

1
00:00:06,000 --> 00:00:10,359
hello everybody and welcome to today's

2
00:00:08,108 --> 00:00:11,800
Hubble hang out my name is Tony Darnell

3
00:00:10,359 --> 00:00:13,779
I work at the Space Telescope Science

4
00:00:11,800 --> 00:00:15,910
Institute and we haven't really good

5
00:00:13,779 --> 00:00:21,278
hangout plan fee today we're gonna be

6
00:00:15,910 --> 00:00:24,609
talking about 3d printing in space I've

7
00:00:21,278 --> 00:00:26,800
been dying to do that okay so with and

8
00:00:24,609 --> 00:00:28,329
we have with us today Jason Donna he's

9
00:00:26,800 --> 00:00:29,978
the chief technology officer from made

10
00:00:28,329 --> 00:00:32,200
in space and he's going to tell us all

11
00:00:29,978 --> 00:00:36,219
about what the future looks like for

12
00:00:32,200 --> 00:00:38,109
printing up when zero g and but before i

13
00:00:36,219 --> 00:00:40,179
get started let me tell you we're

14
00:00:38,109 --> 00:00:41,679
looking to hat get your questions and

15
00:00:40,179 --> 00:00:44,560
comments and you can do it in all the

16
00:00:41,679 --> 00:00:47,920
usual ways twitter using Hubble hang out

17
00:00:44,560 --> 00:00:50,350
hashtag you can comment on the youtube

18
00:00:47,920 --> 00:00:52,780
channel you can comment on our event

19
00:00:50,350 --> 00:00:54,730
page and you can also use the Q&A app so

20
00:00:52,780 --> 00:00:57,789
we're monitoring all those things and we

21
00:00:54,729 --> 00:00:59,169
really hope that you will use those now

22
00:00:57,789 --> 00:01:01,839
i've been doing these hangouts for a

23
00:00:59,170 --> 00:01:05,618
while and i can't believe that i haven't

24
00:01:01,840 --> 00:01:08,380
been asking you guys to please follow or

25
00:01:05,618 --> 00:01:10,629
subscribe to our youtube channel if you

26
00:01:08,379 --> 00:01:12,759
want to get notified of more of these

27
00:01:10,629 --> 00:01:14,259
events or things like that please go to

28
00:01:12,759 --> 00:01:16,388
Hubble site channel on youtube and

29

00:01:14,259 --> 00:01:18,459
subscribe and you'll be able to get

30
00:01:16,388 --> 00:01:20,319
notifications when we go live so hope

31
00:01:18,459 --> 00:01:22,989
you'll do that and also follow us on

32
00:01:20,319 --> 00:01:25,539
twitter we're at hubble telescope so you

33
00:01:22,989 --> 00:01:28,419
can follow us there as well we also have

34
00:01:25,539 --> 00:01:31,420
a Facebook page hubble telescope on on

35
00:01:28,420 --> 00:01:33,759
that you can also follow so like us or

36
00:01:31,420 --> 00:01:35,888
follow us on that as well and we would

37
00:01:33,759 --> 00:01:37,539
very much appreciate it so there are

38
00:01:35,888 --> 00:01:39,188
many Hubble telescopes on Facebook

39
00:01:37,539 --> 00:01:41,498
they'll go for the verified one because

40
00:01:39,188 --> 00:01:44,288
that's that's us that's there's like

41
00:01:41,498 --> 00:01:47,920
five different Hubble Space I know and

42
00:01:44,289 --> 00:01:49,509
we verified one yes then now the Hubble

43
00:01:47,920 --> 00:01:51,759

I guess we relate to the game in

44

00:01:49,509 --> 00:01:53,170

facebook it was before my time but yeah

45

00:01:51,759 --> 00:01:55,420

there's a lot of Facebook pages out

46

00:01:53,170 --> 00:01:58,569

there that it's and many are Hubble

47

00:01:55,420 --> 00:02:00,638

Space Telescope of Facebook pages they

48

00:01:58,569 --> 00:02:02,228

have a lot more likes than us too so we

49

00:02:00,638 --> 00:02:03,699

one would like to try and catch up so we

50

00:02:02,228 --> 00:02:06,099

hope you'll do that so yeah that's a

51

00:02:03,700 --> 00:02:08,439

good point Scott thanks so which brings

52

00:02:06,099 --> 00:02:10,629

me to the people of my introductions

53

00:02:08,439 --> 00:02:13,060

with me as I as always is dr. carol

54

00:02:10,629 --> 00:02:14,019

christian she is the HST the Hubble

55

00:02:13,060 --> 00:02:17,500

Space Telescope

56

00:02:14,020 --> 00:02:19,750

outreach scientist hi Carol welcome and

57

00:02:17,500 --> 00:02:23,469

also scott lewis from know the cosmos

58
00:02:19,750 --> 00:02:25,659
calm and he's basically dinner known

59
00:02:23,469 --> 00:02:27,039
everywhere on the internet so thank you

60
00:02:25,659 --> 00:02:30,579
all i don't know about everywhere that's

61
00:02:27,039 --> 00:02:32,379
scary let's let's do with the good nerdy

62
00:02:30,580 --> 00:02:35,230
part to the internet i was thinkin that

63
00:02:32,379 --> 00:02:38,349
all right oh oh that's right yeah good

64
00:02:35,229 --> 00:02:40,689
clarification yeah okay so as i

65
00:02:38,349 --> 00:02:42,519
mentioned earlier jason dunn he's the

66
00:02:40,689 --> 00:02:47,590
co-founder and chief technology officer

67
00:02:42,520 --> 00:02:48,790
of made in space and you and he is here

68
00:02:47,590 --> 00:02:50,170
to talk to us today about 3d printing

69
00:02:48,789 --> 00:02:52,019
and some of the things they're doing now

70
00:02:50,169 --> 00:02:54,339
you'll remember a couple of weeks ago

71
00:02:52,020 --> 00:02:56,680
carol scott and i did a hangout on 3d

72
00:02:54,340 --> 00:02:58,060
printing that as part of the stuff that

73
00:02:56,680 --> 00:03:01,270
Carol would have been working on with

74
00:02:58,060 --> 00:03:02,920
education materials and and and you know

75
00:03:01,270 --> 00:03:06,610
visually impaired education things like

76
00:03:02,919 --> 00:03:08,919
that and Jason though is working with

77
00:03:06,610 --> 00:03:12,190
his team his company on something

78
00:03:08,919 --> 00:03:14,409
completely different so Jason welcome to

79
00:03:12,189 --> 00:03:16,810
our hangout and thanks for having me

80
00:03:14,409 --> 00:03:20,620
here it's a pleasure why don't you tell

81
00:03:16,810 --> 00:03:23,740
us a little bit about why what what what

82
00:03:20,620 --> 00:03:25,150
made in space is doing and you're you

83
00:03:23,740 --> 00:03:27,250
you helped co-found it along with I

84
00:03:25,150 --> 00:03:28,240
think to other people is that right tell

85
00:03:27,250 --> 00:03:31,629
us what you're doing on what your

86

00:03:28,240 --> 00:03:34,689
company is all about yeah be happy to so

87
00:03:31,629 --> 00:03:36,759
we started main space a little over four

88
00:03:34,689 --> 00:03:39,159
years ago now in the summer of two

89
00:03:36,759 --> 00:03:42,280
thousand ten really myself and my

90
00:03:39,159 --> 00:03:45,819
co-founders came together because we all

91
00:03:42,280 --> 00:03:47,319
believe that humanity needs to live in

92
00:03:45,819 --> 00:03:50,560
more places than just here on the

93
00:03:47,319 --> 00:03:52,269
surface of planet Earth and and we also

94
00:03:50,560 --> 00:03:54,400
believe that that can happen you know

95
00:03:52,270 --> 00:03:56,380
relatively soon as long as the right

96
00:03:54,400 --> 00:04:00,189
people start focusing attention on it so

97
00:03:56,379 --> 00:04:01,900
for us we care a lot about expanding our

98
00:04:00,189 --> 00:04:04,419
reach throughout the solar system and

99
00:04:01,900 --> 00:04:06,039
through that we kind of start looking

100
00:04:04,419 --> 00:04:09,039

all the problems why aren't we doing

101

00:04:06,039 --> 00:04:11,289

that today and identified that you know

102

00:04:09,039 --> 00:04:13,900

we can really live off the land so to

103

00:04:11,289 --> 00:04:16,149

speak and manufacture the things we need

104

00:04:13,900 --> 00:04:19,329

wherever we go we could actually enable

105

00:04:16,149 --> 00:04:21,939

a more rapid pace of sending humans to

106

00:04:19,329 --> 00:04:24,339

other planets and building new plan that

107

00:04:21,939 --> 00:04:26,110

you know new worlds of our own so we

108

00:04:24,339 --> 00:04:27,939

start focusing on space manufacturing

109

00:04:26,110 --> 00:04:31,810

and in 2010

110

00:04:27,939 --> 00:04:35,469

that idea was widely left up to science

111

00:04:31,810 --> 00:04:37,269

fiction some nasta roadmaps had it set a

112

00:04:35,470 --> 00:04:40,420

much further out than you know a few

113

00:04:37,269 --> 00:04:43,779

years later but we we took a different

114

00:04:40,420 --> 00:04:46,650

approach and we looked at how the 3d

115
00:04:43,779 --> 00:04:49,269
printing technology could enable

116
00:04:46,649 --> 00:04:51,879
basically robotic manufacturing in a way

117
00:04:49,269 --> 00:04:53,769
that we haven't had before and like I

118
00:04:51,879 --> 00:04:56,439
like how you put it with living off the

119
00:04:53,769 --> 00:04:58,329
land that's really cool now this is also

120
00:04:56,439 --> 00:05:01,000
this is also driven in part by annick by

121
00:04:58,329 --> 00:05:02,800
something that NASA is doing right there

122
00:05:01,000 --> 00:05:05,050
they had any 3d yet they're calling it

123
00:05:02,800 --> 00:05:06,370
the 3d printing in zero-g technology

124
00:05:05,050 --> 00:05:10,060
demonstration or something like that

125
00:05:06,370 --> 00:05:13,689
yeah so absolutely so the basically the

126
00:05:10,060 --> 00:05:16,329
way the way this worked out is we we

127
00:05:13,689 --> 00:05:18,910
helped reinvigorate NASA in a way we

128
00:05:16,329 --> 00:05:21,459
showed them that as a commercial company

129
00:05:18,910 --> 00:05:23,350
there was actually a business model for

130
00:05:21,459 --> 00:05:25,599
space manufacturing and that's what made

131
00:05:23,350 --> 00:05:27,250
in space would be pursuing and through

132
00:05:25,600 --> 00:05:30,790
that we developed some partnerships with

133
00:05:27,250 --> 00:05:32,800
NASA we took in 2011 we did zero gravity

134
00:05:30,790 --> 00:05:35,350
flights and I believe we even have some

135
00:05:32,800 --> 00:05:37,540
some footage there to show maybe later

136
00:05:35,350 --> 00:05:39,820
of us testing 3d printers in zero

137
00:05:37,540 --> 00:05:42,310
gravity and and then we went to design

138
00:05:39,819 --> 00:05:45,519
one for the space stage and the you know

139
00:05:42,310 --> 00:05:48,280
the really exciting thing is just last

140
00:05:45,519 --> 00:05:50,229
month made in space and nasa launched

141
00:05:48,279 --> 00:05:52,869
the first 3d printer to the space

142
00:05:50,230 --> 00:05:54,580
station so this made in space printer is

143

00:05:52,870 --> 00:05:56,680
up there it would work with NASA to

144
00:05:54,579 --> 00:05:59,019
create a technology demonstration

145
00:05:56,680 --> 00:06:01,300
mission out of this and it's called just

146
00:05:59,019 --> 00:06:04,750
like you said Tony the 3d printing in

147
00:06:01,300 --> 00:06:07,569
zero-g experiment and with a we caught

148
00:06:04,750 --> 00:06:09,730
3d print for short 3d print is really

149
00:06:07,569 --> 00:06:11,439
it's really exciting and for a lot of

150
00:06:09,730 --> 00:06:14,410
reasons but the one I'll say right now

151
00:06:11,439 --> 00:06:16,269
is that up until this point in time

152
00:06:14,410 --> 00:06:18,160
there's only been one way to get

153
00:06:16,269 --> 00:06:20,560
hardware into space and that's been

154
00:06:18,160 --> 00:06:22,150
launching it on rocket and now today

155
00:06:20,560 --> 00:06:24,550
with the 3d printer on the space station

156
00:06:22,149 --> 00:06:27,339
there's actually an entirely new way to

157
00:06:24,550 --> 00:06:29,620

get hardware there we in fact just email

158

00:06:27,339 --> 00:06:32,289

the digital file to our 3d printer and

159

00:06:29,620 --> 00:06:33,790

print it out so you think that's

160

00:06:32,290 --> 00:06:35,260

paradigm shift well I'm going to get to

161

00:06:33,790 --> 00:06:37,090

that in just a minute because to me it

162

00:06:35,259 --> 00:06:38,288

seems like you know mass is mass and

163

00:06:37,089 --> 00:06:39,699

you're going to have to get something up

164

00:06:38,288 --> 00:06:41,050

there to make the print things out of

165

00:06:39,699 --> 00:06:41,680

but we'll get to that in just a sec why

166

00:06:41,050 --> 00:06:43,660

what

167

00:06:41,680 --> 00:06:45,910

uh one let's take a step back though and

168

00:06:43,660 --> 00:06:48,430

let's talk a little bit about what 3d

169

00:06:45,910 --> 00:06:50,620

printing is and in particular what is

170

00:06:48,430 --> 00:06:52,389

your what sets your printer apart from

171

00:06:50,620 --> 00:06:54,009

say the one that we talked about a few

172
00:06:52,389 --> 00:06:55,900
weeks ago with what Carol's got going in

173
00:06:54,009 --> 00:06:57,788
the background and everybody knows carol

174
00:06:55,899 --> 00:07:00,189
always has something printing in the

175
00:06:57,788 --> 00:07:05,349
background all of our hangout so so

176
00:07:00,189 --> 00:07:08,500
probably it mine is really cheap what go

177
00:07:05,350 --> 00:07:10,810
ahead Jason yeah it's a really good

178
00:07:08,500 --> 00:07:13,360
question when we started this this

179
00:07:10,810 --> 00:07:15,939
company and set the the goal of this put

180
00:07:13,360 --> 00:07:18,009
a 3d printer on the space station we we

181
00:07:15,939 --> 00:07:20,529
had a really big hope that a commercial

182
00:07:18,009 --> 00:07:23,410
3d printer would do the job because as a

183
00:07:20,529 --> 00:07:25,448
company what we really want to get to is

184
00:07:23,410 --> 00:07:27,400
the point where anybody on planet earth

185
00:07:25,449 --> 00:07:29,139
can send their hardware to space by

186
00:07:27,399 --> 00:07:31,959
printing it there we want to open the

187
00:07:29,139 --> 00:07:34,150
doors to space this way so getting a

188
00:07:31,959 --> 00:07:37,000
printer there quick was was our goal we

189
00:07:34,149 --> 00:07:39,489
um we took these commercial printers on

190
00:07:37,000 --> 00:07:42,250
the zero-g flights and we tested over a

191
00:07:39,490 --> 00:07:44,079
dozen different printers and then built

192
00:07:42,250 --> 00:07:46,300
some new printers of our own but through

193
00:07:44,079 --> 00:07:48,550
that entire process we did over over

194
00:07:46,300 --> 00:07:49,689
three hours of zero gravity time and we

195
00:07:48,550 --> 00:07:51,490
found that none of the commercial

196
00:07:49,689 --> 00:07:54,339
printers would work we had to modify

197
00:07:51,490 --> 00:07:56,139
them significantly and you know to get

198
00:07:54,339 --> 00:07:57,939
thermal settings right to get the

199
00:07:56,139 --> 00:08:00,009
mechanical settings right I'll do all

200

00:07:57,939 --> 00:08:01,449
the things you would imagine but then on

201
00:08:00,009 --> 00:08:03,879
top of that just to build a printer that

202
00:08:01,449 --> 00:08:05,288
could survive launch to the space

203
00:08:03,879 --> 00:08:06,908
station to meet all the safety

204
00:08:05,288 --> 00:08:09,098
requirements to work on the space

205
00:08:06,908 --> 00:08:12,279
station not to you know the outgassing

206
00:08:09,098 --> 00:08:14,319
can be harmful for the crew and the EMI

207
00:08:12,279 --> 00:08:16,299
and the things like that we actually had

208
00:08:14,319 --> 00:08:18,699
to just go down a road of developing an

209
00:08:16,300 --> 00:08:21,038
entirely new type of printer one that's

210
00:08:18,699 --> 00:08:24,158
much more rugged and reliable it's

211
00:08:21,038 --> 00:08:27,129
extremely safe and it's really easy to

212
00:08:24,158 --> 00:08:28,478
use in fact there's only one button on

213
00:08:27,129 --> 00:08:30,848
the entire printer and that's the on

214
00:08:28,478 --> 00:08:33,578

switch everything else is controlled at

215

00:08:30,848 --> 00:08:36,098

our ground station here in Mountain View

216

00:08:33,578 --> 00:08:37,838

California so we actually operate the

217

00:08:36,099 --> 00:08:39,579

printer from the ground oh so you went

218

00:08:37,839 --> 00:08:43,419

to the apple design school then right

219

00:08:39,578 --> 00:08:45,039

one button is all you need Hughes where

220

00:08:43,418 --> 00:08:47,199

you guys running into when you're in the

221

00:08:45,039 --> 00:08:49,059

the vomit comet as it were doing your

222

00:08:47,200 --> 00:08:51,820

ear research what you said that you're

223

00:08:49,059 --> 00:08:53,828

doing 12 different different commercial

224

00:08:51,820 --> 00:08:55,209

printers of did you see a common issue

225

00:08:53,828 --> 00:08:56,859

among them all that

226

00:08:55,208 --> 00:09:00,609

you needed really address so you get it

227

00:08:56,860 --> 00:09:02,199

mmhmm yeah so the there's there's

228

00:09:00,610 --> 00:09:06,579

definitely kind of a wide range there

229

00:09:02,198 --> 00:09:07,899

but the basic point is you know we had

230

00:09:06,578 --> 00:09:10,659

to figure out is how to get surface

231

00:09:07,899 --> 00:09:11,948

tension to dominate so everybody would

232

00:09:10,659 --> 00:09:13,808

everybody jump straight to the point

233

00:09:11,948 --> 00:09:17,469

well how do you how do you lay down one

234

00:09:13,808 --> 00:09:20,259

layer at a time of plastic if gravity is

235

00:09:17,470 --> 00:09:21,939

not there so for us it was a lot of fine

236

00:09:20,259 --> 00:09:24,278

tune adjustments to make sure that

237

00:09:21,938 --> 00:09:27,368

surface tension alone could hold

238

00:09:24,278 --> 00:09:29,230

these layers in place and to do that

239

00:09:27,369 --> 00:09:31,420

requires a redesign of the entire

240

00:09:29,230 --> 00:09:34,269

printer in a way because the current

241

00:09:31,419 --> 00:09:36,308

printers today we're designed inherently

242

00:09:34,269 --> 00:09:38,230

with gravity in mind so gravity there is

243
00:09:36,308 --> 00:09:40,088
there to hold build platforms in place

244
00:09:38,230 --> 00:09:43,119
and belts and pulleys move appropriately

245
00:09:40,089 --> 00:09:45,220
with gravity so remove of gravity things

246
00:09:43,119 --> 00:09:46,959
start floating around and even if it's

247
00:09:45,220 --> 00:09:48,999
floating by a fraction of a millimeter

248
00:09:46,958 --> 00:09:51,789
back and forth that can screw up a whole

249
00:09:48,999 --> 00:09:53,379
print so we added me to first and

250
00:09:51,789 --> 00:09:55,448
foremost figure out how to fix the

251
00:09:53,379 --> 00:09:57,428
printers to be more rugged and and you

252
00:09:55,448 --> 00:09:59,558
could you know shake them around and

253
00:09:57,428 --> 00:10:01,178
they'll still print in fact we do that

254
00:09:59,558 --> 00:10:03,698
now we can take our printer wallets

255
00:10:01,178 --> 00:10:05,350
pretty shake it turn it upside down do

256
00:10:03,698 --> 00:10:07,778
whatever one is just you know this

257

00:10:05,350 --> 00:10:09,009
really rugged machine so how'd you do

258
00:10:07,778 --> 00:10:11,649
that what how'd you solve the problem

259
00:10:09,009 --> 00:10:16,899
what exactly is doing or is that some

260
00:10:11,649 --> 00:10:18,970
dietary it gets towards a the area of

261
00:10:16,899 --> 00:10:21,730
the proprietary like secret sauce of

262
00:10:18,970 --> 00:10:23,379
what we've done eight unicorn is

263
00:10:21,730 --> 00:10:26,709
essentially what it came down to right

264
00:10:23,379 --> 00:10:29,860
space unicorns have space unicorns that

265
00:10:26,708 --> 00:10:32,588
that that's part of it minor

266
00:10:29,860 --> 00:10:35,499
complication talk about know so we yeah

267
00:10:32,589 --> 00:10:37,360
there's a lot of it's a lot of like you

268
00:10:35,499 --> 00:10:40,149
know redesigning thinking of it with

269
00:10:37,360 --> 00:10:41,589
different requirements we um the thermal

270
00:10:40,149 --> 00:10:43,688
characteristics that's an interesting

271
00:10:41,589 --> 00:10:45,699

one because if you we all know that hot

272

00:10:43,688 --> 00:10:48,159

air rises in the rooms that were sitting

273

00:10:45,698 --> 00:10:50,979

in right now but if you remove gravity

274

00:10:48,159 --> 00:10:53,558

hot air doesn't rise there's no buoyancy

275

00:10:50,980 --> 00:10:56,110

effects so hot there just stays around

276

00:10:53,558 --> 00:10:58,958

the area where it's created so we had to

277

00:10:56,110 --> 00:11:00,610

figure out how to thermally control the

278

00:10:58,958 --> 00:11:04,359

print environment which is also another

279

00:11:00,610 --> 00:11:05,918

important one so you have a you had to

280

00:11:04,360 --> 00:11:08,329

invent things that sounds like to get

281

00:11:05,918 --> 00:11:10,970

all of this stuff to work so I suppose

282

00:11:08,328 --> 00:11:12,409

yeah it's a lot like then that's pretty

283

00:11:10,970 --> 00:11:14,629

typical of a lot of things that you know

284

00:11:12,409 --> 00:11:16,749

isn't its involvement with NASA about

285

00:11:14,629 --> 00:11:19,129

technologies just have to be invented

286
00:11:16,749 --> 00:11:20,749
why is net so NASA is interested in

287
00:11:19,129 --> 00:11:22,399
doing this because they want to be able

288
00:11:20,749 --> 00:11:24,199
to print things or they want to

289
00:11:22,399 --> 00:11:26,958
manufacture things in space that's the

290
00:11:24,198 --> 00:11:29,928
that's the driver for it but um I guess

291
00:11:26,958 --> 00:11:32,388
my question is how how is it really i

292
00:11:29,928 --> 00:11:36,338
mean you didn't really thought you

293
00:11:32,389 --> 00:11:39,379
solved the problem of you know launching

294
00:11:36,339 --> 00:11:41,179
parts individual parts in space but you

295
00:11:39,379 --> 00:11:43,639
did you didn't sound to me like and i

296
00:11:41,178 --> 00:11:46,009
don't know how i also say this i don't

297
00:11:43,639 --> 00:11:47,928
think the problem of getting mass up

298
00:11:46,009 --> 00:11:51,019
into orbit has been solved you still got

299
00:11:47,928 --> 00:11:54,528
to have whatever it is that your printer

300
00:11:51,019 --> 00:11:59,539
is using right to be up there and that

301
00:11:54,528 --> 00:12:01,850
is not you know 00 wait and i wantam

302
00:11:59,539 --> 00:12:05,629
Adam yeah well I mean you brought that

303
00:12:01,850 --> 00:12:08,269
up Tony um we we identified that problem

304
00:12:05,629 --> 00:12:10,308
from really from day one because it's

305
00:12:08,269 --> 00:12:13,188
one thing to say hey it's great that the

306
00:12:10,308 --> 00:12:14,808
printer is in space there are problem

307
00:12:13,188 --> 00:12:17,618
even if you have to send the raw

308
00:12:14,808 --> 00:12:19,850
material it's still beneficial because

309
00:12:17,619 --> 00:12:21,949
when you're when you don't have to

310
00:12:19,850 --> 00:12:24,048
design your card we're to survive launch

311
00:12:21,948 --> 00:12:26,028
and you remove the requirement of it

312
00:12:24,048 --> 00:12:27,289
having it with stance several times the

313
00:12:26,028 --> 00:12:28,999
force of gravity and all these

314

00:12:27,289 --> 00:12:30,980
vibrational loads you can actually

315
00:12:28,999 --> 00:12:35,149
redesign your space structures to be

316
00:12:30,980 --> 00:12:37,129
extremely delicate in a way so imagine

317
00:12:35,149 --> 00:12:39,139
something that only has to work in zero

318
00:12:37,129 --> 00:12:41,600
gravity it doesn't have to support its

319
00:12:39,139 --> 00:12:43,850
own weight so just by sending the raw

320
00:12:41,600 --> 00:12:46,369
material in its like most condensed form

321
00:12:43,850 --> 00:12:48,409
we can actually let that material go

322
00:12:46,369 --> 00:12:50,989
much longer way by building what we call

323
00:12:48,409 --> 00:12:53,629
zero gravity structures so that's um

324
00:12:50,989 --> 00:12:54,980
that's number one so even today with the

325
00:12:53,629 --> 00:12:57,369
printer there and just launching the

326
00:12:54,980 --> 00:13:01,129
feedstock there's still a net benefit

327
00:12:57,369 --> 00:13:03,199
also time just the fact of just getting

328
00:13:01,129 --> 00:13:05,209

things to space quicker we can by

329

00:13:03,198 --> 00:13:07,938

printing there we can we can shortcut

330

00:13:05,208 --> 00:13:09,768

the entire process of launch manifests

331

00:13:07,938 --> 00:13:12,019

and all those things so hardware to

332

00:13:09,769 --> 00:13:14,539

space in in days to weeks is incredibly

333

00:13:12,019 --> 00:13:17,149

beneficial now still wasn't good enough

334

00:13:14,539 --> 00:13:19,368

for us we recognize it at the end of the

335

00:13:17,149 --> 00:13:22,129

day we still don't want to be dependent

336

00:13:19,369 --> 00:13:25,129

on earth if we send

337

00:13:22,129 --> 00:13:27,080

crew to Mars to live on Mars and we rely

338

00:13:25,129 --> 00:13:28,759

on earth dependency and have to keep

339

00:13:27,080 --> 00:13:31,009

launching rocket after rocket of

340

00:13:28,759 --> 00:13:34,189

resupply we really then solve the

341

00:13:31,009 --> 00:13:37,100

problem of living off the land so when

342

00:13:34,190 --> 00:13:39,310

we start to look at the past couple

343
00:13:37,100 --> 00:13:41,779
years is how can we actually produce

344
00:13:39,309 --> 00:13:44,479
feedstock for the 3d printer on the

345
00:13:41,779 --> 00:13:46,879
space station and we started developing

346
00:13:44,480 --> 00:13:49,940
a new piece of technology that we call

347
00:13:46,879 --> 00:13:52,820
redo and redo for the fact that you can

348
00:13:49,940 --> 00:13:54,860
take a 3d printed part and redo it turn

349
00:13:52,820 --> 00:13:57,680
it right back into the feedstock oh wow

350
00:13:54,860 --> 00:13:59,690
that is awesome yeah so redo is it's

351
00:13:57,679 --> 00:14:02,179
under development right now it's in our

352
00:13:59,690 --> 00:14:04,490
lab and it you actually use it for our

353
00:14:02,179 --> 00:14:06,529
3d printer feedstock work we're we're

354
00:14:04,490 --> 00:14:08,210
getting to the point where in our lab

355
00:14:06,529 --> 00:14:09,799
here in Mountain View we don't have to

356
00:14:08,210 --> 00:14:12,920
buy feedstock anymore we just keep

357
00:14:09,799 --> 00:14:15,289
reusing what we already have by redoing

358
00:14:12,919 --> 00:14:16,879
it now the interesting thing is once we

359
00:14:15,289 --> 00:14:19,069
start diving into this problem we

360
00:14:16,879 --> 00:14:22,700
realized that the space station has a

361
00:14:19,070 --> 00:14:25,820
lot of plastic waste a lot of the the

362
00:14:22,700 --> 00:14:27,740
food comes up in polyethylene bags the

363
00:14:25,820 --> 00:14:31,550
packaging foam all these things are

364
00:14:27,740 --> 00:14:33,680
actually a polymer and we redesign redo

365
00:14:31,549 --> 00:14:35,029
to actually take plastic waste on the

366
00:14:33,679 --> 00:14:38,059
space station and turn that into

367
00:14:35,029 --> 00:14:42,709
filament as well so really neat because

368
00:14:38,059 --> 00:14:45,469
what this is is a really useful form of

369
00:14:42,710 --> 00:14:48,259
what we call is are you or in situ

370
00:14:45,470 --> 00:14:50,029
resource utilization so end of the day

371

00:14:48,259 --> 00:14:52,309
we're actually turning waste on the

372
00:14:50,029 --> 00:14:54,319
space station in upcycling it turning

373
00:14:52,309 --> 00:14:56,599
into something more useful that's

374
00:14:54,320 --> 00:14:59,900
amazing so so this there's a question

375
00:14:56,600 --> 00:15:03,440
right now I that space station to make a

376
00:14:59,899 --> 00:15:05,509
new stuff what I I said you can scuttle

377
00:15:03,440 --> 00:15:07,160
butt the space station to make new stuff

378
00:15:05,509 --> 00:15:08,299
once you have enough large up there you

379
00:15:07,159 --> 00:15:10,219
just like oh I don't like this

380
00:15:08,299 --> 00:15:11,959
experiment well if I gonna park what'd

381
00:15:10,220 --> 00:15:18,259
you do with my experiment I I agree

382
00:15:11,960 --> 00:15:19,700
printed it up for a new culture so this

383
00:15:18,259 --> 00:15:22,220
is related to a question jonathan peters

384
00:15:19,700 --> 00:15:23,780
is asking on the Q&A have what types of

385
00:15:22,220 --> 00:15:25,040

materials does a printer use and you've

386

00:15:23,779 --> 00:15:27,769

already said that you've got this redo

387

00:15:25,039 --> 00:15:30,349

that's in development you're looking at

388

00:15:27,769 --> 00:15:32,990

recycling or reusing the waste material

389

00:15:30,350 --> 00:15:35,600

that's already on the space station what

390

00:15:32,990 --> 00:15:39,379

is there a base stock that you use just

391

00:15:35,600 --> 00:15:42,560

commonly yeah we uh the printer that is

392

00:15:39,379 --> 00:15:45,139

on the space station today is an ABS

393

00:15:42,559 --> 00:15:46,989

printer so a lot like the 3d printers

394

00:15:45,139 --> 00:15:50,089

that were all used to using in our homes

395

00:15:46,990 --> 00:15:52,159

we're printing with ABS main reason why

396

00:15:50,089 --> 00:15:53,899

there is because this is it it like we

397

00:15:52,159 --> 00:15:56,088

mentioned the technology demonstration

398

00:15:53,899 --> 00:15:58,159

and we need a really good way to compare

399

00:15:56,089 --> 00:16:00,920

our printer works in space compared to

400
00:15:58,159 --> 00:16:03,828
one on the ground so using abs we can

401
00:16:00,919 --> 00:16:06,318
compare against a wide wide amount of

402
00:16:03,828 --> 00:16:08,750
data on the ground now that actually

403
00:16:06,318 --> 00:16:10,578
isn't the end-all be-all we can't you

404
00:16:08,750 --> 00:16:13,190
know build everything we need out of ABS

405
00:16:10,578 --> 00:16:14,870
plastic so made in space will launch a

406
00:16:13,190 --> 00:16:17,300
second printer next year it's a

407
00:16:14,870 --> 00:16:19,278
commercial facilities so that's where

408
00:16:17,299 --> 00:16:21,409
all the viewers here if they get excited

409
00:16:19,278 --> 00:16:23,778
and want to build hardware and space by

410
00:16:21,409 --> 00:16:26,149
you know giving us the digital file and

411
00:16:23,778 --> 00:16:27,500
3d printing it it will most likely get

412
00:16:26,149 --> 00:16:29,958
printed on the second printer which

413
00:16:27,500 --> 00:16:32,028
flies next year and it's it does a wide

414
00:16:29,958 --> 00:16:35,059
arrangement of materials so we have

415
00:16:32,028 --> 00:16:37,220
space qualified polymers if you want to

416
00:16:35,059 --> 00:16:39,109
build a CubeSat for instance we can

417
00:16:37,220 --> 00:16:41,689
build that and put it out in the vacuum

418
00:16:39,110 --> 00:16:44,028
we've developed materials that can be

419
00:16:41,688 --> 00:16:45,469
used for biological experiments and

420
00:16:44,028 --> 00:16:47,990
other experiments you do on the space

421
00:16:45,470 --> 00:16:50,420
station so really how much or whatever

422
00:16:47,990 --> 00:16:52,938
you like it's designed to do those

423
00:16:50,419 --> 00:16:56,838
materials nice that's that's really

424
00:16:52,938 --> 00:16:59,120
amazing so I understand the importance

425
00:16:56,839 --> 00:17:02,959
or that where you know the savings of

426
00:16:59,120 --> 00:17:04,338
not having to anticipate you know which

427
00:17:02,958 --> 00:17:05,509
spare part you're going to need when

428

00:17:04,338 --> 00:17:06,828
you're up in space and making sure that

429
00:17:05,509 --> 00:17:08,480
they're all launched I can see the

430
00:17:06,828 --> 00:17:10,338
weight savings there and I also now see

431
00:17:08,480 --> 00:17:13,509
that you especially with redo you'll be

432
00:17:10,338 --> 00:17:16,158
able to remake some of these parts uh

433
00:17:13,509 --> 00:17:18,709
yeah and you're also saving weight from

434
00:17:16,159 --> 00:17:20,179
being able to not when making the part

435
00:17:18,709 --> 00:17:22,578
in space it doesn't have to be as heavy

436
00:17:20,179 --> 00:17:26,240
as when you make it here on earth what

437
00:17:22,578 --> 00:17:28,819
um how I guess is anything being made

438
00:17:26,240 --> 00:17:31,700
now right I mean that as they sort have

439
00:17:28,819 --> 00:17:33,950
they started using the printer yet the

440
00:17:31,700 --> 00:17:38,120
the printer has not been turned on yet

441
00:17:33,950 --> 00:17:40,370
it's a it's basically this printer goes

442
00:17:38,119 --> 00:17:41,989

inside of the microgravity science

443

00:17:40,369 --> 00:17:43,668

glovebox in fact I'll know how well you

444

00:17:41,990 --> 00:17:46,250

can see the image behind me on the wall

445

00:17:43,669 --> 00:17:49,190

but it might look like I'm inside of the

446

00:17:46,250 --> 00:17:52,339

space station the msg the

447

00:17:49,190 --> 00:17:54,140

so somewhere up in the corner and it's a

448

00:17:52,339 --> 00:17:55,879

it's what it sounds like it's a glove

449

00:17:54,140 --> 00:17:58,009

box that you can put it in experiment

450

00:17:55,880 --> 00:18:00,280

into and and and the astronauts have

451

00:17:58,009 --> 00:18:02,960

this like safety containment around it

452

00:18:00,279 --> 00:18:04,579

now the glove box also gets used for a

453

00:18:02,960 --> 00:18:06,980

lot of other experiments if you've been

454

00:18:04,579 --> 00:18:10,250

following what launched on on space

455

00:18:06,980 --> 00:18:12,049

explorer with our printer there was the

456

00:18:10,250 --> 00:18:14,089

road and habitat there's a bunch of

457
00:18:12,049 --> 00:18:16,849
other experiments so we're basically in

458
00:18:14,089 --> 00:18:18,679
the waiting line to get into the glove

459
00:18:16,849 --> 00:18:21,259
box and so it should be it should be

460
00:18:18,680 --> 00:18:23,210
really soon and you know fingers crossed

461
00:18:21,259 --> 00:18:26,089
so we started seeing parts printed in

462
00:18:23,210 --> 00:18:28,640
the near future okay I have a question

463
00:18:26,089 --> 00:18:31,069
actually about the parts and you you

464
00:18:28,640 --> 00:18:32,540
touch upon it a little bit so you've

465
00:18:31,069 --> 00:18:34,669
been thinking about not only you know

466
00:18:32,539 --> 00:18:36,680
every which way and being able to print

467
00:18:34,670 --> 00:18:39,710
but my experience with my cheap little

468
00:18:36,680 --> 00:18:41,870
printer and we don't use abs because ma

469
00:18:39,710 --> 00:18:43,759
I have no environmental control in my

470
00:18:41,869 --> 00:18:47,839
office some days 100 degrees in

471
00:18:43,759 --> 00:18:50,420
sometimes it's 50 so we use PLA but it

472
00:18:47,839 --> 00:18:53,449
with either technology and your I know

473
00:18:50,420 --> 00:18:56,060
your you've thought about this is that

474
00:18:53,450 --> 00:18:58,670
you get these threads and you get and

475
00:18:56,059 --> 00:19:00,649
sometimes the parts need to be polished

476
00:18:58,670 --> 00:19:03,529
and things like that so I assume that

477
00:19:00,650 --> 00:19:05,840
you're addressing those because can't be

478
00:19:03,529 --> 00:19:08,180
you know sanding stuff on the space

479
00:19:05,839 --> 00:19:10,639
station and how that stuff go everywhere

480
00:19:08,180 --> 00:19:12,350
so good point yeah making making the

481
00:19:10,640 --> 00:19:15,080
parts a little more perfect that the

482
00:19:12,349 --> 00:19:18,949
ones I'm printing must be part of your

483
00:19:15,079 --> 00:19:20,299
strategy yeah it's a it's a good

484
00:19:18,950 --> 00:19:22,430
question Carol it's something that

485

00:19:20,299 --> 00:19:25,819
anybody who's working with 3d printers

486
00:19:22,430 --> 00:19:27,769
today already understands so um we had

487
00:19:25,819 --> 00:19:30,019
to address that from in several

488
00:19:27,769 --> 00:19:31,960
different ways the the fact is is we

489
00:19:30,019 --> 00:19:34,400
can't have a printer that is it is

490
00:19:31,960 --> 00:19:36,289
breaking off little pieces of plastic

491
00:19:34,400 --> 00:19:38,540
and letting it float around because at

492
00:19:36,289 --> 00:19:40,670
the moment the Astron opens the door of

493
00:19:38,539 --> 00:19:42,680
the printer and those pieces start

494
00:19:40,670 --> 00:19:44,300
floating out they get stuck in all the

495
00:19:42,680 --> 00:19:48,440
nooks and crannies of the space station

496
00:19:44,299 --> 00:19:50,269
so we've built it's a really

497
00:19:48,440 --> 00:19:53,420
sophisticated type of environmental

498
00:19:50,269 --> 00:19:56,319
control it's something that can recycle

499
00:19:53,420 --> 00:19:59,120

the the harmful gases being created so

500

00:19:56,319 --> 00:20:02,000

you know off gassing of things like

501

00:19:59,119 --> 00:20:02,899

styrene that come out of a print but it

502

00:20:02,000 --> 00:20:04,880

also captures

503

00:20:02,900 --> 00:20:07,700

particulates and it controls the the

504

00:20:04,880 --> 00:20:09,350

temperature of the print volume so so

505

00:20:07,700 --> 00:20:11,090

you know the end of the day the best way

506

00:20:09,349 --> 00:20:13,449

to get a really good print is to control

507

00:20:11,089 --> 00:20:19,730

that volume have the right temperature

508

00:20:13,450 --> 00:20:21,049

settings and things like that um used we

509

00:20:19,730 --> 00:20:23,029

mentioned this briefly and Scott asked

510

00:20:21,049 --> 00:20:26,299

you about this also about the the

511

00:20:23,029 --> 00:20:28,430

testing that was done how long did you

512

00:20:26,299 --> 00:20:30,349

guys I mean what was it like in the in

513

00:20:28,430 --> 00:20:32,390

the vomit comet to to test all of this

514

00:20:30,349 --> 00:20:34,309

stuff and was it difficult to get

515

00:20:32,390 --> 00:20:39,920

everything set up in there and do the

516

00:20:34,309 --> 00:20:43,490

testing um yeah so there's a lot of fun

517

00:20:39,920 --> 00:20:48,350

stuff I can say about the the weightless

518

00:20:43,490 --> 00:20:50,750

wonder I don't have like yeah honestly

519

00:20:48,349 --> 00:20:53,149

like my the one thing I always say to

520

00:20:50,750 --> 00:20:56,630

anyone whenever I talk about this is if

521

00:20:53,150 --> 00:21:00,009

you ever get the chance to go do it this

522

00:20:56,630 --> 00:21:03,500

is being weightless is it's one of the

523

00:21:00,009 --> 00:21:05,359

best experience I've ever felt I've um

524

00:21:03,500 --> 00:21:07,490

through this test program we've done

525

00:21:05,359 --> 00:21:10,639

with NASA I've now spent an entire hour

526

00:21:07,490 --> 00:21:12,470

of my life being weightless it's a

527

00:21:10,640 --> 00:21:16,790

really quick weight loss program if you

528
00:21:12,470 --> 00:21:21,019
need one so do your evo zipper its

529
00:21:16,789 --> 00:21:22,609
harbors come right back on yeah twenty

530
00:21:21,019 --> 00:21:24,349
seconds of being weightless and then

531
00:21:22,609 --> 00:21:28,219
next 20 seconds you're about twice your

532
00:21:24,349 --> 00:21:30,199
weight so it's a reasonable it's a

533
00:21:28,220 --> 00:21:31,970
really incredible experience being in

534
00:21:30,200 --> 00:21:33,799
being weightless you you realize that

535
00:21:31,970 --> 00:21:36,740
you have a new dimension you can there's

536
00:21:33,799 --> 00:21:38,809
no such thing as down anymore it's just

537
00:21:36,740 --> 00:21:41,329
it's wild to let your you know to

538
00:21:38,809 --> 00:21:42,889
experience that but for us we ended

539
00:21:41,329 --> 00:21:47,779
design we had also be doing real science

540
00:21:42,890 --> 00:21:50,210
so we build our experiment specifically

541
00:21:47,779 --> 00:21:53,839
to make sure that it could run is

542

00:21:50,210 --> 00:21:56,420
autonomously as possible so that if any

543
00:21:53,839 --> 00:21:58,459
of us were maybe having too much fun or

544
00:21:56,420 --> 00:22:02,840
maybe not having enough fun and getting

545
00:21:58,460 --> 00:22:04,430
sick directly logo keep going so um you

546
00:22:02,839 --> 00:22:06,679
know the good thing about 3d printers is

547
00:22:04,430 --> 00:22:08,269
you can you know usually turn them on

548
00:22:06,680 --> 00:22:11,269
and they just keep you know they do

549
00:22:08,269 --> 00:22:14,480
their job so we built the experiments so

550
00:22:11,269 --> 00:22:16,759
that it's basically if we roll the video

551
00:22:14,480 --> 00:22:18,470
you'll see it maybe we already did roll

552
00:22:16,759 --> 00:22:21,740
yeah but I'm living in let's go ahead

553
00:22:18,470 --> 00:22:24,200
and do this uh jeez Kelly of Kelly I can

554
00:22:21,740 --> 00:22:26,509
talk about why while I goes is that okay

555
00:22:24,200 --> 00:22:30,710
yeah yeah yeah go ahead Kelly's got it

556
00:22:26,509 --> 00:22:32,539

up I think yeah narrate this so so

557

00:22:30,710 --> 00:22:37,430

you'll see the box on the left it's our

558

00:22:32,539 --> 00:22:39,470

experiment box it holds about three to

559

00:22:37,430 --> 00:22:42,500

four different experiments at a time so

560

00:22:39,470 --> 00:22:45,019

we designed it really specifically to be

561

00:22:42,500 --> 00:22:47,210

modular we constantly every every we do

562

00:22:45,019 --> 00:22:50,059

our flight we get down we fix something

563

00:22:47,210 --> 00:22:52,610

we put in a new experiment and it's part

564

00:22:50,059 --> 00:22:54,950

of our philosophy as a company that it's

565

00:22:52,609 --> 00:22:58,189

important to iterate early and iterate

566

00:22:54,950 --> 00:23:00,640

often so it's probably too that credit

567

00:22:58,190 --> 00:23:03,500

that we have Hardware in space only a

568

00:23:00,640 --> 00:23:06,680

year after kicking off the actual flight

569

00:23:03,500 --> 00:23:09,859

mission with NASA so iterating quickly

570

00:23:06,680 --> 00:23:12,049

is important to us so we did like I said

571
00:23:09,859 --> 00:23:13,699
over three hours of total zero gravity

572
00:23:12,049 --> 00:23:16,220
time but we've tested dozens of

573
00:23:13,700 --> 00:23:19,819
different experiments and and tweak

574
00:23:16,220 --> 00:23:22,460
things as we go so that's the experiment

575
00:23:19,819 --> 00:23:25,099
box you'll see that it's really quick

576
00:23:22,460 --> 00:23:27,980
you get like 20 seconds of zero-g and

577
00:23:25,099 --> 00:23:30,079
then you're back into 2g and the way we

578
00:23:27,980 --> 00:23:31,690
we figured it out we actually in the

579
00:23:30,079 --> 00:23:34,639
beginning we were we were building

580
00:23:31,690 --> 00:23:36,410
software that would a motion sensors

581
00:23:34,640 --> 00:23:39,770
that would turn the printer pause the

582
00:23:36,410 --> 00:23:42,680
printer between the 2g pull outs so they

583
00:23:39,769 --> 00:23:44,210
would only print during 0g and we got

584
00:23:42,680 --> 00:23:46,279
some useful data but then we realized

585
00:23:44,210 --> 00:23:48,170
that it would be way better if we could

586
00:23:46,279 --> 00:23:50,450
just turn the printer on when we start

587
00:23:48,170 --> 00:23:52,400
flying and then turn it off when we land

588
00:23:50,450 --> 00:23:54,710
at the runway and just have the printer

589
00:23:52,400 --> 00:23:57,259
print the whole time without any problem

590
00:23:54,710 --> 00:23:58,940
so at the end of the day when we had

591
00:23:57,259 --> 00:24:00,920
figured out is a way to make these

592
00:23:58,940 --> 00:24:03,590
printers just operate in zero gravity

593
00:24:00,920 --> 00:24:06,019
but also in 2 g's and everywhere in

594
00:24:03,589 --> 00:24:08,169
between so it's that's why I was saying

595
00:24:06,019 --> 00:24:11,000
earlier it's a very rugged printer that

596
00:24:08,170 --> 00:24:13,519
it was just part of our the way we

597
00:24:11,000 --> 00:24:16,250
tested it was it was made it easier for

598
00:24:13,519 --> 00:24:18,470
us to do it that way but now we have we

599

00:24:16,250 --> 00:24:20,450
call it gravity independent 3d printing

600
00:24:18,470 --> 00:24:22,279
it's not just a zero-g printer I like

601
00:24:20,450 --> 00:24:24,049
that you can print anywhere and it

602
00:24:22,279 --> 00:24:26,930
actually turns out to be really

603
00:24:24,049 --> 00:24:30,139
beneficial on our end because we have a

604
00:24:26,930 --> 00:24:30,659
3d printer in our lab that is basically

605
00:24:30,140 --> 00:24:32,609
I

606
00:24:30,659 --> 00:24:37,049
nicole the one on the space station and

607
00:24:32,608 --> 00:24:39,449
because gravity doesn't really cause an

608
00:24:37,048 --> 00:24:41,460
issue in the printing process that means

609
00:24:39,450 --> 00:24:43,739
that anything we print in our lab should

610
00:24:41,460 --> 00:24:45,450
be just the same as how prints on the

611
00:24:43,739 --> 00:24:48,269
space station so we have a really good

612
00:24:45,450 --> 00:24:49,379
comparison and it allows people to come

613
00:24:48,269 --> 00:24:53,190

in who want to print on Space Station

614

00:24:49,378 --> 00:24:54,658
try it out on our printer first cool

615

00:24:53,190 --> 00:24:57,239
okay we got a lot of questions coming in

616

00:24:54,659 --> 00:24:58,979
from the QA applet John Jonathan I'm

617

00:24:57,239 --> 00:25:01,069
going to get to your follow-up in just a

618

00:24:58,979 --> 00:25:04,769
minute but Rebecca Rodriguez is asking

619

00:25:01,069 --> 00:25:06,778
has regolith with additives been

620

00:25:04,769 --> 00:25:10,249
considered for feedstock in the long run

621

00:25:06,778 --> 00:25:13,858
is that part of the NASA vision oh

622

00:25:10,249 --> 00:25:15,389
that's a cool run Rebecca we you know

623

00:25:13,858 --> 00:25:17,038
it's definitely part of the maiden space

624

00:25:15,388 --> 00:25:19,738
decision and I would say it's part of

625

00:25:17,038 --> 00:25:23,519
NASA's as well you can find you can find

626

00:25:19,739 --> 00:25:27,269
some things NASA's done in terms of ice

627

00:25:23,519 --> 00:25:28,618
are you and and regular printing and

628
00:25:27,269 --> 00:25:31,739
things like that but I'll tell you a

629
00:25:28,618 --> 00:25:33,628
little bit about what we've done we a

630
00:25:31,739 --> 00:25:35,909
little over a year ago as we were

631
00:25:33,628 --> 00:25:37,469
building our 3d printer for space we we

632
00:25:35,909 --> 00:25:40,379
wondered could we make our printer

633
00:25:37,470 --> 00:25:42,960
actually print with regular so we took

634
00:25:40,378 --> 00:25:44,398
the basically the same exact printer

635
00:25:42,960 --> 00:25:48,028
that's on the space station and we

636
00:25:44,398 --> 00:25:50,848
modified it so that it could so they can

637
00:25:48,028 --> 00:25:55,048
print something of like a composite like

638
00:25:50,848 --> 00:25:59,428
a concrete but we used a lunar simulate

639
00:25:55,048 --> 00:26:01,648
so JSC 1a we mix it with with a binder

640
00:25:59,429 --> 00:26:02,909
and a binder that actually we could

641
00:26:01,648 --> 00:26:05,368
produce on the moon if we were living

642
00:26:02,909 --> 00:26:07,200
there and then with a really small

643
00:26:05,368 --> 00:26:10,319
amount of water that theoretically you

644
00:26:07,200 --> 00:26:12,538
could harvest from lunar soil so the IDS

645
00:26:10,319 --> 00:26:15,028
completely is our are you is you get the

646
00:26:12,538 --> 00:26:17,308
dirt you get the you grow your your

647
00:26:15,028 --> 00:26:19,259
binder and you get the water and we we

648
00:26:17,308 --> 00:26:22,048
made our printer print those samples so

649
00:26:19,259 --> 00:26:25,440
um you know we've printed these really

650
00:26:22,048 --> 00:26:27,089
little bricks basically of regolith but

651
00:26:25,440 --> 00:26:29,308
imagine just scale up the printer in

652
00:26:27,089 --> 00:26:33,058
size put it on the moon and and add some

653
00:26:29,308 --> 00:26:35,308
other subsystems to harvest resources

654
00:26:33,058 --> 00:26:38,848
and whatnot and we you have the ability

655
00:26:35,308 --> 00:26:40,858
to actually build you know bricks on the

656

00:26:38,848 --> 00:26:43,740
moon and we think that's cool because

657
00:26:40,858 --> 00:26:46,259
what this would enable is yeah

658
00:26:43,740 --> 00:26:48,000
robotic Commission get to the point

659
00:26:46,259 --> 00:26:49,440
where before you send humans you've

660
00:26:48,000 --> 00:26:52,380
already sent a robot that built them a

661
00:26:49,440 --> 00:26:56,009
habitat that's amazing that's good

662
00:26:52,380 --> 00:26:57,840
question Rebecca thank you so Philip

663
00:26:56,009 --> 00:26:59,940
keen on the Q&A app is also asking

664
00:26:57,839 --> 00:27:01,919
question I'd like to know as well have

665
00:26:59,940 --> 00:27:03,808
you think hi Jason have you figured out

666
00:27:01,920 --> 00:27:06,230
the price for researchers to use the

667
00:27:03,808 --> 00:27:09,470
commercial printer when it gets there

668
00:27:06,230 --> 00:27:14,549
it's gonna cost to do use this thing

669
00:27:09,470 --> 00:27:15,870
sell a good question not surprised we

670
00:27:14,549 --> 00:27:20,428

know we know each other that's a rice

671

00:27:15,869 --> 00:27:24,119

field but yeah so you know him okay yes

672

00:27:20,429 --> 00:27:26,309

so this is this is one of those golden

673

00:27:24,119 --> 00:27:29,579

questions people people are ready to use

674

00:27:26,308 --> 00:27:31,769

the printer we've got a lot of people

675

00:27:29,579 --> 00:27:34,369

actually kind of lined up with their

676

00:27:31,769 --> 00:27:37,889

ideas and and and parts ready to print

677

00:27:34,369 --> 00:27:41,189

the pricing question is not public yet

678

00:27:37,890 --> 00:27:44,700

but what I can say is that it's that

679

00:27:41,190 --> 00:27:47,039

it's extremely reasonable we've it were

680

00:27:44,700 --> 00:27:48,600

definitely like at the end of the day

681

00:27:47,039 --> 00:27:53,250

what we're doing and what we want to do

682

00:27:48,599 --> 00:27:55,049

is make it so that a much larger group

683

00:27:53,250 --> 00:27:57,690

of people have access to space than

684

00:27:55,049 --> 00:27:59,159

previously if we can't do that then we

685
00:27:57,690 --> 00:28:01,679
don't feel like we've accomplished our

686
00:27:59,160 --> 00:28:04,890
mission because the at the end of the

687
00:28:01,679 --> 00:28:06,960
day space to is is pretty prohibitive

688
00:28:04,890 --> 00:28:10,230
it's expensive it's costly it's why it's

689
00:28:06,960 --> 00:28:12,720
largely been a government-run industry

690
00:28:10,230 --> 00:28:14,490
but we feel like if we can if we can

691
00:28:12,720 --> 00:28:16,289
make it more accessible we'll start to

692
00:28:14,490 --> 00:28:19,289
see innovation happen like we haven't

693
00:28:16,289 --> 00:28:21,990
seen before in space so for all the

694
00:28:19,289 --> 00:28:24,089
individuals the researchers the small

695
00:28:21,990 --> 00:28:27,420
companies out there using the printer

696
00:28:24,089 --> 00:28:29,220
will not be you know it will be within

697
00:28:27,420 --> 00:28:31,590
the cost range that that can be

698
00:28:29,220 --> 00:28:33,960
affording okay well I don't related note

699
00:28:31,589 --> 00:28:35,819
then it would seem to me like you're

700
00:28:33,960 --> 00:28:37,319
going to have to do kind of like what we

701
00:28:35,819 --> 00:28:38,428
do at the Institute for deciding who

702
00:28:37,319 --> 00:28:40,919
gets to use the Hubble Space Telescope

703
00:28:38,429 --> 00:28:42,929
we have a time allocation committee wut

704
00:28:40,920 --> 00:28:45,058
m8 way there certain criterion that the

705
00:28:42,929 --> 00:28:47,340
scientists use to decide what what to

706
00:28:45,058 --> 00:28:49,319
give Hubble time to what are you going

707
00:28:47,339 --> 00:28:51,029
to do how are you going to decide who

708
00:28:49,319 --> 00:28:54,259
gets to use it what are the criterion

709
00:28:51,029 --> 00:28:57,480
like any have you thought about that yet

710
00:28:54,259 --> 00:29:00,808
uh yeah we're we're actually working

711
00:28:57,480 --> 00:29:02,970
nasa work with NASA for most of these

712
00:29:00,808 --> 00:29:08,369
things and this one's a pretty important

713

00:29:02,970 --> 00:29:11,039
one because you know nASA has you know

714
00:29:08,369 --> 00:29:12,119
lots of processes for what can fly on

715
00:29:11,039 --> 00:29:16,139
the space station there's a lot of

716
00:29:12,119 --> 00:29:17,849
safety processes there too so what we've

717
00:29:16,140 --> 00:29:19,620
had to do you know we've created a

718
00:29:17,849 --> 00:29:22,798
completely new way to get hardware there

719
00:29:19,619 --> 00:29:25,048
and the question that it has to be asked

720
00:29:22,798 --> 00:29:26,759
is well if you know if you want to send

721
00:29:25,048 --> 00:29:28,470
a wrench to the space station today that

722
00:29:26,759 --> 00:29:31,379
wrench has to go through testing on the

723
00:29:28,470 --> 00:29:32,519
ground it goes to a safety review panel

724
00:29:31,380 --> 00:29:35,280
who make sure it's safe for the

725
00:29:32,519 --> 00:29:37,410
astronauts so what do you do when that

726
00:29:35,279 --> 00:29:39,329
wrench is printed in space how do you

727
00:29:37,410 --> 00:29:41,610

know that you actually printed the thing

728

00:29:39,329 --> 00:29:44,759

that you wanted to print so we've been

729

00:29:41,609 --> 00:29:46,649

developing kind of a new process that we

730

00:29:44,759 --> 00:29:48,839

can that we work with NASA on to make

731

00:29:46,650 --> 00:29:51,059

sure that whatever we build is is the

732

00:29:48,839 --> 00:29:52,859

thing we want to build but it's that

733

00:29:51,058 --> 00:29:56,579

process it will start to build the queue

734

00:29:52,859 --> 00:29:58,889

of who gets who prints first but aside

735

00:29:56,579 --> 00:30:02,939

from that it's really like a lot of it

736

00:29:58,890 --> 00:30:05,100

is is you know first come for a servant

737

00:30:02,940 --> 00:30:07,710

way who comes to us and is ready to go

738

00:30:05,099 --> 00:30:11,548

and we have a queue of people lined up

739

00:30:07,710 --> 00:30:15,450

ready to print so go ahead ready for you

740

00:30:11,548 --> 00:30:17,519

know open invitation to use the printer

741

00:30:15,450 --> 00:30:20,279

you you mentioned something that

742
00:30:17,519 --> 00:30:22,470
actually had a question about was when

743
00:30:20,279 --> 00:30:24,629
you're going to be printing things in

744
00:30:22,470 --> 00:30:29,009
zero gravity of microgravity out there

745
00:30:24,630 --> 00:30:31,230
is it like how let's see what's the word

746
00:30:29,009 --> 00:30:32,910
I want to use here how accurate are you

747
00:30:31,230 --> 00:30:34,980
going to be able to rate it as I know

748
00:30:32,910 --> 00:30:36,929
when we're sending stuff up into space

749
00:30:34,980 --> 00:30:38,039
especially for science experiments we

750
00:30:36,929 --> 00:30:40,980
need to make sure that they're

751
00:30:38,039 --> 00:30:42,269
rigorously tested too yes withstand

752
00:30:40,980 --> 00:30:43,950
launch which you're going to be able to

753
00:30:42,269 --> 00:30:46,019
get through but to make sure that it's

754
00:30:43,950 --> 00:30:47,548
actually scientifically accurate for

755
00:30:46,019 --> 00:30:49,980
what you're going to be using it for

756
00:30:47,548 --> 00:30:52,769
right now are you just looking for you

757
00:30:49,980 --> 00:30:54,808
know a scaffolding or something I like

758
00:30:52,769 --> 00:30:57,298
that more rugged and then in the future

759
00:30:54,808 --> 00:30:59,308
be able to more fine-tuned it or is

760
00:30:57,298 --> 00:31:01,558
there a way that you'll be able to rate

761
00:30:59,308 --> 00:31:06,119
it for different scientific levels of

762
00:31:01,558 --> 00:31:08,908
accuracy yeah the answer is is yes the

763
00:31:06,119 --> 00:31:11,459
uh you know there's a couple ways to

764
00:31:08,909 --> 00:31:13,110
look at we have there's we have a

765
00:31:11,460 --> 00:31:15,269
since we control the printer from the

766
00:31:13,109 --> 00:31:17,459
ground we have the ability to control a

767
00:31:15,269 --> 00:31:20,129
lot of the settings so in terms of

768
00:31:17,460 --> 00:31:21,990
quality resolution things like that we

769
00:31:20,130 --> 00:31:25,110
have control over that so depending on

770

00:31:21,990 --> 00:31:29,069
the demands of that part we can control

771
00:31:25,109 --> 00:31:30,599
how well it prints and and so on um but

772
00:31:29,069 --> 00:31:33,898
it's important to remember that this is

773
00:31:30,599 --> 00:31:35,398
the first step I mean this is like the

774
00:31:33,898 --> 00:31:37,949
tip of the iceberg for space

775
00:31:35,398 --> 00:31:39,750
manufacturing so as made in space moves

776
00:31:37,950 --> 00:31:41,519
forward with technology development it

777
00:31:39,750 --> 00:31:44,099
will get better and better and better so

778
00:31:41,519 --> 00:31:47,069
today it does a percentage of things

779
00:31:44,099 --> 00:31:48,959
NASA estimated that this printer can do

780
00:31:47,069 --> 00:31:50,389
thirty percent of all the parts that

781
00:31:48,960 --> 00:31:53,700
have already broken on the space station

782
00:31:50,390 --> 00:31:55,980
so actually a surprisingly good number

783
00:31:53,700 --> 00:31:58,649
of things could be fixed with a 3d

784
00:31:55,980 --> 00:32:00,210

printer like this but but we're moving

785

00:31:58,648 --> 00:32:01,648

forward towards you know much more than

786

00:32:00,210 --> 00:32:05,069

that percentage and we want to get to

787

00:32:01,648 --> 00:32:07,519

the point where you know that's not just

788

00:32:05,069 --> 00:32:11,009

for fixing and upkeep and crew

789

00:32:07,519 --> 00:32:12,569

utilization is for experimenters to

790

00:32:11,009 --> 00:32:14,700

build better experiments you know today

791

00:32:12,569 --> 00:32:16,109

we when we put an experiment on the

792

00:32:14,700 --> 00:32:17,730

space station we have to launch it

793

00:32:16,109 --> 00:32:19,769

already hoping that it just works

794

00:32:17,730 --> 00:32:21,419

because if it doesn't it would cost

795

00:32:19,769 --> 00:32:23,548

millions of dollars ever to launch the

796

00:32:21,419 --> 00:32:25,500

next version so we were working with

797

00:32:23,548 --> 00:32:27,658

experimenters now to design their

798

00:32:25,500 --> 00:32:29,460

experiments so that they're already 3d

799
00:32:27,659 --> 00:32:32,370
printed so that when something changes

800
00:32:29,460 --> 00:32:34,230
if you need a larger microfluidic

801
00:32:32,369 --> 00:32:36,359
channel or you need a lot of you know a

802
00:32:34,230 --> 00:32:37,679
different size petri dish or so on you

803
00:32:36,359 --> 00:32:39,898
print that out after you've already

804
00:32:37,679 --> 00:32:41,750
tested the first one so enabling

805
00:32:39,898 --> 00:32:44,369
iteration to happen for science is

806
00:32:41,750 --> 00:32:47,009
obviously the the key towards

807
00:32:44,369 --> 00:32:49,439
breakthrough and it's those things that

808
00:32:47,009 --> 00:32:51,690
we want to you know make happen I was

809
00:32:49,440 --> 00:32:53,788
going to say that you know in discussion

810
00:32:51,690 --> 00:32:55,919
astronomers have to think in very long

811
00:32:53,788 --> 00:32:58,048
timescales about building new telescopes

812
00:32:55,919 --> 00:33:00,690
that are going to go in space and the

813
00:32:58,048 --> 00:33:03,509
thought of at least 3d printing part of

814
00:33:00,690 --> 00:33:05,220
these parts for those telescopes and

815
00:33:03,509 --> 00:33:06,960
also refurbishment because we're how

816
00:33:05,220 --> 00:33:09,450
will people so we love the idea of

817
00:33:06,960 --> 00:33:11,340
having a telescope you can refurbish so

818
00:33:09,450 --> 00:33:14,610
it's very much of interest to the

819
00:33:11,339 --> 00:33:16,949
astronomical community on very relevant

820
00:33:14,609 --> 00:33:19,648
to the humble James Webb at last

821
00:33:16,950 --> 00:33:21,960
community but another thing that you

822
00:33:19,648 --> 00:33:24,750
made me think of is I know you're not

823
00:33:21,960 --> 00:33:26,220
doing it today but but remember

824
00:33:24,750 --> 00:33:28,619
we first said we were going to go to

825
00:33:26,220 --> 00:33:31,110
space remember how they said oh the

826
00:33:28,619 --> 00:33:34,289
stuff you manufacture and space is going

827

00:33:31,109 --> 00:33:36,000
to be like amazing compared to what is

828
00:33:34,289 --> 00:33:40,049
made on the ground because it won't be

829
00:33:36,000 --> 00:33:43,049
constrained by gravity so I if you guys

830
00:33:40,049 --> 00:33:45,480
had discussions of things that could be

831
00:33:43,049 --> 00:33:48,329
manufactured that possibly could be of

832
00:33:45,480 --> 00:33:51,299
use to people on the ground that would

833
00:33:48,329 --> 00:33:52,949
be better manufactured in debate number

834
00:33:51,299 --> 00:33:54,930
we're supposed to all have bald perfect

835
00:33:52,950 --> 00:33:56,910
ball bearings because they working

836
00:33:54,930 --> 00:33:59,130
perfectly man your final its face

837
00:33:56,910 --> 00:34:02,610
remember that I mean I'm showing my age

838
00:33:59,130 --> 00:34:06,990
but no you're I guess mine to them

839
00:34:02,609 --> 00:34:09,239
because I remember that that is a that's

840
00:34:06,990 --> 00:34:12,918
always been kind of one of the biggest

841
00:34:09,239 --> 00:34:15,689

things for us was to figure out not just

842

00:34:12,918 --> 00:34:18,119

not just what can we build in space 4

843

00:34:15,690 --> 00:34:21,990

space but what can we build in space for

844

00:34:18,119 --> 00:34:23,878

Earth and um there's definitely some

845

00:34:21,989 --> 00:34:25,589

really interesting things there you know

846

00:34:23,878 --> 00:34:28,710

obviously like you know ball bearings

847

00:34:25,590 --> 00:34:31,440

cool example but what are the things

848

00:34:28,710 --> 00:34:33,269

that you can't that you can actually use

849

00:34:31,440 --> 00:34:36,000

zero gravity to your advantage to build

850

00:34:33,269 --> 00:34:37,918

um not needing you know not needing

851

00:34:36,000 --> 00:34:40,860

things like support structure as as an

852

00:34:37,918 --> 00:34:42,989

example we've had we've had a lot of

853

00:34:40,860 --> 00:34:46,200

interests actually from people coming to

854

00:34:42,989 --> 00:34:48,589

us with ideas there most of them you

855

00:34:46,199 --> 00:34:51,719

know we we sign a lot of you know

856
00:34:48,590 --> 00:34:54,059
agreements with these groups you know

857
00:34:51,719 --> 00:34:56,878
who only talked about their ideas one of

858
00:34:54,059 --> 00:34:58,440
the more interesting ones that i can say

859
00:34:56,878 --> 00:35:01,799
a little bit about was had to do with

860
00:34:58,440 --> 00:35:04,380
fuel cell technology somebody had found

861
00:35:01,800 --> 00:35:07,140
a way to make more efficient fuel cells

862
00:35:04,380 --> 00:35:09,960
if they were manufactured in zoo and

863
00:35:07,139 --> 00:35:13,589
then bringing those parts down so so we

864
00:35:09,960 --> 00:35:16,320
think there's probably time will tell I

865
00:35:13,590 --> 00:35:18,539
think but as we as we get the machines

866
00:35:16,320 --> 00:35:19,890
operating and start to learn exactly you

867
00:35:18,539 --> 00:35:23,130
know the correct material and

868
00:35:19,889 --> 00:35:26,129
resolutions and so on we'll see that

869
00:35:23,130 --> 00:35:27,630
happen okay i want to get over to

870
00:35:26,130 --> 00:35:30,960
youtube there's some comments coming in

871
00:35:27,630 --> 00:35:33,300
Craig Landon is asking any ideas as to

872
00:35:30,960 --> 00:35:36,360
how any of these materials might perform

873
00:35:33,300 --> 00:35:38,190
in solar radiation anything outside the

874
00:35:36,360 --> 00:35:40,349
ISS that is similar in

875
00:35:38,190 --> 00:35:42,960
position or due to be tested so how does

876
00:35:40,349 --> 00:35:45,359
this how does this stuff work out in

877
00:35:42,960 --> 00:35:50,699
space i mean the ring with irradiated

878
00:35:45,358 --> 00:35:54,449
environment yep um so this the the

879
00:35:50,699 --> 00:35:57,689
printer itself is it stays inside of the

880
00:35:54,449 --> 00:36:00,269
space station so it operates it you know

881
00:35:57,690 --> 00:36:01,588
in the the atmosphere of the space

882
00:36:00,269 --> 00:36:04,769
station at the pressure and the

883
00:36:01,588 --> 00:36:07,349
temperature and things like that so it's

884

00:36:04,769 --> 00:36:08,969
a you know for the sake of developing a

885
00:36:07,349 --> 00:36:12,109
printer that works in space we had to

886
00:36:08,969 --> 00:36:14,789
solve zero gravity it's the main problem

887
00:36:12,108 --> 00:36:16,889
but it's it's really the question is

888
00:36:14,789 --> 00:36:19,500
really you know how do you build parts

889
00:36:16,889 --> 00:36:22,199
that you can then take out into space so

890
00:36:19,500 --> 00:36:24,929
we've you know right now the first

891
00:36:22,199 --> 00:36:28,078
printer does abs and we all know that

892
00:36:24,929 --> 00:36:30,328
ABS out gases so can what can actually

893
00:36:28,079 --> 00:36:31,859
put out in space it was there was a bee

894
00:36:30,329 --> 00:36:33,599
acid you know if it's if it's out

895
00:36:31,858 --> 00:36:36,289
gassing too much maybe you don't use it

896
00:36:33,599 --> 00:36:38,579
for very many things so that's why we

897
00:36:36,289 --> 00:36:40,920
we've been working for our second

898
00:36:38,579 --> 00:36:42,990

printer that launches next year the

899

00:36:40,920 --> 00:36:46,200

ability to do new types of materials so

900

00:36:42,989 --> 00:36:48,358

we have space qualified polymers and

901

00:36:46,199 --> 00:36:49,828

polymer composites that we can we can

902

00:36:48,358 --> 00:36:53,400

manufacture with and take them out and

903

00:36:49,829 --> 00:36:54,568

they'll work just fine so and that's you

904

00:36:53,400 --> 00:36:56,639

know there's there's still a lot of

905

00:36:54,568 --> 00:36:58,769

testing there you can do we've done a

906

00:36:56,639 --> 00:37:00,210

lot of testing the lab but there's some

907

00:36:58,769 --> 00:37:02,460

things you just can't actually know

908

00:37:00,210 --> 00:37:06,809

until you get into the actual space

909

00:37:02,460 --> 00:37:09,269

environment to test it out okay so let

910

00:37:06,809 --> 00:37:10,679

me get it let me get to back to the Q&A

911

00:37:09,269 --> 00:37:12,719

app we have jonathan peters he had a

912

00:37:10,679 --> 00:37:15,929

follow-up question to his what did you

913
00:37:12,719 --> 00:37:18,179
use to make a stuff out of and he goes

914
00:37:15,929 --> 00:37:20,098
are there plans to test physical

915
00:37:18,179 --> 00:37:25,529
strength durability of objects printed

916
00:37:20,099 --> 00:37:28,079
in zero-g in different gravities um well

917
00:37:25,530 --> 00:37:30,569
what I feel like what I can say is we've

918
00:37:28,079 --> 00:37:33,990
taken the printers not just on the

919
00:37:30,568 --> 00:37:36,389
zero-gravity parabolas with NASA but

920
00:37:33,989 --> 00:37:38,879
we've also done lunar and Martian so the

921
00:37:36,389 --> 00:37:42,809
art printer itself actually already is

922
00:37:38,880 --> 00:37:44,640
designed for on the moon and on Mars ok

923
00:37:42,809 --> 00:37:47,578
young good question thanks Jonathan

924
00:37:44,639 --> 00:37:50,400
Phillip keen is back and he's also

925
00:37:47,579 --> 00:37:52,079
asking you have you seen the news that

926
00:37:50,400 --> 00:37:54,059
ISA that ISA will be

927
00:37:52,079 --> 00:37:55,859
testing metal casting machines on a

928
00:37:54,059 --> 00:37:57,420
sounding rocket looks like they want to

929
00:37:55,858 --> 00:38:00,778
manufacture titanium parts and

930
00:37:57,420 --> 00:38:06,709
microgravity too yeah interesting stuff

931
00:38:00,778 --> 00:38:08,849
so so you know like any other good idea

932
00:38:06,708 --> 00:38:10,889
there's always going to be more than one

933
00:38:08,849 --> 00:38:12,390
group that that wants to pursue it and I

934
00:38:10,889 --> 00:38:15,929
think that's important to see the

935
00:38:12,389 --> 00:38:18,598
technology advanced quickly because you

936
00:38:15,929 --> 00:38:22,169
know we started this company because we

937
00:38:18,599 --> 00:38:24,028
want humans living in space so the more

938
00:38:22,170 --> 00:38:25,920
people trying to focus on solving those

939
00:38:24,028 --> 00:38:28,228
problems better we've talked a lot with

940
00:38:25,920 --> 00:38:31,528
ISA I you know our goals really align

941

00:38:28,228 --> 00:38:33,149
well with them that for instance the

942
00:38:31,528 --> 00:38:34,018
printer that we're putting on this that

943
00:38:33,150 --> 00:38:35,489
you know the printer on the space

944
00:38:34,018 --> 00:38:38,338
station today and then definitely the

945
00:38:35,489 --> 00:38:40,708
next one is designed for anyone to use

946
00:38:38,338 --> 00:38:43,078
so that definitely goes for all the

947
00:38:40,708 --> 00:38:45,958
other space agencies already on on Space

948
00:38:43,079 --> 00:38:51,589
Station so we'll see you know II cuzn

949
00:38:45,958 --> 00:38:54,509
and Jackson and so on cool okay so um

950
00:38:51,588 --> 00:38:55,949
Eric charland is commented also he says

951
00:38:54,509 --> 00:38:57,329
gotta admire the patience of these guys

952
00:38:55,949 --> 00:38:59,998
would take me a half a second after

953
00:38:57,329 --> 00:39:01,259
receiving it to turn on a 3d printer so

954
00:38:59,998 --> 00:39:02,788
I guess that he's talked about the

955
00:39:01,259 --> 00:39:05,190

patience of the astronauts a they have

956

00:39:02,789 --> 00:39:08,789

to have to wait for the cows laughingly

957

00:39:05,190 --> 00:39:11,249

we actually video you can watch a reid

958

00:39:08,789 --> 00:39:12,569

wiseman right before he launched and he

959

00:39:11,248 --> 00:39:14,129

you know he's up there right now so he's

960

00:39:12,568 --> 00:39:16,768

likely the one to operate the printer

961

00:39:14,130 --> 00:39:19,858

and he was so excited about it he in

962

00:39:16,768 --> 00:39:21,929

this interview he says you know NASA

963

00:39:19,858 --> 00:39:26,568

better be careful because we're gonna

964

00:39:21,929 --> 00:39:29,429

use up all the ink he's a ball today

965

00:39:26,568 --> 00:39:31,558

that's good yeah I gotta you know to

966

00:39:29,429 --> 00:39:32,909

follow up on a comment that or the what

967

00:39:31,559 --> 00:39:34,469

carol was saying about you know

968

00:39:32,909 --> 00:39:35,818

astronomers wanting you know excited

969

00:39:34,469 --> 00:39:37,949

being excited about using this i mean

970
00:39:35,818 --> 00:39:39,748
already we're talking about you know

971
00:39:37,949 --> 00:39:42,930
after jwst the James Webb Space

972
00:39:39,748 --> 00:39:47,009
Telescope launching these giant 8 meter

973
00:39:42,929 --> 00:39:49,259
and 16 meter telescopes um I wonder you

974
00:39:47,009 --> 00:39:50,849
know for me I know that's the far future

975
00:39:49,259 --> 00:39:54,358
but that would be the kind of thing that

976
00:39:50,849 --> 00:39:56,068
I think it would excite me about this as

977
00:39:54,358 --> 00:39:59,130
well as not only can we go into space

978
00:39:56,068 --> 00:40:00,420
and we can you know manufacture parts

979
00:39:59,130 --> 00:40:02,338
and things like that up there and live

980
00:40:00,420 --> 00:40:04,590
off the land as you say but we can also

981
00:40:02,338 --> 00:40:06,449
put things up in space that are

982
00:40:04,590 --> 00:40:08,970
really hard to put up there like 16

983
00:40:06,449 --> 00:40:15,119
meter telescopes just being able to

984
00:40:08,969 --> 00:40:18,329
print one out point would be yep so you

985
00:40:15,119 --> 00:40:20,759
look for the history of humans putting

986
00:40:18,329 --> 00:40:22,619
things into space we've only we've done

987
00:40:20,760 --> 00:40:25,410
it exactly the same way we've always put

988
00:40:22,619 --> 00:40:27,299
things on the top of chemical rockets

989
00:40:25,409 --> 00:40:29,219
and launch them there that obviously

990
00:40:27,300 --> 00:40:30,930
puts the you know a lot of burden

991
00:40:29,219 --> 00:40:33,299
there's like it we already mentioned

992
00:40:30,929 --> 00:40:35,250
there's the constraints of the G load

993
00:40:33,300 --> 00:40:37,620
and the vibration load but the other

994
00:40:35,250 --> 00:40:41,550
thing is we're constrained to the volume

995
00:40:37,619 --> 00:40:43,619
of the fairing of spacecraft so so we've

996
00:40:41,550 --> 00:40:45,990
reached we've done a lot in terms of

997
00:40:43,619 --> 00:40:48,389
getting really clever about how we build

998

00:40:45,989 --> 00:40:51,149
things that can fit into a rocket and

999
00:40:48,389 --> 00:40:52,650
then deploy open well that's yet JW seas

1000
00:40:51,150 --> 00:40:55,950
are not prime example of that it had

1001
00:40:52,650 --> 00:40:57,990
them all folded up origami yeah one of

1002
00:40:55,949 --> 00:41:00,359
the best examples so but we've still

1003
00:40:57,989 --> 00:41:03,719
reached in in many ways to physical

1004
00:41:00,360 --> 00:41:05,940
limits of what we can do so this the

1005
00:41:03,719 --> 00:41:08,730
idea of space manufacturing gets around

1006
00:41:05,940 --> 00:41:10,950
that problem entirely we we can remove

1007
00:41:08,730 --> 00:41:14,400
the constraint of the launch fairing and

1008
00:41:10,949 --> 00:41:16,769
start to build things that don't have to

1009
00:41:14,400 --> 00:41:18,780
rely on deployment mechanisms and and

1010
00:41:16,769 --> 00:41:21,090
other things like that just build the

1011
00:41:18,780 --> 00:41:23,250
the large shapes that you needed to

1012
00:41:21,090 --> 00:41:25,050

begin with so you said they're not

1013

00:41:23,250 --> 00:41:27,599

starting yet you're waiting for your

1014

00:41:25,050 --> 00:41:28,800

turn in the glove box um how are you

1015

00:41:27,599 --> 00:41:31,110

going to let people how are we going to

1016

00:41:28,800 --> 00:41:33,000

know that this is but you know what's

1017

00:41:31,110 --> 00:41:35,190

the best way for us to keep in track

1018

00:41:33,000 --> 00:41:37,820

keep track of what what's going on in

1019

00:41:35,190 --> 00:41:41,159

the status is well uh twitter feed

1020

00:41:37,820 --> 00:41:43,980

follow our twitter i'm at made in space

1021

00:41:41,159 --> 00:41:47,219

we we're keeping keeping everybody up to

1022

00:41:43,980 --> 00:41:50,099

date there and our facebook it's a we

1023

00:41:47,219 --> 00:41:53,219

are made in space so our social media is

1024

00:41:50,099 --> 00:41:55,920

is really um you know when we hear news

1025

00:41:53,219 --> 00:41:58,079

we share it so that's probably number

1026

00:41:55,920 --> 00:42:01,430

one NASA is doing a lot of work there to

1027
00:41:58,079 --> 00:42:04,079
to to let everybody know about this so

1028
00:42:01,429 --> 00:42:06,629
they'll be you know we expect that it

1029
00:42:04,079 --> 00:42:09,420
will be a good amount of heads up before

1030
00:42:06,630 --> 00:42:13,559
the printer starts printing this is this

1031
00:42:09,420 --> 00:42:17,130
is a it's an incredibly historical event

1032
00:42:13,559 --> 00:42:18,269
for Humanity there's it's been up you

1033
00:42:17,130 --> 00:42:20,760
know this will be the first

1034
00:42:18,269 --> 00:42:23,009
time as a species we've ever made faq

1035
00:42:20,760 --> 00:42:25,470
shirt off a planet earth and we want

1036
00:42:23,010 --> 00:42:28,590
everybody to share in that occasion

1037
00:42:25,469 --> 00:42:30,119
because it's you know this is I think

1038
00:42:28,590 --> 00:42:32,250
it'll go down as a really important

1039
00:42:30,119 --> 00:42:34,259
piece in history I agree in Jonathan I

1040
00:42:32,250 --> 00:42:35,550
but Jonathan and Phillip are just you

1041
00:42:34,260 --> 00:42:38,040
guys are blowing up I thank you for all

1042
00:42:35,550 --> 00:42:39,450
the comments uh so Jonathan's like is

1043
00:42:38,039 --> 00:42:41,579
the next I beat you to this one I think

1044
00:42:39,449 --> 00:42:44,099
jonathan is the next version going to be

1045
00:42:41,579 --> 00:42:45,719
able to print glassware and if so are we

1046
00:42:44,099 --> 00:42:47,219
expecting better telescopes and we just

1047
00:42:45,719 --> 00:42:48,809
we just talked about this but what about

1048
00:42:47,219 --> 00:42:50,599
the glass part of it is that says that a

1049
00:42:48,809 --> 00:42:54,090
material that perhaps is in the future

1050
00:42:50,599 --> 00:42:55,949
so um it's a pretty cool question there

1051
00:42:54,090 --> 00:42:57,870
the quit you know like there's a few

1052
00:42:55,949 --> 00:43:01,159
pieces of that if we want to talk about

1053
00:42:57,869 --> 00:43:03,630
optics you know printing optical element

1054
00:43:01,159 --> 00:43:05,519
you know that's a tricky problem we a

1055

00:43:03,630 --> 00:43:08,070
lot of what we've done as a company as

1056
00:43:05,519 --> 00:43:11,610
we look at where technology is headed

1057
00:43:08,070 --> 00:43:14,280
and anticipate when it will be ready to

1058
00:43:11,610 --> 00:43:17,640
actually go into real applications so in

1059
00:43:14,280 --> 00:43:20,250
2010 we we realize that we could work on

1060
00:43:17,639 --> 00:43:22,319
this fdm style of 3d printing and get it

1061
00:43:20,250 --> 00:43:24,989
ready for space if you if you start

1062
00:43:22,320 --> 00:43:27,930
looking at what's out there um you know

1063
00:43:24,989 --> 00:43:29,609
in industry and research for optics type

1064
00:43:27,929 --> 00:43:32,190
of printing there's still a lot of

1065
00:43:29,610 --> 00:43:34,800
challenges to overcome but it will it

1066
00:43:32,190 --> 00:43:36,420
will it will get there and until them

1067
00:43:34,800 --> 00:43:38,700
there's always things that will have to

1068
00:43:36,420 --> 00:43:41,490
launch that we just can't print up you

1069
00:43:38,699 --> 00:43:43,739

know and we can't print transistors and

1070

00:43:41,489 --> 00:43:45,269

and circuit boards and everything yet so

1071

00:43:43,739 --> 00:43:47,069

there's things that you have to launch

1072

00:43:45,269 --> 00:43:50,460

and they're things that you can print

1073

00:43:47,070 --> 00:43:52,260

over time though our view is that one

1074

00:43:50,460 --> 00:43:54,990

day everything in space will be made in

1075

00:43:52,260 --> 00:43:56,430

space and won't every at every point in

1076

00:43:54,989 --> 00:43:58,529

time there'll be something that you

1077

00:43:56,429 --> 00:44:00,899

don't have to launch because you can 3d

1078

00:43:58,530 --> 00:44:02,640

print it so if you can print it there

1079

00:44:00,900 --> 00:44:04,410

you will it will just make more sense

1080

00:44:02,639 --> 00:44:05,730

and with the printer on the space

1081

00:44:04,409 --> 00:44:07,769

station day there's already something

1082

00:44:05,730 --> 00:44:09,719

that can be printed it's actually a lot

1083

00:44:07,769 --> 00:44:11,250

of things those things don't have to get

1084
00:44:09,719 --> 00:44:13,679
launched anymore and the second printer

1085
00:44:11,250 --> 00:44:15,989
will expand upon that and so on so I

1086
00:44:13,679 --> 00:44:18,389
hope it's soon that we see you know

1087
00:44:15,989 --> 00:44:21,419
optics and optical elements and things

1088
00:44:18,389 --> 00:44:24,150
like that but it's a lot of development

1089
00:44:21,420 --> 00:44:26,190
needed well personally I was gonna I was

1090
00:44:24,150 --> 00:44:27,720
just going to interject that that once

1091
00:44:26,190 --> 00:44:30,690
you've decided that you can manufacture

1092
00:44:27,719 --> 00:44:32,129
in space there's no reason to you know

1093
00:44:30,690 --> 00:44:33,990
restrict yourself to one

1094
00:44:32,130 --> 00:44:35,849
sheen you can have a machine that does

1095
00:44:33,989 --> 00:44:37,649
metals and another one that does sort of

1096
00:44:35,849 --> 00:44:40,589
plastic materials so that you can

1097
00:44:37,650 --> 00:44:43,500
optimize the machine what you understand

1098
00:44:40,590 --> 00:44:46,170
the zero g or Moulton you know if G

1099
00:44:43,500 --> 00:44:47,849
independent stuff you can think about oh

1100
00:44:46,170 --> 00:44:49,559
I need metal parts over here and they

1101
00:44:47,849 --> 00:44:51,509
need plastic parts over here and I need

1102
00:44:49,559 --> 00:44:53,759
chocolate over here and then you can

1103
00:44:51,510 --> 00:44:55,800
print what you want I'm always a jungle

1104
00:44:53,760 --> 00:45:00,590
yeah i would i would want one that

1105
00:44:55,800 --> 00:45:02,670
prince chief editors yeah you would

1106
00:45:00,590 --> 00:45:04,579
especially if i'm in Mars and i haven't

1107
00:45:02,670 --> 00:45:07,320
had a had a cheeseburger in a while

1108
00:45:04,579 --> 00:45:09,690
Scott I want to meet me ask you am I am

1109
00:45:07,320 --> 00:45:12,570
I missing any comments or questions here

1110
00:45:09,690 --> 00:45:14,340
that I think we've got a all of them

1111
00:45:12,570 --> 00:45:16,470
taking care for the most part of ones

1112

00:45:14,340 --> 00:45:20,789
that we've already answered before they

1113
00:45:16,469 --> 00:45:23,969
ask them so yeah yeah okay um let's see

1114
00:45:20,789 --> 00:45:26,940
ask about the bit so we had a video but

1115
00:45:23,969 --> 00:45:29,609
we had some other imagery oh yeah we

1116
00:45:26,940 --> 00:45:31,889
have it would it would be nice to take a

1117
00:45:29,610 --> 00:45:33,480
look at some of those yeah if you can

1118
00:45:31,889 --> 00:45:36,829
can you put up some of those and what

1119
00:45:33,480 --> 00:45:40,019
have Jason talk about design photos

1120
00:45:36,829 --> 00:45:42,989
moment it shot up for the first printer

1121
00:45:40,019 --> 00:45:44,909
it's a nice like you can see some

1122
00:45:42,989 --> 00:45:48,509
hardware in the background and yeah

1123
00:45:44,909 --> 00:45:50,909
there it is so this is this is actually

1124
00:45:48,510 --> 00:45:54,170
the printer in the foreground that's the

1125
00:45:50,909 --> 00:45:56,969
printer that is on Space Station today

1126
00:45:54,170 --> 00:45:59,309

and then in the background is the

1127
00:45:56,969 --> 00:46:01,739
microgravity science glovebox the msg

1128
00:45:59,309 --> 00:46:03,509
that's what we that's where what the

1129
00:46:01,739 --> 00:46:06,089
printer goes in the space station so

1130
00:46:03,510 --> 00:46:10,410
this picture was taken at NASA Marshall

1131
00:46:06,090 --> 00:46:13,380
flight Marshall Flight Center so at

1132
00:46:10,409 --> 00:46:15,420
Marshall that's that's where our main

1133
00:46:13,380 --> 00:46:18,240
contract goes through it's our

1134
00:46:15,420 --> 00:46:20,670
partnership with NASA and we work really

1135
00:46:18,239 --> 00:46:23,339
hand-in-hand with NASA Marshall to

1136
00:46:20,670 --> 00:46:27,690
develop this entire first 3d printer

1137
00:46:23,340 --> 00:46:29,100
program so made in space does the design

1138
00:46:27,690 --> 00:46:32,039
and development of the hardware and

1139
00:46:29,099 --> 00:46:35,519
software electronics and so on and then

1140
00:46:32,039 --> 00:46:37,590
NASA Marshall helped with the testing

1141
00:46:35,519 --> 00:46:40,199
and the qualification of the system as

1142
00:46:37,590 --> 00:46:42,480
well as that's where the payload

1143
00:46:40,199 --> 00:46:45,669
Operations Center is for Space Station

1144
00:46:42,480 --> 00:46:49,780
so we are able to go there and test

1145
00:46:45,670 --> 00:46:53,250
out the printer in the simulated msg

1146
00:46:49,780 --> 00:46:55,540
scenario so really good partnership and

1147
00:46:53,250 --> 00:46:57,489
it's one of those examples of how

1148
00:46:55,539 --> 00:47:00,849
government and commercial works really

1149
00:46:57,489 --> 00:47:02,739
well together okay one show there we go

1150
00:47:00,849 --> 00:47:07,420
here's another one now here's a close-up

1151
00:47:02,739 --> 00:47:09,189
of of the printer actually looks really

1152
00:47:07,420 --> 00:47:12,039
close up on my screen I can only see

1153
00:47:09,190 --> 00:47:14,500
part of it but uh so let me pop it out a

1154
00:47:12,039 --> 00:47:18,068
couple things here on the left is a

1155
00:47:14,500 --> 00:47:20,500
smaller box and there you go so that the

1156
00:47:18,068 --> 00:47:23,469
box on the left is our electronics and

1157
00:47:20,500 --> 00:47:27,250
computer that's a it's our power supply

1158
00:47:23,469 --> 00:47:29,769
it's the notes that the all the

1159
00:47:27,250 --> 00:47:31,989
electronics and the sensor packages and

1160
00:47:29,769 --> 00:47:35,500
things like that that's what plugs into

1161
00:47:31,989 --> 00:47:36,848
the glove box and then multiple then we

1162
00:47:35,500 --> 00:47:38,949
have two ports that plug into the

1163
00:47:36,849 --> 00:47:41,559
printer so you can see the switch on the

1164
00:47:38,949 --> 00:47:42,848
back left of the electronics box that

1165
00:47:41,559 --> 00:47:44,829
like I was saying it's the only switch

1166
00:47:42,849 --> 00:47:48,099
on the entire printer the entire thing

1167
00:47:44,829 --> 00:47:50,680
is definitely looks a little special

1168
00:47:48,099 --> 00:47:53,740
compared to a printer here you're used

1169

00:47:50,679 --> 00:47:56,409
to seeing the surface it's made of

1170
00:47:53,739 --> 00:48:00,879
aerospace grade aluminum that's coated

1171
00:47:56,409 --> 00:48:03,670
in nickel plated its nickel plated so

1172
00:48:00,880 --> 00:48:06,099
that that makes it safe to use on Space

1173
00:48:03,670 --> 00:48:10,000
Station it doesn't scratch it doesn't

1174
00:48:06,099 --> 00:48:12,010
leak EMI um feedstock cartridge is that

1175
00:48:10,000 --> 00:48:13,900
box on the left of the printer that

1176
00:48:12,010 --> 00:48:16,299
comes in and out so it's replaceable and

1177
00:48:13,900 --> 00:48:18,880
then there's a door so the door has a

1178
00:48:16,298 --> 00:48:20,318
window and there's cameras it will look

1179
00:48:18,880 --> 00:48:22,539
through the window while we print but

1180
00:48:20,318 --> 00:48:25,329
the entire printer is is closed in so it

1181
00:48:22,539 --> 00:48:27,099
keeps the outgassing inside of there and

1182
00:48:25,329 --> 00:48:31,150
we who are environmental environmental

1183
00:48:27,099 --> 00:48:33,039

control inside the box great yep

1184

00:48:31,150 --> 00:48:38,650

anything else we have do you have

1185

00:48:33,039 --> 00:48:41,079

anything else rkelly nope oh that's the

1186

00:48:38,650 --> 00:48:46,539

song yeah so let me know part coming off

1187

00:48:41,079 --> 00:48:48,640

a printer a basically the printer remove

1188

00:48:46,539 --> 00:48:51,670

is you know the entire print rate comes

1189

00:48:48,639 --> 00:48:53,618

in and out we've made every step along

1190

00:48:51,670 --> 00:48:56,260

the way we've worked with NASA to really

1191

00:48:53,619 --> 00:48:58,809

make it easy for the astronauts to use

1192

00:48:56,260 --> 00:49:01,150

and to reduce the time spent using so

1193

00:48:58,809 --> 00:49:03,820

what you know when we first started most

1194

00:49:01,150 --> 00:49:05,619

most people think while they build a 3d

1195

00:49:03,820 --> 00:49:08,800

printer for for the astronauts and let's

1196

00:49:05,619 --> 00:49:12,009

have all these you know the gizmos and

1197

00:49:08,800 --> 00:49:15,220

all these good thing features but it

1198
00:49:12,010 --> 00:49:17,350
really had to be really simple the

1199
00:49:15,219 --> 00:49:19,089
astronauts time is depending how you

1200
00:49:17,349 --> 00:49:23,139
look at it it's about fifty thousand

1201
00:49:19,090 --> 00:49:25,710
dollars an hour so making it complex and

1202
00:49:23,139 --> 00:49:27,929
arby's not something we could do so

1203
00:49:25,710 --> 00:49:31,720
actually the printer is really easy

1204
00:49:27,929 --> 00:49:34,179
doesn't require calibration so Carol you

1205
00:49:31,719 --> 00:49:35,169
know everything your your desktop

1206
00:49:34,179 --> 00:49:38,049
printer you probably have to calibrate

1207
00:49:35,170 --> 00:49:40,570
it make sure your Z alignments correct

1208
00:49:38,050 --> 00:49:44,080
and the print trays absolutely yeah we

1209
00:49:40,570 --> 00:49:47,410
have stds we don't do that the printer

1210
00:49:44,079 --> 00:49:49,509
is just built to not need the

1211
00:49:47,409 --> 00:49:51,460
calibration it launches calibrated and

1212
00:49:49,510 --> 00:49:53,620
it will get its writ once they put it in

1213
00:49:51,460 --> 00:49:56,110
they'll turn it on and all they have to

1214
00:49:53,619 --> 00:49:59,230
do is plug it in turn it on and we do

1215
00:49:56,110 --> 00:50:03,030
everything else okay I so at the end of

1216
00:49:59,230 --> 00:50:03,030
this broadcaster sending me one right

1217
00:50:04,530 --> 00:50:12,640
without we printed it printed out oh

1218
00:50:09,840 --> 00:50:14,170
yeah bill Keane's gotik Mickey mechanics

1219
00:50:12,639 --> 00:50:16,329
a good point here when he comments and

1220
00:50:14,170 --> 00:50:17,950
you know traditionally glass and mirrors

1221
00:50:16,329 --> 00:50:19,269
have been made with gravity dependent

1222
00:50:17,949 --> 00:50:20,829
processes that's a good point the

1223
00:50:19,269 --> 00:50:22,869
figures and mirrors and things like that

1224
00:50:20,829 --> 00:50:26,289
are all more or less dependent on

1225
00:50:22,869 --> 00:50:28,630
gravity and the release the process is

1226

00:50:26,289 --> 00:50:30,579
used to make those figures so that that

1227
00:50:28,630 --> 00:50:33,340
is going to be an interesting you don't

1228
00:50:30,579 --> 00:50:35,440
have to because the optical design if

1229
00:50:33,340 --> 00:50:37,630
you make a perfect optical design you

1230
00:50:35,440 --> 00:50:41,019
can have a perfect object the problem is

1231
00:50:37,630 --> 00:50:43,780
that designers have to worry about the

1232
00:50:41,019 --> 00:50:46,210
gravity effect in the materials will sag

1233
00:50:43,780 --> 00:50:48,550
or whatever and so they accommodate that

1234
00:50:46,210 --> 00:50:50,559
in design but optical designers would

1235
00:50:48,550 --> 00:50:52,870
love to make something that's a perfect

1236
00:50:50,559 --> 00:50:54,940
optical design that doesn't sag out of

1237
00:50:52,869 --> 00:50:57,609
the materials made out of that's right a

1238
00:50:54,940 --> 00:50:59,200
wonderful really large telescope mirrors

1239
00:50:57,610 --> 00:51:01,269
like way ground-based telescopes and

1240
00:50:59,199 --> 00:51:03,789

stuff actually can flow a little bit I

1241
00:51:01,269 --> 00:51:06,190
remember a story I heard a long time ago

1242
00:51:03,789 --> 00:51:07,150
I don't know if this is urban legend I

1243
00:51:06,190 --> 00:51:09,220
have never been a mcdonald observatory

1244
00:51:07,150 --> 00:51:11,619
but there are actually bullet holes in

1245
00:51:09,219 --> 00:51:12,068
the primary mirror at McDonald's herba

1246
00:51:11,619 --> 00:51:14,318
Tory

1247
00:51:12,068 --> 00:51:16,239
we're and they it just didn't crack or

1248
00:51:14,318 --> 00:51:18,788
break the glass at all it just it just

1249
00:51:16,239 --> 00:51:19,900
went right through so interesting

1250
00:51:18,789 --> 00:51:21,910
interesting properties of glass

1251
00:51:19,900 --> 00:51:26,019
especially when you're really large so

1252
00:51:21,909 --> 00:51:28,149
that's a good point okay so um it so

1253
00:51:26,018 --> 00:51:30,758
what it you've told us a little bit I

1254
00:51:28,150 --> 00:51:32,499
given us a glimpse about about your

1255
00:51:30,759 --> 00:51:34,329
company and you've told us what you're

1256
00:51:32,498 --> 00:51:36,968
doing with 3d printing in the near term

1257
00:51:34,329 --> 00:51:38,318
what what do you what do you have in the

1258
00:51:36,969 --> 00:51:40,119
wings what else are you working on that

1259
00:51:38,318 --> 00:51:43,690
you'd like us to know about and for the

1260
00:51:40,119 --> 00:51:45,729
lot for the distant future well look I

1261
00:51:43,690 --> 00:51:49,329
think what's most important and most

1262
00:51:45,728 --> 00:51:51,458
exciting is that is that we you know

1263
00:51:49,329 --> 00:51:53,199
from here on out they'll always be a new

1264
00:51:51,458 --> 00:51:55,268
way to get things into space aside from

1265
00:51:53,199 --> 00:51:57,219
launching them and for us that's

1266
00:51:55,268 --> 00:52:00,129
important because we want we want

1267
00:51:57,219 --> 00:52:02,380
everybody on the planet to use this

1268
00:52:00,130 --> 00:52:05,979
printer in a way if they can we want to

1269
00:52:02,380 --> 00:52:07,660
connect the world to space we want new

1270
00:52:05,978 --> 00:52:10,179
initiatives in space to be spawned

1271
00:52:07,659 --> 00:52:13,690
because there's a new faster cheaper way

1272
00:52:10,179 --> 00:52:16,239
to get things there that's important for

1273
00:52:13,690 --> 00:52:18,909
us we've we've had you know some really

1274
00:52:16,239 --> 00:52:22,358
exciting ideas we've had people talking

1275
00:52:18,909 --> 00:52:24,368
to us about building cube sets with the

1276
00:52:22,358 --> 00:52:26,619
3d printer so imagine not needing to

1277
00:52:24,369 --> 00:52:28,900
build your cube sat on the ground and

1278
00:52:26,619 --> 00:52:31,630
said just having it built there and tell

1279
00:52:28,900 --> 00:52:36,059
us what cube SATs are oh yeah sorry so I

1280
00:52:31,630 --> 00:52:36,059
keep sounds like a really tiny Hubble

1281
00:52:36,150 --> 00:52:41,499
CubeSat it's it's a 10 centimeter cube

1282
00:52:38,829 --> 00:52:44,619
it's a small little satellite but packed

1283

00:52:41,498 --> 00:52:46,629
inside is the latest technology you know

1284
00:52:44,619 --> 00:52:48,640
keeping up with Moore's law in a way we

1285
00:52:46,630 --> 00:52:50,709
can everything that's in your cell phone

1286
00:52:48,639 --> 00:52:53,170
could be a satellite so imagine putting

1287
00:52:50,708 --> 00:52:56,018
that technology into a little box and

1288
00:52:53,170 --> 00:52:58,449
putting in space it's what today there's

1289
00:52:56,018 --> 00:53:01,298
it's a revolution because of where that

1290
00:52:58,449 --> 00:53:03,309
technology's headed but it's still it's

1291
00:53:01,298 --> 00:53:06,429
still timely manner it's a very hands-on

1292
00:53:03,309 --> 00:53:09,278
manner to build even these really small

1293
00:53:06,429 --> 00:53:11,798
satellites and you know when I was in

1294
00:53:09,278 --> 00:53:14,440
college several years ago I built a keep

1295
00:53:11,798 --> 00:53:16,630
that just like a lot of aerospace

1296
00:53:14,440 --> 00:53:18,099
engineering students do it's really good

1297
00:53:16,630 --> 00:53:20,349

exercise to learn how to build

1298

00:53:18,099 --> 00:53:23,920

satellites but they never they never

1299

00:53:20,349 --> 00:53:25,240

really flew arzga roof today it's that's

1300

00:53:23,920 --> 00:53:27,760

starting to change EB SATs are

1301

00:53:25,239 --> 00:53:30,969

flying a lot there's companies that are

1302

00:53:27,760 --> 00:53:34,360

launching you know in the hundreds of

1303

00:53:30,969 --> 00:53:37,359

cute sets in a year and that's changing

1304

00:53:34,360 --> 00:53:39,579

how we do satellites how we how we look

1305

00:53:37,360 --> 00:53:42,910

at our earth how we do science and space

1306

00:53:39,579 --> 00:53:44,980

and so on so one of the exciting things

1307

00:53:42,909 --> 00:53:46,599

is we could we can actually just build

1308

00:53:44,980 --> 00:53:49,510

those on the space station with the

1309

00:53:46,599 --> 00:53:51,819

printer so now what I'm excited about is

1310

00:53:49,510 --> 00:53:53,950

for the future students who instead of

1311

00:53:51,820 --> 00:53:55,570

spending a year building akita on the

1312
00:53:53,949 --> 00:53:58,329
ground they said spend all that time

1313
00:53:55,570 --> 00:54:00,610
designing a mission and have their boots

1314
00:53:58,329 --> 00:54:01,809
at bill on the man really fast and

1315
00:54:00,610 --> 00:54:04,660
launched and then they get to do a

1316
00:54:01,809 --> 00:54:08,650
mission and you know that's that's

1317
00:54:04,659 --> 00:54:10,480
actually possible now forth for anybody

1318
00:54:08,650 --> 00:54:13,150
to have their own space mission so

1319
00:54:10,480 --> 00:54:16,900
that's something that I see coming to

1320
00:54:13,150 --> 00:54:18,880
the zoo and and as a company you know we

1321
00:54:16,900 --> 00:54:21,910
what we've done is we've done a couple

1322
00:54:18,880 --> 00:54:23,820
things you we reduce earth dependency

1323
00:54:21,909 --> 00:54:26,379
for astronauts that's number one so

1324
00:54:23,820 --> 00:54:28,300
astron people in space today are less

1325
00:54:26,380 --> 00:54:30,820
dependent on earth they can when they

1326
00:54:28,300 --> 00:54:33,780
need something whether it's emergency

1327
00:54:30,820 --> 00:54:36,340
fix or a new tool or anything like that

1328
00:54:33,780 --> 00:54:39,880
the chances are it can actually be 3d

1329
00:54:36,340 --> 00:54:41,650
printed in space we don't need to launch

1330
00:54:39,880 --> 00:54:44,200
an entire rocket to bring them a new

1331
00:54:41,650 --> 00:54:45,639
wrench and that's important for Space

1332
00:54:44,199 --> 00:54:49,509
Station but it's absolutely necessary

1333
00:54:45,639 --> 00:54:52,900
for a Mars mission yeah we need if we

1334
00:54:49,510 --> 00:54:55,210
really want to do a Mars mission or or

1335
00:54:52,900 --> 00:54:58,180
even a moon mission and put people in

1336
00:54:55,210 --> 00:55:00,849
the moon we need to get off of the

1337
00:54:58,179 --> 00:55:03,429
paradigm that the only way to do it is

1338
00:55:00,849 --> 00:55:07,599
to have the ability to keep relaunching

1339
00:55:03,429 --> 00:55:09,730
rockets so so our technology will always

1340

00:55:07,599 --> 00:55:13,659
be wherever there's humans in space from

1341
00:55:09,730 --> 00:55:15,849
here on out and and then well if along

1342
00:55:13,659 --> 00:55:17,440
with it anybody else on earth will be

1343
00:55:15,849 --> 00:55:19,539
able to go along because they'll be able

1344
00:55:17,440 --> 00:55:23,920
to send their things there you know at

1345
00:55:19,539 --> 00:55:26,619
the speed of light co Adam synergies

1346
00:55:23,920 --> 00:55:28,059
back and hey Adam he goes he's

1347
00:55:26,619 --> 00:55:29,380
confirming what I just said it's true

1348
00:55:28,059 --> 00:55:30,489
there are several bullet holes in the

1349
00:55:29,380 --> 00:55:33,490
primary mirror of the Large Telescope

1350
00:55:30,489 --> 00:55:35,829
and McDonald Observatory courtesy of a

1351
00:55:33,489 --> 00:55:37,569
crazy Texan employee in the seventies

1352
00:55:35,829 --> 00:55:38,909
yeah I don't recall who I heard it from

1353
00:55:37,570 --> 00:55:40,349
but yeah there's

1354
00:55:38,909 --> 00:55:47,608

right into them down the tube of the

1355

00:55:40,349 --> 00:55:49,380

telescope so it's absolutely sure all

1356

00:55:47,608 --> 00:55:50,068

right let's see here Scotty you want to

1357

00:55:49,380 --> 00:55:52,588

help me make sure I'm not missing

1358

00:55:50,068 --> 00:55:54,480

anybody Oh Phillip is commenting the VLT

1359

00:55:52,588 --> 00:55:58,380

mirrors float on magnets that's right a

1360

00:55:54,480 --> 00:56:01,139

very large telescope in in Chile let's

1361

00:55:58,380 --> 00:56:02,338

see jonathan peters is asking i wanna

1362

00:56:01,139 --> 00:56:04,078

get it to a couple more before we're

1363

00:56:02,338 --> 00:56:06,838

running out of time here is it possible

1364

00:56:04,079 --> 00:56:10,500

to print aerogel materials from this or

1365

00:56:06,838 --> 00:56:12,538

future devices yeah you know we probably

1366

00:56:10,500 --> 00:56:15,059

will see future devices do exotic

1367

00:56:12,539 --> 00:56:18,660

materials like aerogel and the the

1368

00:56:15,059 --> 00:56:20,970

printers are Joe aerogel is awesome

1369
00:56:18,659 --> 00:56:22,469
you're is off you really got it like

1370
00:56:20,969 --> 00:56:25,019
Google and look at a picture of it

1371
00:56:22,469 --> 00:56:27,389
you'll probably think it's photoshopped

1372
00:56:25,019 --> 00:56:31,048
image but it's just this incredible

1373
00:56:27,389 --> 00:56:34,409
material that's extremely light it can

1374
00:56:31,048 --> 00:56:35,608
it has really high you know temperatures

1375
00:56:34,409 --> 00:56:37,649
that it can withstand so that you'll

1376
00:56:35,608 --> 00:56:40,558
find a picture of a match burning

1377
00:56:37,650 --> 00:56:42,630
sitting on top of this stuff um but it's

1378
00:56:40,559 --> 00:56:44,990
you know works really well for for

1379
00:56:42,630 --> 00:56:48,059
things like insulators and so on so

1380
00:56:44,989 --> 00:56:50,429
exotic materials are are always in the

1381
00:56:48,059 --> 00:56:52,769
realm of where research is for 3d

1382
00:56:50,429 --> 00:56:57,000
printing the printer that's on the space

1383
00:56:52,769 --> 00:56:59,068
station today does thermoplastics so and

1384
00:56:57,000 --> 00:57:02,338
a thermoplastic is a type of plastic

1385
00:56:59,068 --> 00:57:04,469
that you can melt and form and then ream

1386
00:57:02,338 --> 00:57:08,778
ill and that's that's kind of important

1387
00:57:04,469 --> 00:57:11,669
for the way that process works cool

1388
00:57:08,778 --> 00:57:14,670
let's see jonathan peters is also

1389
00:57:11,670 --> 00:57:16,619
commenting in space chocolate and space

1390
00:57:14,670 --> 00:57:20,460
cheeburger don't forget space g bugga

1391
00:57:16,619 --> 00:57:22,440
you can manufacture last one you can

1392
00:57:20,460 --> 00:57:25,710
manufacture plastic lenses with stereo

1393
00:57:22,440 --> 00:57:28,440
lithography which is fluid printing good

1394
00:57:25,710 --> 00:57:30,329
for telescopes maybe yep yeah good i

1395
00:57:28,440 --> 00:57:33,809
think it's that you know that my little

1396
00:57:30,329 --> 00:57:36,420
comment there is well absolutely but

1397

00:57:33,809 --> 00:57:38,190
we've when we started this process we

1398
00:57:36,420 --> 00:57:39,750
our goal was how can we get

1399
00:57:38,190 --> 00:57:43,019
manufacturing the space of the quickest

1400
00:57:39,750 --> 00:57:46,019
and and i also have an impact so we

1401
00:57:43,019 --> 00:57:49,048
identified that the tight this fused

1402
00:57:46,019 --> 00:57:50,788
deposition modeling or fdm style 3d

1403
00:57:49,048 --> 00:57:52,710
printing it's really an extrusion based

1404
00:57:50,789 --> 00:57:55,260
printing where you have a solid fly

1405
00:57:52,710 --> 00:57:57,480
lastic feedstock and you melted through

1406
00:57:55,260 --> 00:58:00,750
a nozzle so it's like imagine like a hot

1407
00:57:57,480 --> 00:58:03,179
glue gun that was something that we saw

1408
00:58:00,750 --> 00:58:04,949
at the highest potential just working in

1409
00:58:03,179 --> 00:58:07,379
zero gravity we didn't have to control a

1410
00:58:04,949 --> 00:58:10,250
fluid we have to control a powder of

1411
00:58:07,380 --> 00:58:12,780

metal and it also would be useful

1412

00:58:10,250 --> 00:58:16,289

astronauts can use it people could use

1413

00:58:12,780 --> 00:58:18,030

it so that was our path there's we would

1414

00:58:16,289 --> 00:58:20,519

definitely are working now on many other

1415

00:58:18,030 --> 00:58:22,800

technologies so I mentioned for one the

1416

00:58:20,519 --> 00:58:26,130

lunar printing we were making sure our

1417

00:58:22,800 --> 00:58:28,109

technology could be used on the moon but

1418

00:58:26,130 --> 00:58:30,450

you know we have to keep developing new

1419

00:58:28,108 --> 00:58:32,130

technologies or we will never get the

1420

00:58:30,449 --> 00:58:33,838

full picture of space manufacturing

1421

00:58:32,130 --> 00:58:35,309

awesome well that's we're going to I

1422

00:58:33,838 --> 00:58:37,009

guess well that'll be a good place to

1423

00:58:35,309 --> 00:58:39,719

close it there we're running out of time

1424

00:58:37,010 --> 00:58:41,820

Jason Dunn he's the co-founder and the

1425

00:58:39,719 --> 00:58:44,429

chief technology officer of made in

1426
00:58:41,820 --> 00:58:45,780
space a company that is currently

1427
00:58:44,429 --> 00:58:47,969
working with NASA to test this

1428
00:58:45,780 --> 00:58:50,550
technology of manufacturing out in

1429
00:58:47,969 --> 00:58:55,199
zero-g their website is made in space

1430
00:58:50,550 --> 00:58:57,390
dot u dot us right based on us and you

1431
00:58:55,199 --> 00:59:00,000
can follow these guys and at made his

1432
00:58:57,389 --> 00:59:01,230
faith and keep in Jason I hope we can

1433
00:59:00,000 --> 00:59:03,300
have you back and you'll talk to us

1434
00:59:01,230 --> 00:59:05,010
again about how things are going and but

1435
00:59:03,300 --> 00:59:07,380
and how it went after you get some

1436
00:59:05,010 --> 00:59:09,570
results I would love to thanks for

1437
00:59:07,380 --> 00:59:12,930
having awesome that's great thank you so

1438
00:59:09,570 --> 00:59:15,210
much that's for the up okay well guys I

1439
00:59:12,929 --> 00:59:18,059
guess that's it for now next week we're

1440
00:59:15,210 --> 00:59:20,220
going to be talking about comet siding

1441
00:59:18,059 --> 00:59:22,529
spring I believe for the Hubble you're

1442
00:59:20,219 --> 00:59:24,239
supposed to be looking at it I guess

1443
00:59:22,530 --> 00:59:27,720
this weekend it's looking at isn't right

1444
00:59:24,239 --> 00:59:29,309
up in ok so we'll be talking about what

1445
00:59:27,719 --> 00:59:30,598
it sees and we'll have images to show

1446
00:59:29,309 --> 00:59:32,369
you and hopefully there will be some

1447
00:59:30,599 --> 00:59:35,849
cool stuff that comes out of that so

1448
00:59:32,369 --> 00:59:37,858
until then we would like you to follow

1449
00:59:35,849 --> 00:59:39,809
us on all the follow us on Facebook and

1450
00:59:37,858 --> 00:59:42,838
Twitter and all of that in our help and

1451
00:59:39,809 --> 00:59:45,119
our YouTube channel is publicité channel

1452
00:59:42,838 --> 00:59:47,759
so please subscribe to us there Carol

1453
00:59:45,119 --> 00:59:51,240
Scott another one in the back the guy

1454

00:59:47,760 --> 00:59:54,650
they m been watching and as always keep

1455
00:59:51,239 --> 00:59:54,649
looking up