,870 --> 00:42:38,640
to go

1204
00:42:42,630 --> 00:42:40,880
take a little bit more look at

1205
00:42:45,270 --> 00:42:42,640
you know we talked a lot about

1206
00:42:46,710 --> 00:42:45,280
other the canada arm dexter

1207
00:42:47,510 --> 00:42:46,720
the darpa friend arm and those are

1208
00:42:49,030 --> 00:42:47,520
things

1209
00:42:50,550 --> 00:42:49,040
you know probably would be not for the

1210
00:42:51,750 --> 00:42:50,560
first mission but maybe maybe down the

1211
00:42:52,550 --> 00:42:51,760
road there would be something we would

1212
00:42:54,790 --> 00:42:52,560
add

1213
00:42:56,390 --> 00:42:54,800

but these telescoping booms are pretty

1214
00:42:58,550 --> 00:42:56,400
intriguing and then

1215
00:43:01,270 --> 00:42:58,560
something we'll go look at a little bit

1216
00:43:03,030 --> 00:43:01,280
more we were very interested in those

1217
00:43:06,230 --> 00:43:03,040
something that both mark and i commented

1218
00:43:08,230 --> 00:43:06,240
on as we went through the session today

1219
00:43:11,349 --> 00:43:08,240
any other comments on translation aids

1220
00:43:13,750 --> 00:43:11,359
or robotics as we

1221
00:43:16,230 --> 00:43:13,760
move forward

1222
00:43:21,190 --> 00:43:18,309
and then you know we've talked about

1223
00:43:23,190 --> 00:43:21,200
you know what do we do to uh to further

1224
00:43:25,750 --> 00:43:23,200
um explore the asteroid relative to

1225
00:43:27,030 --> 00:43:25,760
things like in situ resource utilization

1226
00:43:28,870 --> 00:43:27,040
this was an intriguing robotic

1227
00:43:30,710 --> 00:43:28,880
capability to maybe maybe look inside

1228
00:43:32,150 --> 00:43:30,720
the asteroid maybe this is something

1229
00:43:33,349 --> 00:43:32,160
we could think about pre-positioning on

1230
00:43:35,430 --> 00:43:33,359
the robotic spacecraft i think that's

1231
00:43:37,270 --> 00:43:35,440
something we need to talk about

1232
00:43:39,750 --> 00:43:37,280
how do we package things there's there's

1233
00:43:42,790 --> 00:43:39,760
been a lot of mass trades done but as we

1234
00:43:44,230 --> 00:43:42,800
move forward for uh for future missions

1235
00:43:46,230 --> 00:43:44,240
you know how do we add things that

1236
00:43:47,829 --> 00:43:46,240
really improve our our utilization of

1237
00:43:54,150 --> 00:43:47,839
the asteroid or maybe turn it over to

1238
00:43:58,069 --> 00:43:56,870

and then uh again we've got a really

1239
00:43:59,910 --> 00:43:58,079
focus on

1240
00:44:02,230 --> 00:43:59,920
how do we how do we

1241
00:44:04,309 --> 00:44:02,240
build functionality across the modules

1242
00:44:05,990 --> 00:44:04,319
we've talked about for extensibility

1243
00:44:08,150 --> 00:44:06,000
obviously orion there's going to be some

1244
00:44:10,390 --> 00:44:08,160
limit at some point orion is really a

1245
00:44:11,990 --> 00:44:10,400
crew transportation vehicle but it can

1246
00:44:14,069 --> 00:44:12,000
be used as an airlock for the simple

1247
00:44:15,430 --> 00:44:14,079
missions where do we move

1248
00:44:17,349 --> 00:44:15,440
where do we put hardware in the future

1249
00:44:18,790 --> 00:44:17,359
it's probably on

1250
00:44:20,550 --> 00:44:18,800
some of the modules that we propose

1251
00:44:22,550 --> 00:44:20,560
either an exploration module or some of

1252
00:44:24,870 --> 00:44:22,560
these robotic modules

1253
00:44:26,710 --> 00:44:24,880
to optimize future missions

1254
00:44:28,870 --> 00:44:26,720
um you know we

1255
00:44:30,790 --> 00:44:28,880
we liked the simulation work that has

1256
00:44:32,550 --> 00:44:30,800
been been done at goddard and things

1257
00:44:33,910 --> 00:44:32,560
that can enhance the mission obviously

1258
00:44:36,069 --> 00:44:33,920
goddard has done a lot of work on the

1259
00:44:37,670 --> 00:44:36,079
sensor technology as well that that

1260
00:44:39,670 --> 00:44:37,680
feeds forward not only for this mission

1261
00:44:41,430 --> 00:44:39,680
but future missions

1262
00:44:43,190 --> 00:44:41,440
and then you know everything that we do

1263
00:44:45,030 --> 00:44:43,200

we really need to keep affordability in

1264
00:44:47,750 --> 00:44:45,040
mind we we have

1265
00:44:49,510 --> 00:44:47,760
as uh as the human space flight

1266
00:44:50,870 --> 00:44:49,520
team knows it's a

1267
00:44:52,309 --> 00:44:50,880
we need to

1268
00:44:54,230 --> 00:44:52,319
work within our budget constraints

1269
00:44:55,190 --> 00:44:54,240
continue to work on sls and orion and

1270
00:44:57,430 --> 00:44:55,200
then

1271
00:44:59,270 --> 00:44:57,440
use this as the first mission for those

1272
00:45:00,230 --> 00:44:59,280
for those vehicles

1273
00:45:01,430 --> 00:45:00,240
so

1274
00:45:03,589 --> 00:45:01,440
in summary

1275
00:45:06,230 --> 00:45:03,599
we might wrap up a little early

1276
00:45:07,670 --> 00:45:06,240
we had a lot of really good ideas

1277
00:45:09,109 --> 00:45:07,680
we're going to take those ideas and go

1278
00:45:11,349 --> 00:45:09,119
back in our team and

1279
00:45:13,750 --> 00:45:11,359
use those to approve the mission

1280
00:45:15,750 --> 00:45:13,760
extensibility is very important as we

1281
00:45:17,990 --> 00:45:15,760
take this mission build forward

1282
00:45:19,670 --> 00:45:18,000
for exploration

1283
00:45:22,150 --> 00:45:19,680
this isn't a one of mission it's a

1284
00:45:23,910 --> 00:45:22,160
stepping stone to future missions uh to

1285
00:45:25,990 --> 00:45:23,920
build upon

1286
00:45:27,670 --> 00:45:26,000
initially in cis lunar space and then

1287
00:45:29,349 --> 00:45:27,680
onward to mars

1288
00:45:31,430 --> 00:45:29,359

it very much lines up with a global

1289
00:45:32,950 --> 00:45:31,440
exploration roadmap which we've been

1290
00:45:34,309 --> 00:45:32,960
working

1291
00:45:36,470 --> 00:45:34,319
hand-in-hand with our partners which was

1292
00:45:37,990 --> 00:45:36,480
released earlier this calendar year

1293
00:45:39,910 --> 00:45:38,000
we'll maintain some flexibility in the

1294
00:45:41,589 --> 00:45:39,920
design and this is a good time in fact

1295
00:45:43,510 --> 00:45:41,599
today has been what i think is the best

1296
00:45:45,750 --> 00:45:43,520
interaction we've had

1297
00:45:46,870 --> 00:45:45,760
getting a lot of good ideas from from a

1298
00:45:49,589 --> 00:45:46,880
broad

1299
00:45:51,030 --> 00:45:49,599
source of teammates that we work with

1300
00:45:53,190 --> 00:45:51,040
day in and day out some that we don't

1301
00:45:55,030 --> 00:45:53,200
work with and some in academia

1302
00:45:57,030 --> 00:45:55,040
and we're going to continue to leverage

1303
00:45:59,750 --> 00:45:57,040
this team and and work in the future to

1304
00:46:02,630 --> 00:45:59,760
put together the best mission we can so

1305
00:46:04,550 --> 00:46:02,640
thank you very much for attending and uh

1306
00:46:06,790 --> 00:46:04,560
really appreciate the support

1307
00:46:10,230 --> 00:46:06,800
any last comments or questions from the

1308
00:46:14,550 --> 00:46:11,589
so we're really looking for

1309
00:46:17,270 --> 00:46:14,560
recommendations for further work

1310
00:46:18,950 --> 00:46:17,280
i didn't really see any here so

1311
00:46:20,630 --> 00:46:18,960
i'd like to see that tomorrow morning

1312
00:46:22,390 --> 00:46:20,640
when you brief out

1313
00:46:24,069 --> 00:46:22,400

because we have to write a final report

1314
00:46:25,510 --> 00:46:24,079
about this workshop and that's going to

1315
00:46:27,190 --> 00:46:25,520
be key

1316
00:46:29,190 --> 00:46:27,200
yeah we'll put together that's what we

1317
00:46:31,190 --> 00:46:29,200
have tonight some recommendations we

1318
00:46:33,430 --> 00:46:31,200
really wanted to have a discussion

1319
00:46:34,710 --> 00:46:33,440
uh in this phase but

1320
00:46:36,870 --> 00:46:34,720
you know the telescoping boom is

1321
00:46:39,349 --> 00:46:36,880
something we will carry forward

1322
00:46:42,790 --> 00:46:39,359
i think that the suit dust

1323
00:46:45,190 --> 00:46:42,800
item is something we'll carry forward

1324
00:46:46,790 --> 00:46:45,200
the the drill technology and using the

1325
00:46:48,390 --> 00:46:46,800
the pgt

1326
00:46:49,750 --> 00:46:48,400
with the drill is something will carry

1327
00:46:52,870 --> 00:46:49,760
forward

1328
00:46:54,390 --> 00:46:52,880
so uh the extensibility ideas that mike

1329
00:46:55,589 --> 00:46:54,400
rafferty and the boeing team propose on

1330
00:46:57,190 --> 00:46:55,599
how to build upon it something will

1331
00:46:58,470 --> 00:46:57,200
carry forward so those are three or four

1332
00:47:00,069 --> 00:46:58,480
things that will

1333
00:47:03,030 --> 00:47:00,079
will carry forward

1334
00:47:04,710 --> 00:47:03,040
there are also in the first um

1335
00:47:06,470 --> 00:47:04,720
paper there were some ideas on

1336
00:47:08,069 --> 00:47:06,480
partnerships

1337
00:47:10,950 --> 00:47:08,079
that would be really interesting to

1338
00:47:14,309 --> 00:47:10,960

explore as well

1339
00:47:17,990 --> 00:47:16,230
any other clues and comments thanks

1340
00:47:19,990 --> 00:47:18,000
steve and i both took some notes on ones

1341
00:47:21,670 --> 00:47:20,000
that piqued our interest for

1342
00:47:23,670 --> 00:47:21,680
continued work and we'll collaborate on

1343
00:47:25,190 --> 00:47:23,680
that after to me i found it very hard

1344
00:47:26,549 --> 00:47:25,200
it's one thing to read the papers it's

1345
00:47:27,750 --> 00:47:26,559
one thing to

1346
00:47:28,630 --> 00:47:27,760
look at the presentations but it's

1347
00:47:30,790 --> 00:47:28,640
another thing to hear their

1348
00:47:32,150 --> 00:47:30,800
presentations in person and and see how

1349
00:47:34,230 --> 00:47:32,160
they're delivered and listen to the

1350
00:47:36,150 --> 00:47:34,240
ideas and get the exchange i think we

1351
00:47:38,069 --> 00:47:36,160
get a better product that way

1352
00:47:40,069 --> 00:47:38,079
so but we'll have some recognitions

1353
00:47:42,630 --> 00:47:40,079
tomorrow as well so

1354
00:47:45,190 --> 00:47:42,640
for our headquarters friends

1355
00:47:47,510 --> 00:47:45,200
i wanted to comment that um i also think

1356
00:47:49,750 --> 00:47:47,520
that the dust on the suit has a lot of

1357
00:47:51,430 --> 00:47:49,760
promise and i want to echo that i do

1358
00:47:53,349 --> 00:47:51,440
think though that there's a lot of maybe

1359
00:47:55,589 --> 00:47:53,359
material durability and the fact that

1360
00:47:57,589 --> 00:47:55,599
it's an electronic material and take

1361
00:47:59,910 --> 00:47:57,599
into consideration

1362
00:48:01,670 --> 00:47:59,920
some of those maybe long-term material

1363
00:48:05,030 --> 00:48:01,680

certification things like flammability

1364
00:48:07,270 --> 00:48:05,040
concerns as they go forward and do more

1365
00:48:09,430 --> 00:48:07,280
detailed evaluation on those types of

1366
00:48:11,670 --> 00:48:09,440
materials

1367
00:48:13,190 --> 00:48:11,680
thank you

1368
00:48:18,630 --> 00:48:13,200
any other comments

1369
00:48:23,270 --> 00:48:20,230
this this may be a bad one when

1370
00:48:25,829 --> 00:48:23,280
everybody's ready to leave but uh

1371
00:48:28,549 --> 00:48:25,839
so i i know uh space technology mission

1372
00:48:30,630 --> 00:48:28,559
directorate is playing an active role in

1373
00:48:32,150 --> 00:48:30,640
the robotic vehicle because they're very

1374
00:48:33,910 --> 00:48:32,160
interested in forwarding the solar

1375
00:48:35,910 --> 00:48:33,920
electric propulsion

1376
00:48:37,910 --> 00:48:35,920
and the question is whether

1377
00:48:40,230 --> 00:48:37,920
they've engaged

1378
00:48:41,430 --> 00:48:40,240
you guys in the crew portion of the

1379
00:48:43,750 --> 00:48:41,440
mission yet

1380
00:48:45,190 --> 00:48:43,760
and if you see a role for them to help

1381
00:48:47,589 --> 00:48:45,200
support

1382
00:48:51,030 --> 00:48:47,599
some of these activities or building out

1383
00:48:53,670 --> 00:48:51,040
some of the future capabilities so i can

1384
00:48:55,670 --> 00:48:53,680
comment a little bit uh

1385
00:48:57,910 --> 00:48:55,680
yes they've been very engaged on the

1386
00:48:59,190 --> 00:48:57,920
solar array technology and the

1387
00:49:00,950 --> 00:48:59,200
set

1388
00:49:01,670 --> 00:49:00,960

systems and the hall thruster technology

1389
00:49:03,109 --> 00:49:01,680
which

1390
00:49:04,790 --> 00:49:03,119
feeds four we've talked to them about

1391
00:49:07,750 --> 00:49:04,800
how that feeds forward in terms of the

1392
00:49:09,910 --> 00:49:07,760
array size the mass and power that that

1393
00:49:12,309 --> 00:49:09,920
we need but they're also participating

1394
00:49:14,549 --> 00:49:12,319
in a lot of different areas

1395
00:49:16,470 --> 00:49:14,559
for example in our advanced exploration

1396
00:49:17,990 --> 00:49:16,480
suit development they are a partner in

1397
00:49:19,990 --> 00:49:18,000
our suit development they've funded some

1398
00:49:21,190 --> 00:49:20,000
advanced glove work today they continue

1399
00:49:23,670 --> 00:49:21,200
to do that

1400
00:49:25,670 --> 00:49:23,680
human robotic systems

1401
00:49:27,829 --> 00:49:25,680
some of the technology that

1402
00:49:29,829 --> 00:49:27,839
that rob from ksc talked about are

1403
00:49:32,790 --> 00:49:29,839
actually being funded by the human

1404
00:49:34,470 --> 00:49:32,800
robotic systems project in space tech so

1405
00:49:36,549 --> 00:49:34,480
they're already

1406
00:49:37,990 --> 00:49:36,559
looking at technologies we need

1407
00:49:41,430 --> 00:49:38,000
for exploration

1408
00:49:43,670 --> 00:49:41,440
i know chris moore and jason crusad from

1409
00:49:45,910 --> 00:49:43,680
advanced exploration systems works hand

1410
00:49:48,150 --> 00:49:45,920
in hand with space tech on helping them

1411
00:49:49,589 --> 00:49:48,160
to define the technologies required that

1412
00:49:52,150 --> 00:49:49,599
feed forward

1413
00:49:53,990 --> 00:49:52,160

they've got work on going on in situ

1414
00:49:56,710 --> 00:49:54,000
resource utilization

1415
00:49:59,270 --> 00:49:56,720
for various destinations so

1416
00:50:01,270 --> 00:49:59,280
they've been a partner with us

1417
00:50:04,549 --> 00:50:01,280
we've talked a lot probably maybe too

1418
00:50:06,630 --> 00:50:04,559
much about the sep which is really

1419
00:50:09,349 --> 00:50:06,640
a big factor in this mission in fact

1420
00:50:11,750 --> 00:50:09,359
accept technology really enables

1421
00:50:13,430 --> 00:50:11,760
us to even dream of bringing back these

1422
00:50:15,349 --> 00:50:13,440
kinds of masses

1423
00:50:17,270 --> 00:50:15,359
from deep space but there's other things

1424
00:50:22,470 --> 00:50:17,280
that space tech has been

1425
00:50:28,870 --> 00:50:25,030
any other questions or comments

1426
00:50:32,470 --> 00:50:30,710
thank you very much this has been an

1427
00:50:33,829 --> 00:50:32,480
incredible session so thanks for all

1428
00:50:35,670 --> 00:50:33,839
your time and

1429
00:50:37,750 --> 00:50:35,680
and i really appreciate it and continue

1430
00:50:39,109 --> 00:50:37,760
to watch the asteroid initiative on

1431
00:50:40,549 --> 00:50:39,119
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