
Ames Research Center
NASA
SILICON VALLEY
LIVE

1
00:00:03,660 --> 00:00:13,920
(Music)

2
00:00:13,920 --> 00:00:16,760
- Hey folks. Thank you for joining us. Go ahead,

3
00:00:16,760 --> 00:00:22,480
don't be shy, jump in the chat, send us your questions but before we do the whole rigmarole,

4
00:00:22,480 --> 00:00:26,281
Terry is already an alum of the podcast. So, for

5
00:00:26,281 --> 00:00:28,529
folks if you are not familiar with the podcast, we

6
00:00:28,529 --> 00:00:31,099
do the... we recorded an episode last year for -

7
00:00:31,099 --> 00:00:32,920
- A year ago, yeah.

8
00:00:32,920 --> 00:00:36,580
- For CES but we did a Throwback Thursday, it was

9
00:00:36,580 --> 00:00:40,110
what the crazy kids do nowadays online. But that

10
00:00:40,110 --> 00:00:41,940
episode is out there where we talked to Terry in

11
00:00:41,940 --> 00:00:44,920

detail about his background and stuff, but
Diana

12
00:00:44,920 --> 00:00:47,890
this is the first time that you have joined
us. We

13
00:00:47,890 --> 00:00:50,140
always start off the same way with, just tell
us

14
00:00:50,140 --> 00:00:54,100
about yourself. How did you join NASA? What
brought you to Silicon Valley?

15
00:00:54,100 --> 00:00:58,539
- Yeah, so I never thought I would work at
NASA.

16
00:00:58,539 --> 00:01:04,151
It was not a dream as a child. Actually, NASA
showed up on my radar back in 1997. I was

17
00:01:04,151 --> 00:01:07,040
a high schooler, a young high schooler at the time

18
00:01:07,040 --> 00:01:10,350
and NASA just sent the Pathfinder mission to Mars.

19
00:01:10,350 --> 00:01:13,680
And so we had the Sojourner rover driving around

20
00:01:13,680 --> 00:01:16,979
Mars and I thought it was fascinating. Not really

21
00:01:16,979 --> 00:01:19,920
because of the science, like Jim and Greg
last

22

00:01:19,920 --> 00:01:23,360
time, but more the problem that they had to
solve

23
00:01:23,360 --> 00:01:27,960
to get there. NASA hadn't been to Mars
successfully in 20 years and since then, we

24
00:01:27,960 --> 00:01:31,330
have been back there eight times but for me I thought,

25
00:01:31,330 --> 00:01:34,740
wow this is a really hard challenge that I
want to

26
00:01:34,740 --> 00:01:37,100
know how to solve. I want to be a part of
that

27
00:01:37,100 --> 00:01:38,100
problem.

28
00:01:38,100 --> 00:01:39,210
- Like in high school or college?

29
00:01:39,210 --> 00:01:40,369
- That was in high school.

30
00:01:40,369 --> 00:01:41,369
- Oh wow.

31
00:01:41,369 --> 00:01:44,860
- That was early high school. And so I didn't
really know quite how to get in that world.

32
00:01:44,860 --> 00:01:46,780
It wasn't necessarily the rover problem I wanted

33
00:01:46,780 --> 00:01:48,729

to solve but I wanted to do something really

34
00:01:48,729 --> 00:01:53,210
difficult and overcome that. So, I found myself in

35
00:01:53,210 --> 00:01:56,540
engineering in college and wound up going
to

36
00:01:56,540 --> 00:02:00,540
aeronautical and aerospace engineering in
college.

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00:02:00,540 --> 00:02:03,119
And as always looking for part of the field
that

38
00:02:03,119 --> 00:02:05,630
was changing, that was evolving, that was
growing

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00:02:05,630 --> 00:02:07,830
and some of the things were, well, we figured it

40
00:02:07,830 --> 00:02:11,860
out it. And it was just a matter of optimising and getting it just a little bit better. But

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00:02:11,860 --> 00:02:13,790
I wanted something that was rapidly changing

42
00:02:13,790 --> 00:02:17,470
and with computers and control systems, that seemed

43
00:02:17,470 --> 00:02:18,470
like the place to be.

44
00:02:18,470 --> 00:02:22,470
- This is just like an internship or something
that you ended up jumping in or were you working

45
00:02:22,470 --> 00:02:23,470
in the field?

46
00:02:23,470 --> 00:02:26,150
- I found a professor that I really liked
working

47
00:02:26,150 --> 00:02:29,370
with and so was working that, and involved
with an

48
00:02:29,370 --> 00:02:31,940
internship with JPL, down at JPL.

49
00:02:31,940 --> 00:02:34,110
- Our friends in the south.

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00:02:34,110 --> 00:02:37,150
- Yeah, exactly. And then afterwards, I was
just

51
00:02:37,150 --> 00:02:44,580
looking at places that did the kind of algorithms
and math and engineering that I had learned

52
00:02:44,580 --> 00:02:47,470
to do in grad school and found my way here.

53
00:02:47,470 --> 00:02:48,470
- Nice.

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00:02:48,470 --> 00:02:50,660
- I met people at a conference, came and gave a

55
00:02:50,660 --> 00:02:53,050
presentation and received an offer.

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00:02:53,050 --> 00:02:55,800
- Awesome. We'll go a little bit more into
some

57
00:02:55,800 --> 00:02:59,430
of the stuff you are working on and some stuff that Terry is working on. And, of course,

58
00:02:59,430 --> 00:03:01,941
we'll get questions from the chat. Folks, if you

59
00:03:01,941 --> 00:03:06,379
are joining us, you are watching the second ever

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00:03:06,379 --> 00:03:09,990
episode of the NASA…NASA in Silicon Valley Live.

61
00:03:09,990 --> 00:03:13,409
This is a conversational show on Twitch TV. With

62
00:03:13,409 --> 00:03:16,560
various researchers, scientists, engineers
and all

63
00:03:16,560 --> 00:03:19,330
round cool people at NASA. Specifically, here at

64
00:03:19,330 --> 00:03:23,310
NASA's Ames Research Center in Silicon Valley. So,

65
00:03:23,310 --> 00:03:26,709
as I mentioned at our premier episode, we
are

66
00:03:26,709 --> 00:03:29,709
trying something new here. We are basically taking

67
00:03:29,709 --> 00:03:32,990
the audio podcast and doing it live on Twitch. And

68
00:03:32,990 --> 00:03:35,220
so, last time we had a lot of fun talking
about

69
00:03:35,220 --> 00:03:42,980
the moon and today, we are talking about
self-driving robot, planes and automobiles.

70
00:03:42,980 --> 00:03:47,409
- First and foremost a shout out to the live
audience on the chat. We are going to kick

71
00:03:47,409 --> 00:03:50,530
things off by talking with our guests and we're going

72
00:03:50,530 --> 00:03:52,610
to try to answer as many questions as possible

73
00:03:52,610 --> 00:03:55,550
from the chat and based off of last time, we're

74
00:03:55,550 --> 00:03:57,870
going to try some rapid fire questions at the very

75
00:03:57,870 --> 00:04:01,290
end, so don't be shy, send in as many questions

76
00:04:01,290 --> 00:04:04,129
as you can. Or just feel free to just send emotes

77
00:04:04,129 --> 00:04:06,200
and spam that at us non-stop in the chat, because

78
00:04:06,200 --> 00:04:08,910
we're going to be looking at it. So, I am
your

79
00:04:08,910 --> 00:04:12,060

host, Matthew Buffington and this time my
host

80
00:04:12,060 --> 00:04:17,669
Abby Tabor will be looking and taking the
questions from the chat. So good luck with

81
00:04:17,669 --> 00:04:18,669
that Abby.

82
00:04:18,669 --> 00:04:19,970
- Oh yes, thank you very much. I look forward to

83
00:04:19,970 --> 00:04:22,970
the challenge. And first of all, we already
have

84
00:04:22,970 --> 00:04:27,820
some action. So let me say hello to [CafeMedfica].
I'm going to butcher your handle, sorry about

85
00:04:27,820 --> 00:04:31,230
that. Hello from Sweden and [Rigaydee], hello there

86
00:04:31,230 --> 00:04:34,990
to you too. And now, let me introduce our guests.

87
00:04:34,990 --> 00:04:40,190
Right here next to me I have Terry Fong, chief roboticist at NASA Ames and the lead of the

88
00:04:40,190 --> 00:04:42,320
Intelligent Robotics Group here, right?

89
00:04:42,320 --> 00:04:43,320
-Yep!

90
00:04:43,320 --> 00:04:44,321
- Excellent, we gotta hear what all of that
that

91
00:04:44,321 --> 00:04:50,449
means in a minute and right down there, Diana Acosta, aerospace engineer with the Intelligent

92
00:04:50,449 --> 00:04:52,610
Systems Division at Ames, right?

93
00:04:52,610 --> 00:04:53,610
- Right.

94
00:04:53,610 --> 00:04:54,642
- And you're also working on innovation I
believe.

95
00:04:54,642 --> 00:05:00,570
The NASA Innovation Collaborative Initiative. That sounds intriguing. So, you'll tell us

96
00:05:00,570 --> 00:05:01,860
more
about that later?

97
00:05:01,860 --> 00:05:02,860
- Absolutely.

98
00:05:02,860 --> 00:05:03,860
- Great. Welcome .

99
00:05:03,860 --> 00:05:09,060
- Before we get into the good stuff and talking about robots and self-driving cars, I want

100
00:05:09,060 --> 00:05:11,770
to sort through some housekeeping. We're going to

101
00:05:11,770 --> 00:05:16,360
do this podcast live and on Twitch TV/NASA, for the

102
00:05:16,360 --> 00:05:19,270
next couple of weeks. We'll be back next Friday

103
00:05:19,270 --> 00:05:23,160
at 2 o'clock, 2 p.m. Pacific time and we have a

104
00:05:23,160 --> 00:05:25,960
special treat for that episode, where we are doing

105
00:05:25,960 --> 00:05:27,860
a little bit of a "Let's Play." So, I'm sure

106
00:05:27,860 --> 00:05:30,310
that Twitch audience is a little bit familiar with

107
00:05:30,310 --> 00:05:31,830
some, there is a lot of space video games
out

108
00:05:31,830 --> 00:05:35,570
there. So, get ready for that for next week.
But

109
00:05:35,570 --> 00:05:40,009
for this week, just to let you know, we really
want your feedback. We are figuring this all

110
00:05:40,009 --> 00:05:43,949
out, trying to - any feedback, advice, stuff you

111
00:05:43,949 --> 00:05:47,050
want to tell us, just let us know. If you cannot

112
00:05:47,050 --> 00:05:49,110
catch us live, that's no big deal. You can catch

113
00:05:49,110 --> 00:05:53,650
us on YouTube.com/NASAAmes afterwards or on podcast

114
00:05:53,650 --> 00:05:59,460

services throughout the solar system and beyond. But right now, the plan is to have the versions

115
00:05:59,460 --> 00:06:02,240
up, I think, on Monday, is we are going to
have

116
00:06:02,240 --> 00:06:04,619
those on demand versions up.

117
00:06:04,619 --> 00:06:08,520
- But, now that we have got to know Diana
and

118
00:06:08,520 --> 00:06:12,320
Terry a little bit, we can just jump right
into

119
00:06:12,320 --> 00:06:14,229
the conversation. So whenever we are talking about

120
00:06:14,229 --> 00:06:19,880
self-driving cars and in NASA-speak, we keep referring to it as autonomy. I purposely did

121
00:06:19,880 --> 00:06:23,020
not put autonomy in the title of the show because

122
00:06:23,020 --> 00:06:24,660
that was like, I don't know what that means to

123
00:06:24,660 --> 00:06:27,930
most people. So I replaced it with self-driving.

124
00:06:27,930 --> 00:06:32,080
But is that really fair or accurate? Let's talk

125
00:06:32,080 --> 00:06:34,990
a little bit about what is autonomy? So, Terry..

126

00:06:34,990 --> 00:06:36,730
- Autonomy means that you do things by yourself. I

127
00:06:36,730 --> 00:06:41,120
mean, it's a simple as that. I mean, my cat's
autonomous. My kids are autonomous. Probably

128
00:06:41,120 --> 00:06:45,480
more autonomous than I want oftentimes. Robots

129
00:06:45,480 --> 00:06:48,410
can be autonomous and that really just means that

130
00:06:48,410 --> 00:06:52,190
they can go off and do things and achieve goals

131
00:06:52,190 --> 00:06:55,230
or
objectives that they are carrying out by

132
00:06:55,230 --> 00:06:58,240
themselves. And whether it is self-driving
or

133
00:06:58,240 --> 00:06:59,940
autonomous, frankly, I don't care. It just
means

134
00:06:59,940 --> 00:07:02,050
that hey, they are off independent, I don't
have

135
00:07:02,050 --> 00:07:04,289
to be hands on, I am not joy sticking them,
I say

136
00:07:04,289 --> 00:07:06,740
hey go do something and hopefully they will get

137

00:07:06,740 --> 00:07:07,740
something done.

138
00:07:07,740 --> 00:07:09,349
- Yeah, a lot of people make references to
joy

139
00:07:09,349 --> 00:07:12,949
sticking it. So, this is literally like a
video

140
00:07:12,949 --> 00:07:16,690
game? You're driving the rover or you're driving the machine, you are operating it. That's

141
00:07:16,690 --> 00:07:17,690
the idea?

142
00:07:17,690 --> 00:07:19,810
- Yeah, I mean. People look at NASA, they
think,

143
00:07:19,810 --> 00:07:21,810
Oh, my God you have the most advanced robots out

144
00:07:21,810 --> 00:07:24,520
there, but sometimes we are joy sticking it
and

145
00:07:24,520 --> 00:07:26,880
that literally means we have hands on the
joy

146
00:07:26,880 --> 00:07:32,630
sticks or we use the technical terms: hand
controllers. And we control how robots move,

147
00:07:32,630 --> 00:07:34,800
whether their arms, robot arms or or they're
free

148
00:07:34,800 --> 00:07:39,669
flying systems or rovers. A lot of what we
try to

149
00:07:39,669 --> 00:07:43,449
do these days, at least in research and
development, is to go beyond that. We want

150
00:07:43,449 --> 00:07:45,750
the robots to be, you know, more independent.

151
00:07:45,750 --> 00:07:48,680
I don't want to joy stick my kids to say, go left,

152
00:07:48,680 --> 00:07:52,150
go right, stop, come back. I say hey, go mow

153
00:07:52,150 --> 00:07:54,510
the lawn or go to the store and get something for me.

154
00:07:54,510 --> 00:07:55,939
And
I want robots to do the same thing.

155
00:07:55,939 --> 00:08:02,169
- I have a question here that might be relevant. [Radiateurs], maybe? Are you going to talk

156
00:08:02,169 --> 00:08:05,370
about deep learning or neural networks? Genetic

157
00:08:05,370 --> 00:08:09,120
algorithms? What kinds of things are controlling these robots that connect independently.

158
00:08:09,120 --> 00:08:11,330
- Well, I mean there are lots of different
things

159
00:08:11,330 --> 00:08:14,190

you can use to make these robots or systems in

160
00:08:14,190 --> 00:08:18,849
general more independent. There is a tremendous amount of research going on today involving

161
00:08:18,849 --> 00:08:23,460
machine learning, deep learning, AI. All these different words you hear out there, but at

162
00:08:23,460 --> 00:08:25,840
the end of the day it is trying to make the system

163
00:08:25,840 --> 00:08:29,930
function more intelligently or in a way that
seems

164
00:08:29,930 --> 00:08:32,520
more intelligent. That is, you want it to
be more

165
00:08:32,520 --> 00:08:38,580
capable, more competent. You want it to do something in a way that seems to make sense.

166
00:08:38,580 --> 00:08:41,979
I look at like a, like a… Lots of robot vacuum

167
00:08:41,979 --> 00:08:42,979
cleaner out there.

168
00:08:42,979 --> 00:08:44,101
- Like the Roombas and stuff.

169
00:08:44,101 --> 00:08:46,320
- Like a Roombas you see. Roombas can do a great

170
00:08:46,320 --> 00:08:48,360
job, but you look at them and you have no
idea

171

00:08:48,360 --> 00:08:49,839
what they are doing, because they are kind
of

172
00:08:49,839 --> 00:08:52,450
wandering around and bumping into stuff. It is

173
00:08:52,450 --> 00:08:56,930
not really clear, you know, how they are cleaning. And so I look at that, is that intelligent?

174
00:08:56,930 --> 00:08:59,960
Well, if I watch it, it certainly doesn't look

175
00:08:59,960 --> 00:09:01,460
intelligent but it can still do a good job.

176
00:09:06,600 --> 00:09:02,770
- It gets the job done.

177
00:09:06,600 --> 00:09:08,740
lawnmower patterns and it's very obvious what they

178
00:09:08,740 --> 00:09:12,640
are doing and you think, that looks more
intelligent because it is doing this in a,

179
00:09:12,640 --> 00:09:16,640
you know, very careful way. And a way that's very

180
00:09:16,640 --> 00:09:19,510
efficient. But I look at a Roomba it is doing
this

181
00:09:19,510 --> 00:09:22,830
kind of stuff, yeah, I'm not sure how smart
is

182
00:09:22,830 --> 00:09:25,170
that.

183
00:09:25,170 --> 00:09:26,399
- How does that match into some of the work that

184
00:09:26,399 --> 00:09:27,571
you are doing Diana? Because I know you and Terry

185
00:09:27,571 --> 00:09:32,981
work quite a bit, but as a fancy aerospace
engineer. How does one go from aerospace engineer

186
00:09:32,981 --> 00:09:39,760
to working on autonomous systems? I'm guessing
that aviation… How does that work?

187
00:09:39,760 --> 00:09:43,470
- Actually, when I was studying aerospace
engineering, I focused on machine learning

188
00:09:43,470 --> 00:09:46,610
in terms of being able to not collect an abundance

189
00:09:46,610 --> 00:09:49,860
of data but be able to take the data that
you are

190
00:09:49,860 --> 00:09:51,279
receiving at the time from all the sensors
that

191
00:09:51,279 --> 00:09:55,111
on the aircraft or spacecraft or airship and
be

192
00:09:55,111 --> 00:09:58,410
able to utilise that in a smart way. Learn
from

193
00:09:58,410 --> 00:10:01,550

it and then control that vehicle in a way
that

194
00:10:01,550 --> 00:10:03,400
will be successful to achieve the goals. It
is

195
00:10:03,400 --> 00:10:06,130
quite a bit different than the big data that
is

196
00:10:06,130 --> 00:10:10,690
going on within industry, around us, especially in Silicon Valley, where they have a lot of

197
00:10:10,690 --> 00:10:13,200
data that they are collecting and they are using

198
00:10:13,200 --> 00:10:16,459
that to be able to, in general, assist the humans

199
00:10:16,459 --> 00:10:19,070
and provide information to the humans or make

200
00:10:19,070 --> 00:10:22,230
sound business decisions. In our cases, whether

201
00:10:22,230 --> 00:10:25,720
it's a robot or a spacecraft or an aircraft, we are

202
00:10:25,720 --> 00:10:29,589
looking at taking that data and being able
to let

203
00:10:29,589 --> 00:10:32,790
the robot or the aircraft or the spacecraft
make

204
00:10:32,790 --> 00:10:36,260
the decision itself. And act on that decision. So

205
00:10:36,260 --> 00:10:39,980
I think that's the differentiator between
what we

206
00:10:39,980 --> 00:10:42,040
see outside the gate and what we are doing
on the

207
00:10:42,040 --> 00:10:43,040
inside.

208
00:10:43,040 --> 00:10:44,040
- OK.

209
00:10:44,040 --> 00:10:45,040
- I'm not sure the chat is blowing up..

210
00:10:45,040 --> 00:10:49,230
- Yeah, it is. I'm already way behind in
questions. [Valask] is saying" I can get behind

211
00:10:49,230 --> 00:10:52,540
self-driving cars. With self-driving planes
is it

212
00:10:52,540 --> 00:10:56,040
the same idea of autonomy? is it a lesser
degree

213
00:10:56,040 --> 00:10:58,520
of independence for a plane than a car?"

214
00:10:58,520 --> 00:11:02,480
- You know, airplanes have been self-flying
for

215
00:11:02,480 --> 00:11:03,480
decades.

216
00:11:03,480 --> 00:11:04,480
-Okay. Interesting.

217
00:11:04,480 --> 00:11:08,360
- We have been flying with auto pilots, and
flight

218
00:11:08,360 --> 00:11:13,641
management systems, and the pilot can get in, make

219
00:11:13,641 --> 00:11:20,261
sure the company programed the route correctly, and go. Now, they are fully responsible, as

220
00:11:20,261 --> 00:11:22,860
a pilot, when you're going on a trip, they are

221
00:11:22,860 --> 00:11:25,190
fully responsible for the safety of that aircraft

222
00:11:25,190 --> 00:11:29,529
and monitoring all the various systems. It is

223
00:11:29,529 --> 00:11:33,089
incredibly complicated. But aircraft, they
have a

224
00:11:33,089 --> 00:11:37,970
nice safety buffer between them and other
aircraft. It's pretty predictable. We understand

225
00:11:37,970 --> 00:11:40,481
the impacts of weather and other contingencies. We

226
00:11:40,481 --> 00:11:46,440
know how to handle that. So, in a way I see
aircraft as being on the forefront of that

227

00:11:46,440 --> 00:11:51,529
self-driving or self-flying area, and it's
a lot

228
00:11:51,529 --> 00:11:54,970
further ahead of the game. The car is so much more

229
00:11:54,970 --> 00:11:58,970
challenging with all the dynamics. You know, cars

230
00:11:58,970 --> 00:12:04,410
and kids and pedestrians and weather and sun and

231
00:12:04,410 --> 00:12:07,170
oh, it is very complicated. And…

232
00:12:07,170 --> 00:12:09,100
- I have a question about weather. What sort of

233
00:12:09,100 --> 00:12:11,649
considerations have weather conditions had on

234
00:12:11,649 --> 00:12:15,529
designs of self-driving vehicles? Do you know how

235
00:12:15,529 --> 00:12:16,529
that's considered?

236
00:12:16,529 --> 00:12:18,930
- I will ask Terry to take that one.

237
00:12:18,930 --> 00:12:21,660
- Well, so we do a lot of work these days
and

238
00:12:21,660 --> 00:12:27,279
trying to make robots function more robustly across all kinds of conditions. Whether it's

239

00:12:27,279 --> 00:12:31,970
weather, or frankly, traffic patterns or
congestion, all kinds of different things.

240
00:12:31,970 --> 00:12:35,790
In terms of cars, we have been working with some

241
00:12:35,790 --> 00:12:39,470
companies in Silicon Valley that work on
self-driving cars. A lot of the challenges

242
00:12:39,470 --> 00:12:42,440
have to do with the fact they all rely on sensor data.

243
00:12:42,440 --> 00:12:45,589
You know, cameras, radars, laser systems, to

244
00:12:45,589 --> 00:12:47,910
understand what's around them. And if you
have

245
00:12:47,910 --> 00:12:50,339
weather, which fortunately we don't have is
a

246
00:12:50,339 --> 00:12:52,809
whole lot here in Silicon Valley, then you...

247
00:12:52,809 --> 00:12:55,160
- You have the best weather.

248
00:12:55,160 --> 00:12:56,160
-[Crosstalk] We have the best weather.

249
00:12:56,160 --> 00:13:00,350
- We don't get rain and fog and snow and sleet, those are the kind of things which make all

250
00:13:00,350 --> 00:13:03,680
the sensors stop functioning. It's lile any of

251
00:13:03,680 --> 00:13:06,290
us trying to drive on the roads by saving "Hey,

252
00:13:06,290 --> 00:13:08,450
okay, where am I going to go next?" The answer is,

253
00:13:08,450 --> 00:13:10,850
it's really hard if you can't see. The same is

254
00:13:10,850 --> 00:13:13,089
true about self-driving cars and robots.

255
00:13:13,089 --> 00:13:19,220
- Okay, right. Along the lines but specifically
about GPS, [Cafe Medfica] is asking, is NASA

256
00:13:19,220 --> 00:13:21,820
working with big car makers to make GPS better for

257
00:13:21,820 --> 00:13:24,109
self-driving cars? Is that an important part?

258
00:13:24,109 --> 00:13:30,070
- I don't know if anyone across NASA is doing that. I mean, GPS is used a lot, not just

259
00:13:30,070 --> 00:13:34,020
in terms of like cars, but terrestrial robots. Agricultural

260
00:13:34,020 --> 00:13:39,870
robots, drones. They all rely on GPS for
understanding where they are in the world

261
00:13:39,870 --> 00:13:42,690
but the reality is for things like automobiles, it

262
00:13:42,690 --> 00:13:45,790
is not sufficient just to rely on GPS. You need to

263
00:13:45,790 --> 00:13:48,949
worry, for example, am I exactly right next to the

264
00:13:48,949 --> 00:13:50,779
car, you will not tell that from GPS.

265
00:13:50,779 --> 00:13:51,779
-It's a finer scale?

266
00:13:51,779 --> 00:13:52,931
- It's a finer scale. So, you're going to
need

267
00:13:52,931 --> 00:13:56,720
other sensors. We rely on all kinds of things to

268
00:13:56,720 --> 00:14:01,279
give us very precise positioning information, especially how close to objects that we might

269
00:14:01,279 --> 00:14:04,079
want to stay away from. And so that's far beyond

270
00:14:04,079 --> 00:14:05,079
GPS.

271
00:14:05,079 --> 00:14:06,079
- Yeah.

272
00:14:06,079 --> 00:14:09,699
- I will jump on in, because if you are just
joining us now you are watching NASA in Silicon

273
00:14:09,699 --> 00:14:12,790
Valley Live. A new conversational show that we are

274
00:14:12,790 --> 00:14:16,850
trying out on Twitch.tv/NASA and are chatting with

275
00:14:16,850 --> 00:14:22,010
Terry and with Diana about self-driving robots, planes and automobiles. So, we're going to

276
00:14:22,010 --> 00:14:24,480
keep taking as many questions as we possibly can.

277
00:14:24,480 --> 00:14:26,300
But I gotta jump in. Because there was one thing

278
00:14:26,300 --> 00:14:28,779
where, when we the podcast, Terry and I were talking.

279
00:14:28,779 --> 00:14:31,100
We were talking about the early days of autonomy,

280
00:14:31,100 --> 00:14:34,589
you
were talking about 3D mapping and how even

281
00:14:34,589 --> 00:14:38,060
some of
your early work with VR, helped kind of play

282
00:14:38,060 --> 00:14:40,959
into
some of that. So, maybe we can talk about

283
00:14:40,959 --> 00:14:44,350
some of the early days and I think not like self-driving

284
00:14:44,350 --> 00:14:47,480
cars and VR, very much buzzwords, anybody who is

285
00:14:47,480 --> 00:14:49,880
into gaming, is hearing all about that. So,
talk

286

00:14:49,880 --> 00:14:52,000
about some of the early days and I'm pretty
sure

287
00:14:52,000 --> 00:14:54,459
Bill over in the back has some cool images
that

288
00:14:54,459 --> 00:14:55,779
we're going to pop on up.

289
00:14:55,779 --> 00:14:59,420
- So, I mean, a lot of people think that VR
is

290
00:14:59,420 --> 00:15:01,199
something that just happened a couple of years ago

291
00:15:01,199 --> 00:15:05,500
but this is actually the third or fourth wave.
Actually, the picture that's up here was from

292
00:15:05,500 --> 00:15:07,830
about 1990 or so. There was a lot of research and

293
00:15:07,830 --> 00:15:11,140
development here at NASA Ames and Silicon Valley,

294
00:15:11,140 --> 00:15:12,970
looking at different VR headsets. You look
at

295
00:15:12,970 --> 00:15:15,440
this, and it looks kind of clunky, but at
the same

296
00:15:15,440 --> 00:15:17,780
time it has a lot of things you see today.
It's

297
00:15:17,780 --> 00:15:20,199
just that today, they are a hundred times
cheaper,

298
00:15:20,199 --> 00:15:25,810
they are higher resolution. But, some of the
basic fundamentals of how to put people in

299
00:15:25,810 --> 00:15:28,820
these virtual worlds was done here at Ames. And

300
00:15:28,820 --> 00:15:29,820
we used that…

301
00:15:29,820 --> 00:15:30,820
- That's awesome!

302
00:15:30,820 --> 00:15:32,019
- …a long time ago because we were interested of

303
00:15:32,019 --> 00:15:34,840
transporting scientists to other worlds. The
idea

304
00:15:34,840 --> 00:15:38,050
that you could remotely explore Mars by using a

305
00:15:38,050 --> 00:15:40,329
head mounted display, maybe you have some data

306
00:15:40,329 --> 00:15:43,140
glove on. Maybe you're trying to reach out
and

307
00:15:43,140 --> 00:15:46,190
manipulate a virtual rock. These were the
kinds of

308

00:15:46,190 --> 00:15:47,800
things that we were really interested in,
you

309
00:15:47,800 --> 00:15:51,130
know, even back 30 years ago at the previous wave.

310
00:15:51,130 --> 00:15:54,330
Or maybe it was two or three waves ago of
VR. But

311
00:15:54,330 --> 00:16:01,110
for us, at NASA, it's all about how can you
better touch the data and immersive 3D, rendering

312
00:16:01,110 --> 00:16:03,381
3D user interfaces, head-mounted displays.
That's

313
00:16:03,381 --> 00:16:09,279
all part of that. This is actually, the screen
shot here is from a robot control interface

314
00:16:09,279 --> 00:16:13,230
that we developed here back around 1992, it was

315
00:16:13,230 --> 00:16:16,310
called VEVI. It was the Virtual Environment Vehicle

316
00:16:16,310 --> 00:16:20,829
Interface. It wasn't a particularly good acronym, but the idea here was we could use it to remotely

317
00:16:20,829 --> 00:16:24,150
operate robots by way of a VR interface. So
we

318
00:16:24,150 --> 00:16:27,370
control the robot in VR. It sends commands
to the

319
00:16:27,370 --> 00:16:30,350
actual robot, which might have been thousands of

320
00:16:30,350 --> 00:16:33,370
miles away or even on other planets. The idea here

321
00:16:33,370 --> 00:16:35,639
is that we interact with the data and that
allows

322
00:16:35,639 --> 00:16:37,949
us to better understand what's going on with the

323
00:16:37,949 --> 00:16:40,130
robot and then the robot can go off and do
its own

324
00:16:40,130 --> 00:16:41,130
work.

325
00:16:41,130 --> 00:16:43,269
- Alright. Abby, how is the chat going?

326
00:16:43,269 --> 00:16:44,779
- Oh, my gosh.

327
00:16:44,779 --> 00:16:46,790
- It is blowing up.

328
00:16:46,790 --> 00:16:49,900
- Our friend [CafeMedfica]: "Dope show, thank you

329
00:16:49,900 --> 00:16:57,459
very much." And Diana. How will, from [Jay
Stubbles], how will automated aircraft handle

330
00:16:57,459 --> 00:17:00,029
perilous situations such as bird strike? Will

it

331
00:17:00,029 --> 00:17:04,280
look like a landing solution? Like Sully
Sullenberger's Hudson River landing? Like

332
00:17:04,280 --> 00:17:05,890
in the movie Sully.

333
00:17:05,890 --> 00:17:12,640
- Absolutely. Actually, one of our colleagues,
David Smith, he's actually retiring today,

334
00:17:12,640 --> 00:17:15,990
so shout out to David. And he developed an emergency

335
00:17:15,990 --> 00:17:18,500
landing planner with some of our colleagues
and

336
00:17:18,500 --> 00:17:25,000
what it does is, that flight management system
where the company can put in the route and

337
00:17:25,000 --> 00:17:27,420
the aircraft can follow from one point to another

338
00:17:27,420 --> 00:17:31,419
to another. The emergency landing planner helps

339
00:17:31,419 --> 00:17:35,800
to look at where the aircraft is, given the

340
00:17:35,800 --> 00:17:37,360
circumstance, whether it's a bird strike,
an

341
00:17:37,360 --> 00:17:40,789
engine out, fire, whatever the emergency might

be,

342
00:17:40,789 --> 00:17:43,990
and take into account all of the airports
within

343
00:17:43,990 --> 00:17:47,440
the area and what emergency services they
have,

344
00:17:47,440 --> 00:17:49,520
and any weather that's between the aircraft
and

345
00:17:49,520 --> 00:17:53,450
those landing points. And then it develops
a

346
00:17:53,450 --> 00:17:55,980
route that can also take into consideration
the

347
00:17:55,980 --> 00:18:01,820
ability of the aircraft. if you lose an engine,
you don't want to turn in certain ways. You

348
00:18:01,820 --> 00:18:04,570
want to turn one way or the other. If you lose

349
00:18:04,570 --> 00:18:06,350
part of your tail, you certainly don't want to be

350
00:18:06,350 --> 00:18:09,280
doing certain maneuvers. So it can take into the

351
00:18:09,280 --> 00:18:13,450
maneuverability… take into account that
maneuverability of the aircraft and provide

352

00:18:13,450 --> 00:18:16,530
routes and suggested landing points for the pilots.

353
00:18:16,530 --> 00:18:21,100
And give even explanations as to why this airport,

354
00:18:21,100 --> 00:18:23,200
why not that one. I can see that one, that one

355
00:18:23,200 --> 00:18:26,920
is over there, and so it helps drill down. So David

356
00:18:26,920 --> 00:18:29,140
Smith along with colleagues in the Intelligent Systems

357
00:18:29,140 --> 00:18:32,950
Division and the Human Systems Interaction
or

358
00:18:32,950 --> 00:18:36,140
Integration Division have worked that out
and

359
00:18:36,140 --> 00:18:38,940
yeah, absolutely, we're making progress, here
at

360
00:18:38,940 --> 00:18:39,940
Ames.

361
00:18:39,940 --> 00:18:42,860
- Awesome. Cool to hear about. A couple of
more

362
00:18:42,860 --> 00:18:47,520
comments. [Noxum96] likes I'm smiling at the
laptop all the time because this chat is crazy.

363
00:18:47,520 --> 00:18:48,670

[Laughter]

364
00:18:48,670 --> 00:18:50,630
- Thanks for noticing! [LaraBug] says "Thanks
so

365
00:18:50,630 --> 00:18:55,200
much for doing this stream." And here's an
interesting one. [YoungReefer] asks "If these

366
00:18:55,200 --> 00:18:57,850
self-driving things are using AI, can they
take on

367
00:18:57,850 --> 00:19:00,110
solutions they have created themselves? "

368
00:19:00,110 --> 00:19:01,910
- Yeah, that's a great question. And I hope
the

369
00:19:01,910 --> 00:19:10,080
answer is yes. Because I don't believe that
anyone, certainly not me or people necessarily

370
00:19:10,080 --> 00:19:13,480
here at NASA have all the answers. In fact,
what

371
00:19:13,480 --> 00:19:15,560
we really would like are systems that can
be

372
00:19:15,560 --> 00:19:18,230
adaptive to the world. It is really difficult
to

373
00:19:18,230 --> 00:19:22,880
sort of like program a system for every single
thing that could possibly happen. In fact,

374
00:19:22,880 --> 00:19:24,260
we don't train ourselves to do that. When you

375
00:19:24,260 --> 00:19:26,640
teach someone to drive a car, it is not like these

376
00:19:26,640 --> 00:19:28,100
are
the 100 things you you're ever going to encounter

377
00:19:28,100 --> 00:19:30,669
and only these hundred. Instead, you try to
teach

378
00:19:30,669 --> 00:19:33,480
them how to deal with different things. Oh
hey! A

379
00:19:33,480 --> 00:19:35,531
tree fell down on the road. Or maybe, for
some

380
00:19:35,531 --> 00:19:37,640
reason there is a cow in the middle of the
street.

381
00:19:37,640 --> 00:19:40,210
At least maybe not around Mountain View, but
in

382
00:19:40,210 --> 00:19:43,620
some places, that could happen. And so we
want are

383
00:19:43,620 --> 00:19:46,150
systems that can really learn or at least
adapt to

384

00:19:46,150 --> 00:19:49,050
changing circumstances. That it's not stuff
we

385
00:19:49,050 --> 00:19:50,050
programmed.

386
00:19:50,050 --> 00:19:53,070
- Yeah, it's gotta be. Especially if that's
space exploration, right? We don't know what

387
00:19:53,070 --> 00:19:54,399
we we're going to find on Mars.

388
00:19:54,399 --> 00:19:55,399
- That's true.

389
00:19:55,399 --> 00:19:57,500
- So the challenge for us, as developers,
as

390
00:19:57,500 --> 00:20:00,860
humans, is to really blow out that space of
what

391
00:20:00,860 --> 00:20:05,630
could be the possibilities so that the computer
can really fill in its knowledge. And then

392
00:20:05,630 --> 00:20:06,630
act on that knowledge.

393
00:20:06,630 --> 00:20:11,420
- Isn't that not too different from the humans?
What you actually physically see, your brain

394
00:20:11,420 --> 00:20:14,441
fills in a lot of gaps. Because I mean, it is how

395

00:20:14,441 --> 00:20:16,790
optical illusions and stuff work. I would
imagine

396
00:20:16,790 --> 00:20:20,140
that robots, the software has to take short
cuts

397
00:20:20,140 --> 00:20:23,120
as well, to be more efficient, I'm guessing?

398
00:20:23,120 --> 00:20:26,660
- I think that humans make a lot of guesses
and

399
00:20:26,660 --> 00:20:28,659
some of those guesses are hopefully educated.
I

400
00:20:28,659 --> 00:20:32,310
mean, in general, we don't let drive until
they

401
00:20:32,310 --> 00:20:34,929
have learned how to drive and pass the test
and

402
00:20:34,929 --> 00:20:37,559
did a road test and that kind of thing. And
maybe

403
00:20:37,559 --> 00:20:41,659
at some point in time we going to have something
similar for say, self driving cars or robots

404
00:20:41,659 --> 00:20:44,380
as well. Because one of the, I guess real problems

405
00:20:44,380 --> 00:20:47,539
we have, is that when you guess, usually you

406
00:20:47,539 --> 00:20:49,400
will guess right. At least humans, we like to believe

407
00:20:49,400 --> 00:20:51,400
we can guess right, but you're right. There
are

408
00:20:51,400 --> 00:20:57,070
times we guess wrong or we have incomplete
information and we make a mistake. Those are

409
00:20:57,070 --> 00:20:59,539
things that I do worry about as well for any
sort

410
00:20:59,539 --> 00:21:04,160
of autonomous vehicle or robot tjat we create.
Whether or not… are they going to make the

411
00:21:04,160 --> 00:21:05,710
wrong assumption? Are they going to leap to the

412
00:21:05,710 --> 00:21:09,419
wrong conclusion? But we'll see.

413
00:21:09,419 --> 00:21:11,289
- Do you have more, Abby?

414
00:21:11,289 --> 00:21:17,510
- Yeah. I hesitated because was a long handle
that I had trouble pronouncing. So, [TigerionDono]

415
00:21:17,510 --> 00:21:20,700
was asking… Sorry, wait. I mixed up a couple
of

416
00:21:20,700 --> 00:21:23,582
people. [Post VT] wanted to know what are

your

417
00:21:23,582 --> 00:21:25,260
thoughts on AI and self learning tech. Do
you

418
00:21:25,260 --> 00:21:27,420
think this could cause problems in future?
If so

419
00:21:27,420 --> 00:21:29,590
why. I think we touched on that.

420
00:21:29,590 --> 00:21:31,450
- It's always the SkyNet reference.

421
00:21:31,450 --> 00:21:33,720
- Yeah, sure. SkyNet and whatever else is
going to

422
00:21:33,720 --> 00:21:36,101
come take over the world. I tell you, one
of the

423
00:21:36,101 --> 00:21:39,011
things we worry a lot about at NASA, because
we

424
00:21:39,011 --> 00:21:44,330
tend to build systems that are very expensive,
then they go to space or they're flight systems,

425
00:21:44,330 --> 00:21:46,429
is how do you really sort of test and make
sure

426
00:21:46,429 --> 00:21:49,750
they will work as predicted? You know, the
terms

427
00:21:49,750 --> 00:21:54,059
that we typically use are things like
verification, validation, certification, all

428
00:21:54,059 --> 00:21:57,830
those "-ation" kind of things. But that really means,

429
00:21:57,830 --> 00:22:03,600
can you make sure they going to work as planned?
And as soon as you let something learn, and

430
00:22:03,600 --> 00:22:06,471
adapt, the question is how do you test that? That's

431
00:22:06,471 --> 00:22:08,659
a really difficult thing and I am not sure we

432
00:22:08,659 --> 00:22:11,350
really have the answers. Maybe Diana has some great

433
00:22:11,350 --> 00:22:12,980
thoughts about that.

434
00:22:12,980 --> 00:22:16,130
- No, we certainly don't have the answers
there.

435
00:22:16,130 --> 00:22:19,820
When we are not aiming for the highest goal,
we

436
00:22:19,820 --> 00:22:22,670
can certainly let the systems learn, let them
make

437
00:22:22,670 --> 00:22:25,840
decisions but then give them that boundary.
Like

438
00:22:25,840 --> 00:22:27,960
you might a child, putting the child in the
play

439
00:22:27,960 --> 00:22:31,111
yard, and the play yard is fenced. Go off,
have

440
00:22:31,111 --> 00:22:34,500
fun, I know you're not getting past that fence.
So

441
00:22:34,500 --> 00:22:40,390
we can do that with our robots and with our
systems that we equip with AI, but once we

442
00:22:40,390 --> 00:22:43,610
recognise that we want the robots to achieve
more,

443
00:22:43,610 --> 00:22:46,220
we want them to accomplish more and serve
us

444
00:22:46,220 --> 00:22:48,830
better for the NASA missions, we have to take
down

445
00:22:48,830 --> 00:22:54,020
the fence and trust them. So how do you establish
that trust, if you are putting millions of

446
00:22:54,020 --> 00:22:56,880
dollars into that mission? Or you are the scientist

447
00:22:56,880 --> 00:22:59,620
who waited your whole life to get the data from

448
00:22:59,620 --> 00:23:02,299

that mission? Verification and validation, certainly

449
00:23:02,299 --> 00:23:03,299
important.

450
00:23:03,299 --> 00:23:09,730
- Now, I do want to get to [TigerionDono's]
question. It's a great question. Lots of science

451
00:23:09,730 --> 00:23:15,210
produces lots of data. More than can retained.
For example, CERN's Large Hadron Collider,

452
00:23:15,210 --> 00:23:17,790
the LHC. How can you teach then self-controlling

453
00:23:17,790 --> 00:23:19,770
vehicles what to send back for review and
what to

454
00:23:19,770 --> 00:23:20,770
just ignore?

455
00:23:20,770 --> 00:23:23,500
- That that is a really great question. I
think

456
00:23:23,500 --> 00:23:25,060
one thing that people may not be aware of
is that,

457
00:23:25,060 --> 00:23:27,799
every single mission that NASA sends into
space is

458
00:23:27,799 --> 00:23:29,890
capable of acquiring even more data than we
have

459

00:23:29,890 --> 00:23:32,300
ever had before. And at the same time, we
still

460
00:23:32,300 --> 00:23:37,600
have a same narrow communication pipe to send
things back to Earth. Which means, you know,

461
00:23:37,600 --> 00:23:40,130
that oftentimes we have this real problem of how

462
00:23:40,130 --> 00:23:42,410
do you sort through all the data that's collected

463
00:23:42,410 --> 00:23:44,450
and figure out what to prioritise, what to send

464
00:23:44,450 --> 00:23:49,820
back. So, it is true that it is a really challenging

465
00:23:49,820 --> 00:23:54,049
question. And I think one way to kind of address
that is to build systems that can do more

466
00:23:54,049 --> 00:23:59,570
processing on board and try to do some
interpretation of that. That's a kind of

467
00:23:59,570 --> 00:24:02,940
information we like to have used on Mars,
for

468
00:24:02,940 --> 00:24:05,890
example. We have a lot of interest of being
able

469
00:24:05,890 --> 00:24:08,481
to track these things called dust devils.
The kind

470
00:24:08,481 --> 00:24:10,960
of swirling little cyclones because they have
a

471
00:24:10,960 --> 00:24:16,180
practical use for us with our solar powered
Rovers. Spirit and Opportunity, we like to

472
00:24:16,180 --> 00:24:17,809
get them in a place where the dust can come by

473
00:24:17,809 --> 00:24:20,670
and clean off the solar panels so we have better

474
00:24:20,670 --> 00:24:21,670
energy.

475
00:24:21,670 --> 00:24:22,750
- But not too much!

476
00:24:22,750 --> 00:24:24,789
- Not too much. A gentle blow dry kind of
thing,

477
00:24:24,789 --> 00:24:27,559
you know? But in order to do that, we don't
want

478
00:24:27,559 --> 00:24:29,700
to try to loop all the data back to Earth
and make

479
00:24:29,700 --> 00:24:32,080
decisions because it takes too long and by
that

480
00:24:32,080 --> 00:24:34,360
time the dust devil would have passed and
the idea

481
00:24:34,360 --> 00:24:36,720
is to track it on board. So, that means you
have

482
00:24:36,720 --> 00:24:39,460
to do more processing of the data on board
the

483
00:24:39,460 --> 00:24:41,900
spacecraft or on board the robot. I think
that's

484
00:24:41,900 --> 00:24:42,900
where we are headed.

485
00:24:42,900 --> 00:24:45,419
- These are one of the things we talked about
in

486
00:24:45,419 --> 00:24:48,320
the podcast before. That is not just like
Mars.

487
00:24:48,320 --> 00:24:50,720
There is the speed of light. Information can
only

488
00:24:50,720 --> 00:24:53,070
travel back and forth so much and even when
you

489
00:24:53,070 --> 00:24:55,710
are out by Saturn and further out, there is
always

490
00:24:55,710 --> 00:25:00,360
going to be that delay. So you need autonomous
systems or else, the delay is going to be

491
00:25:00,360 --> 00:25:02,200
so extreme.

492
00:25:02,200 --> 00:25:05,840
- And then I was going to add. We were talking
about one system trying to communicate with

493
00:25:05,840 --> 00:25:09,830
Earth. Now, if you add multiple spacecraft and you

494
00:25:09,830 --> 00:25:11,460
need those spacecraft to communicate with each

495
00:25:11,460 --> 00:25:13,640
other to be able to acquire the data, in the right

496
00:25:13,640 --> 00:25:16,030
sequence, at the right time and be able to
fill in

497
00:25:16,030 --> 00:25:19,779
for anything that goes wrong. Prioritising
that

498
00:25:19,779 --> 00:25:26,580
data exchange, that knowledge generation across
multiple spacecraft is a problem we are working

499
00:25:26,580 --> 00:25:27,580
on.

500
00:25:27,580 --> 00:25:30,950
- Awesome. I had a question, we have talked
a lot

501
00:25:30,950 --> 00:25:35,770
about this self-driving cars. OK.
[ReynarTheConquerer] wants to know, I would

502
00:25:35,770 --> 00:25:37,880
really like to know what is NASA doing with autonomous

503
00:25:37,880 --> 00:25:43,340
vehicles other than the fact it would be required
in a rover for a pilot-based system. Basically

504
00:25:43,340 --> 00:25:44,840
you guys are probably looking forward to sending

505
00:25:44,840 --> 00:25:48,150
people to Mars, so how big of a part of your
work

506
00:25:48,150 --> 00:25:53,360
is that? Human-controlled Mars rover versus
what

507
00:25:53,360 --> 00:25:54,559
else you are working on?

508
00:25:54,559 --> 00:25:56,760
- A lot of what we are doing right now is
trying

509
00:25:56,760 --> 00:26:00,730
to make planetary robots more capable because
we

510
00:26:00,730 --> 00:26:05,549
want to send them places that are more difficult
to get to. If we want to send a robot into

511
00:26:05,549 --> 00:26:09,300
a lava
tube, for example, not so easy to have continuous

512
00:26:09,300 --> 00:26:11,760
communication when you are down underneath

the

513
00:26:11,760 --> 00:26:12,760
surface.

514
00:26:12,760 --> 00:26:13,760
- That's like a cave?

515
00:26:13,760 --> 00:26:19,250
- Like a cave robot. If you want to send robots
that are far away, as Diana was saying, if

516
00:26:19,250 --> 00:26:22,520
you go out, even just Mars, for example is 20, 40

517
00:26:22,520 --> 00:26:25,980
minutes delay, if you go beyond Mars, it is even worse.

518
00:26:25,980 --> 00:26:29,050
And so, you can't just have humans and sort of

519
00:26:29,050 --> 00:26:32,460
like real-time control kind of situations.
And so

520
00:26:32,460 --> 00:26:36,990
the key is for us to create systems that can
function by themselves. You know, maybe they

521
00:26:36,990 --> 00:26:38,410
are not going to make all decisions by themselves,

522
00:26:38,410 --> 00:26:40,250
maybe they will make decisions in some way
that's

523
00:26:40,250 --> 00:26:43,480
achieving a particular purpose, like driving
from

524
00:26:43,480 --> 00:26:48,320
point A to point B is a good example of that.
Rather than just trying to say, go discover

525
00:26:48,320 --> 00:26:50,480
stuff, you know. We might say, hey, at least go from

526
00:26:50,480 --> 00:26:52,140
this point to this point and then we will
make

527
00:26:52,140 --> 00:26:53,950
decisions about the science we are trying
to

528
00:26:53,950 --> 00:26:57,380
actually carry out. But all of that means
that we

529
00:26:57,380 --> 00:27:02,650
need the systems to be more reliable, more
autonomous, more able to make their own decisions.

530
00:27:02,650 --> 00:27:06,030
And that's a lot that we are trying to do
here.

531
00:27:06,030 --> 00:27:08,850
- And so if you think about human exploration,
you

532
00:27:08,850 --> 00:27:11,500
can also make a parallel back to your home
when

533
00:27:11,500 --> 00:27:14,610
you go to work every day or you go to school,
when

534
00:27:14,610 --> 00:27:18,700
you leave your home, you can turn the thermostat
on and trust that you will come home to a

535
00:27:18,700 --> 00:27:22,539
warm comfy place. Or if you want to have stew,

536
00:27:22,539 --> 00:27:24,700
you might turn on the crockpot and trust that

537
00:27:24,700 --> 00:27:26,620
all things will go well. And if you want clean

538
00:27:26,620 --> 00:27:28,779
clothes, you can go to bed turning on the
washer

539
00:27:28,779 --> 00:27:31,640
and throw it in the dryer when you wake up.
There

540
00:27:31,640 --> 00:27:35,510
is other things like your oven, you might
not want

541
00:27:35,510 --> 00:27:38,140
to leave on while you run to the grocery store
to

542
00:27:38,140 --> 00:27:39,140
get that extra thing.

543
00:27:39,140 --> 00:27:40,140
- [Laughter] Maybe not.

544
00:27:40,140 --> 00:27:42,760
- And when we are going to be sending humans
to

545
00:27:42,760 --> 00:27:48,820
the moon or Mars, we will want to send their habitat first. And there's many different

546
00:27:48,820 --> 00:27:51,510
mission operations, but one of the main concepts is

547
00:27:51,510 --> 00:27:53,330
have a precursor mission where we are sending the

548
00:27:53,330 --> 00:27:56,299
habitat ahead. Maybe assembling the habitat ahead

549
00:27:56,299 --> 00:27:59,940
and getting it running and operating autonomously

550
00:27:59,940 --> 00:28:02,669
before we send the humans there. Alleviate risk

551
00:28:02,669 --> 00:28:06,950
and I know this pod, or this broadcast is geared

552
00:28:06,950 --> 00:28:10,549
towards robots and airoplanes and automobiles but

553
00:28:10,549 --> 00:28:13,860
think about your habitat. Your house. It is then

554
00:28:13,860 --> 00:28:20,890
self, taking care of itself. You have to monitor all the systems, all the water, life support,

555
00:28:20,890 --> 00:28:25,290
everything. Because those humans rely on everything that we send. And that requires

556
00:28:25,290 --> 00:28:26,369
autonomy.

557
00:28:26,369 --> 00:28:28,779
- Fascinating. That's a cool comparison to
real

558
00:28:28,779 --> 00:28:29,779
life.

559
00:28:29,779 --> 00:28:31,690
- There's one thing you touched on and we
briefly

560
00:28:31,690 --> 00:28:35,110
started talking about before we even started,
you

561
00:28:35,110 --> 00:28:40,220
mentioned multiple systems and like even like
swarms of satellites and that's another thing

562
00:28:40,220 --> 00:28:42,930
that like not only just NASA but like the scientific

563
00:28:42,930 --> 00:28:45,960
community and makers and like universities
have

564
00:28:45,960 --> 00:28:48,929
been putting small sats up. Talk a little
bit how

565
00:28:48,929 --> 00:28:55,200
you could use SmallSats as a swarm? How does
autonomy play into that? And why would NASA

566
00:28:55,200 --> 00:28:56,419

be involved in this?

567
00:28:56,419 --> 00:29:01,900
- Right. So, some scientists are looking at
studying the sun and I'm not an expert in

568
00:29:01,900 --> 00:29:04,220
heliophysics but people are.

569
00:29:04,220 --> 00:29:05,890
- But I have friends.

570
00:29:05,890 --> 00:29:07,180
- We have friends.

571
00:29:07,180 --> 00:29:08,470
- We know people.

572
00:29:08,470 --> 00:29:14,429
- And they want to be able to study the
magnetosphere or the stuff that comes out

573
00:29:14,429 --> 00:29:17,789
of the sun and bombards the Earth all the time or

574
00:29:17,789 --> 00:29:21,510
gets closer to Earth and then we are protected.

575
00:29:21,510 --> 00:29:23,760
But they are look at sending multiple spacecraft.

576
00:29:23,760 --> 00:29:26,919
You can't just send one and get the data from

577
00:29:26,919 --> 00:29:31,230
one to get the big picture of the kind of the tide

578
00:29:31,230 --> 00:29:34,150

that the sun is sending out. It is really a shifting

579
00:29:34,150 --> 00:29:37,220
and dynamic tide. So, they want data points
across

580
00:29:37,220 --> 00:29:38,419
that whole tide

581
00:29:38,419 --> 00:29:39,419
A mosaic…

582
00:29:39,419 --> 00:29:44,930
- And so you think of a string or string of
satellites orbiting in this tide, and can

583
00:29:44,930 --> 00:29:49,380
we collect that data. And do that autonomously.

584
00:29:49,380 --> 00:29:52,910
Now, the reason to push towards autonomy though,

585
00:29:52,910 --> 00:29:56,370
is not that we have so many spacecraft, because we

586
00:29:56,370 --> 00:29:58,810
know how to operate one. You might say, well sure,

587
00:29:58,810 --> 00:30:01,390
let's operate 100 the same way. It does come
down

588
00:30:01,390 --> 00:30:04,279
to cost though. If we have dozens of people
to

589
00:30:04,279 --> 00:30:06,830
operate one spacecraft, what is it going to
take

590
00:30:06,830 --> 00:30:11,800
to operate 100? And if we can have the same
sized

591
00:30:11,800 --> 00:30:15,970
team for that swarm of a hundred spacecraft,
then

592
00:30:15,970 --> 00:30:18,480
we will be able to accomplish the mission.
If we

593
00:30:18,480 --> 00:30:23,460
have to multiply the team by 100 for every
spacecraft, it is beyond the budget. We won't

594
00:30:23,460 --> 00:30:25,580
be able to do it.

595
00:30:25,580 --> 00:30:30,720
- Well, let me interrupt because [BrooklynKnightz]
will like to be reminded who we all are.

596
00:30:30,720 --> 00:30:35,419
- Well, it is about that time. So if you are
just

597
00:30:35,419 --> 00:30:40,990
joining us, you are watching NASA in Silicon
Valley Live. This is a new conversational

598
00:30:40,990 --> 00:30:44,650
show that we are trying out on Twitch dot TV slash

599
00:30:44,650 --> 00:30:48,720
NASA and are chat being self-driving robots, planes

600
00:30:48,720 --> 00:30:52,020

and automobiles with Terry Fong and Diana Acosta.

601
00:30:52,020 --> 00:30:56,139
So, that's who we are.

602
00:30:56,139 --> 00:31:00,110
- I have a couple of comments to share. [monkaS]
says "Thank you for this information." People

603
00:31:00,110 --> 00:31:03,590
are
appreciating this and [PostVT\} says "This

604
00:31:03,590 --> 00:31:05,679
is actually the coolest Twitch stream, freaking

605
00:31:05,679 --> 00:31:08,410
NASA is talking to people on the internet. Like,

606
00:31:08,410 --> 00:31:10,110
what the hell." I love that.

607
00:31:10,110 --> 00:31:11,110
- Nice.

608
00:31:11,110 --> 00:31:13,140
- And then, here is a great question I want
to ask

609
00:31:13,140 --> 00:31:15,510
from [Sunny_Deity]. "How would something like
a

610
00:31:15,510 --> 00:31:18,640
self-driving car or rover deal in a catch
22

611
00:31:18,640 --> 00:31:23,809
situation? Like someone in danger from walking

across the street on a red light?"

612
00:31:23,809 --> 00:31:25,880
- That's a great question also. And it is
probably

613
00:31:25,880 --> 00:31:31,750
the single most challenging thing about making
cars or robots autonomous. How do you deal

614
00:31:31,750 --> 00:31:34,860
with the unusual situations? Especially the ones

615
00:31:34,860 --> 00:31:37,980
that are have lots of life and death consequences.

616
00:31:37,980 --> 00:31:42,090
You pull up, there is a car, you know, blocking

617
00:31:42,090 --> 00:31:43,380
everything that you can see, and all of a
sudden

618
00:31:43,380 --> 00:31:46,230
you see the ball rolling to the street. Is
that

619
00:31:46,230 --> 00:31:48,140
going to mean that there's a kid running after
it

620
00:31:48,140 --> 00:31:50,380
right away? Do you slam on the brakes or you
just

621
00:31:50,380 --> 00:31:53,909
keep going? Because that's a ball, run over
it.

622

00:31:53,909 --> 00:31:56,419
Those are things that really difficult to
deal

623
00:31:56,419 --> 00:31:58,340
with and I think that's one of the reasons
why we

624
00:31:58,340 --> 00:32:00,909
see self-driving car development still taking
a

625
00:32:00,909 --> 00:32:04,970
lot longer than some people had thought. People
are yeah, next year we will self-driving cars

626
00:32:04,970 --> 00:32:07,740
everywhere. Here in Silicon Valley you see
lots of

627
00:32:07,740 --> 00:32:11,960
self-driving cars but you still also see safety
drivers because there are all these difficult

628
00:32:11,960 --> 00:32:15,750
situations. Well, some of the situations are
ones

629
00:32:15,750 --> 00:32:19,059
that you have to react right away. The ball
and

630
00:32:19,059 --> 00:32:23,510
maybe a kid coming out on the street. Other
situations are still things that are unplanned.

631
00:32:23,510 --> 00:32:25,800
The fact you turn down a road and Oh, my God
there

632

00:32:25,800 --> 00:32:27,081
is a tree in the middle of the road, what
do I do?

633
00:32:27,081 --> 00:32:29,470
Do I drive on the wrong side of the road?
Do I

634
00:32:29,470 --> 00:32:33,010
drive on the curb? Do I back up and go around?
For

635
00:32:33,010 --> 00:32:35,640
those kinds of situations, some of the work
we

636
00:32:35,640 --> 00:32:38,320
have done here at NASA actually provides a
good

637
00:32:38,320 --> 00:32:42,799
solution. And that is the idea of having somebody
that you can phone home to. At NASA. we call

638
00:32:42,799 --> 00:32:45,690
it mission control. I know a number of self-driving

639
00:32:45,690 --> 00:32:49,559
car companies with looking at the call centers,
like support centers. Tech support, if you

640
00:32:49,559 --> 00:32:51,799
want to think of it that way. So the car might

641
00:32:51,799 --> 00:32:54,770
get in a situation, and it phones home and then some

642
00:32:54,770 --> 00:32:57,610
human will just, sort of, pop into the car, you

643
00:32:57,610 --> 00:33:00,540
know, via some 4G network data transfer, and say

644
00:33:00,540 --> 00:33:02,860
"Hey, what's going on? So, I see there is a tree

645
00:33:02,860 --> 00:33:04,710
here. Well we'll tell you that you should drive

646
00:33:04,710 --> 00:33:07,529
on the shoulder." That's an acceptable thing here

647
00:33:07,529 --> 00:33:09,559
and that's how you solve that kind of problem.

648
00:33:09,559 --> 00:33:12,710
- I imagine over time, even the system would still

649
00:33:12,710 --> 00:33:13,710
learn…

650
00:33:13,710 --> 00:33:14,710
- Yes.

651
00:33:14,710 --> 00:33:18,280
- …in the unique anomalies and these unique
situations, over time it can probably continue

652
00:33:18,280 --> 00:33:21,010
to learn what… like the correct way. - Sure.

653
00:33:21,010 --> 00:33:23,580
Exactly. So the next time you see a tree in the road,

654
00:33:23,580 --> 00:33:25,200
you think "Oh, last time it was OK to drive on

655

00:33:25,200 --> 00:33:27,320
the shoulder, so maybe we should do that again."

656
00:33:27,320 --> 00:33:29,870
Or at least, that will be the start of a possible

657
00:33:29,870 --> 00:33:31,649
solution around that problem.

658
00:33:31,649 --> 00:33:34,519
- Cool. So I think this point we can do a
little

659
00:33:34,519 --> 00:33:37,100
bit of what I have just made up in my head
called

660
00:33:37,100 --> 00:33:39,500
"Video Roulette" because I know both Diana
and

661
00:33:39,500 --> 00:33:42,030
Terry brought videos we were going to talk
on

662
00:33:42,030 --> 00:33:45,929
over. So Bill and David over in the back,
they

663
00:33:45,929 --> 00:33:49,120
going to do video. And then whoever's video
it is,

664
00:33:49,120 --> 00:33:52,680
they will talk about why they chose this one.
This

665
00:33:52,680 --> 00:33:53,680
is –

666
00:33:53,680 --> 00:33:55,840
- Who brought us this one?

667
00:33:55,840 --> 00:34:01,860
- All right, this is my video. This is a mission concept that we have had here at NASA Ames

668
00:34:01,860 --> 00:34:03,521
and it's not just about the spacecraft here, it

669
00:34:03,521 --> 00:34:05,630
is about the interesting thing that will blow

670
00:34:05,630 --> 00:34:08,311
up, which is well… expand, I should say. This

671
00:34:08,311 --> 00:34:11,119
is called super-ball. It's a robot that doesn't

672
00:34:11,119 --> 00:34:13,010
look like any robot you have seen. It's a basically

673
00:34:13,010 --> 00:34:16,369
a collection of rods and cables and here we

674
00:34:16,369 --> 00:34:19,450
are showing how the system, which is, in technical

675
00:34:19,450 --> 00:34:23,980
terms a dynamic tensegrity system, can land all

676
00:34:23,980 --> 00:34:26,991
the way from orbit and roll around. Basically, by

677
00:34:26,991 --> 00:34:29,780
controlling the length of the cables we can

change

678
00:34:29,780 --> 00:34:32,669
the overall size and shape of the robot. Here
is a

679
00:34:32,669 --> 00:34:35,919
table top model of super-ball. So you can
see we

680
00:34:35,919 --> 00:34:41,139
have the rods and the cables connect all the
different end points here and by changing

681
00:34:41,139 --> 00:34:44,909
the
lengths, we can compress, and we can expand.

682
00:34:44,909 --> 00:34:48,389
I thought you see these sold as baby or cat

683
00:34:48,389 --> 00:34:51,770
toys. But what we are trying to do is take these

684
00:34:51,770 --> 00:34:53,710
and make them from being the things that you just

685
00:34:53,710 --> 00:34:59,000
handle yourself to be ones that are true robots.
And maybe Bill… yeah, here's a picture of

686
00:34:59,000 --> 00:35:02,210
one of our current prototypes. This is super-ball

687
00:35:02,210 --> 00:35:05,670
number two here at NASA Ames and showing it can change

688
00:35:05,670 --> 00:35:07,890
its shape. It can squat all the way down.

It can

689
00:35:07,890 --> 00:35:11,100
become very, very flat, which will allow it
to

690
00:35:11,100 --> 00:35:13,120
scoot under things. It can change its shape
to

691
00:35:13,120 --> 00:35:17,750
become larger. You can imagine putting an
instrument or rocket motor in the center,

692
00:35:17,750 --> 00:35:20,950
so it can do all kinds of things. Here we have the

693
00:35:20,950 --> 00:35:24,480
3D printed little camera as an example of how

694
00:35:24,480 --> 00:35:27,640
you would put an instrument inside of this thing.

695
00:35:27,640 --> 00:35:28,921
And it is really cool. We have been doing all

696
00:35:28,921 --> 00:35:31,810
kinds of
fun - this passes for work sometimes. Drop

697
00:35:31,810 --> 00:35:35,410
tests
here. Trying to say hey can we throw a robot

698
00:35:35,410 --> 00:35:38,400
off
the top of building and see how well it survives?

699
00:35:38,400 --> 00:35:39,950

This is the kind of thing you wouldn't do
with a

700
00:35:39,950 --> 00:35:43,160
more traditional robot but allows us to to
really

701
00:35:43,160 --> 00:35:45,859
explore the whole new space of what robots
can do

702
00:35:45,859 --> 00:35:47,680
for future missions.

703
00:35:47,680 --> 00:35:48,740
- Awesome.

704
00:35:48,740 --> 00:35:49,800
- Cool.

705
00:35:49,800 --> 00:35:51,089
- Can I jump back in?

706
00:35:51,089 --> 00:35:52,700
- Go for it, Abby.

707
00:35:52,700 --> 00:35:54,421
- I just want to mention there are a couple
of

708
00:35:54,421 --> 00:35:56,530
comments about "It's Jason Bourne! and "Matt
Damon!"

709
00:35:56,530 --> 00:36:00,089
- I get the Matt Damon thing. You should see
my

710
00:36:00,089 --> 00:36:02,069

older brother. Literally looks like Matt Damon.

711
00:36:02,069 --> 00:36:05,829
- We are honored to have you with us.

712
00:36:05,829 --> 00:36:07,800
- There are a couple of questions that people
ask

713
00:36:07,800 --> 00:36:14,710
twice. I want to guess to those. [surbazmeister]
really wants to know, how is the research

714
00:36:14,710 --> 00:36:17,390
in robotics advancing in the field of asteroid

715
00:36:17,390 --> 00:36:19,220
mining? Do you know anything about that?

716
00:36:19,220 --> 00:36:25,800
- I will admit I know nothing about asteroid
mining. We do have a lot of work here at NASA

717
00:36:25,800 --> 00:36:29,260
in terms of how do you make use of resources

718
00:36:29,260 --> 00:36:32,120
on different planets. One of the biggest areas

719
00:36:32,120 --> 00:36:33,780
that we are interested in maybe they talked about

720
00:36:33,780 --> 00:36:37,170
this on the last episode, was in terms of things

721
00:36:37,170 --> 00:36:39,670
that
you can find on the moon. We are very interested

722
00:36:39,670 --> 00:36:44,840
for example in going to the moon and locating
pockets of underground water ice, because

723
00:36:44,840 --> 00:36:47,460
we care about the hydrogen that's there. So that's

724
00:36:47,460 --> 00:36:51,360
a resource and we identify a place to go mine

725
00:36:51,360 --> 00:36:53,280
that. Then we will go mine it, but it's probably

726
00:36:53,280 --> 00:36:55,349
not going to be like the mining we see here on

727
00:36:55,349 --> 00:36:59,110
Earth. We will not have giant bulldozers and big

728
00:36:59,110 --> 00:37:02,339
giant trucks hauling away tons and tons of material

729
00:37:02,339 --> 00:37:06,750
but we will find ways of drilling down and excavating

730
00:37:06,750 --> 00:37:09,520
quantities of say water ice, just so we can
get

731
00:37:09,520 --> 00:37:12,029
out the cool thing we care about, which is
hydrogen.

732
00:37:12,029 --> 00:37:13,029
- Yeah, cool

733
00:37:13,029 --> 00:37:15,280
- And, of course, we will do it all robotically.

734
00:37:15,280 --> 00:37:16,890
- And why do we want the hydrogen?

735
00:37:16,890 --> 00:37:21,240
- We want the hydrogen, because we care about making fuel and we also care about water,

736
00:37:21,240 --> 00:37:24,040
just to keep people alive. And water tends to be a

737
00:37:24,040 --> 00:37:25,200
good thing to have.

738
00:37:25,200 --> 00:37:26,200
- Yep.

739
00:37:26,200 --> 00:37:27,200
- Nice.

740
00:37:27,200 --> 00:37:29,230
- [YoungReefer] asked a couple of times, moving on

741
00:37:29,230 --> 00:37:32,100
to spaceships far from Earth, we have built them

742
00:37:32,100 --> 00:37:36,160
to be autonomous, but something could happen. Something goes wrong and they are too far

743
00:37:36,160 --> 00:37:39,720
away
from us to fix it. What can do you? - Is there

744
00:37:39,720 --> 00:37:40,720
a solution?

745
00:37:40,720 --> 00:37:43,350
- Well, it demands on what breaks, of course.
NASA

746
00:37:43,350 --> 00:37:45,450
is doing a fair amount of testing these days
on

747
00:37:45,450 --> 00:37:48,490
the space station of 3D printing. And so,
we are

748
00:37:48,490 --> 00:37:54,360
trying to look how can you 3 D print replacement
parts, if a part breaks. If you are in deep

749
00:37:54,360 --> 00:37:59,080
space
and it's a spacecraft that has humans on board,

750
00:37:59,080 --> 00:38:03,400
and someone falls sick, another thing we are
trying to do, is try to figure out well, what

751
00:38:03,400 --> 00:38:05,869
information does the chief medical officer
in real

752
00:38:05,869 --> 00:38:09,510
life, so not just in science fiction, have
to do?

753
00:38:09,510 --> 00:38:11,200
And it is interesting if you think about this
from

754
00:38:11,200 --> 00:38:14,970
a medical point of view. Here on Earth,
especially in the United States, when you

755
00:38:14,970 --> 00:38:16,760
get sick you go see a doctor, but it's not like you

756
00:38:16,760 --> 00:38:19,160
see just one person. That doctor is tied into

757
00:38:19,160 --> 00:38:21,609
the whole community. He's got all the support

758
00:38:21,609 --> 00:38:25,790
around him. Labs and tests, and specialists and you

759
00:38:25,790 --> 00:38:28,280
can get all the referrals. And that's great in

760
00:38:28,280 --> 00:38:30,960
a connected world, not so great if you are out

761
00:38:30,960 --> 00:38:33,131
on a spacecraft that's in deep space and there

762
00:38:33,131 --> 00:38:35,350
is nobody else there. And if you want to pick

763
00:38:35,350 --> 00:38:37,470
up the phone and call home, it's like, well, I will

764
00:38:37,470 --> 00:38:39,500
call home and they will get the call like five

765
00:38:39,500 --> 00:38:42,160
or six hours later. So, part of what we are trying

766
00:38:42,160 --> 00:38:44,090
to do also is figure out what sort of on board

767
00:38:44,090 --> 00:38:47,360

knowledge, maybe it's a computer system that
can

768
00:38:47,360 --> 00:38:50,020
help out diagnose things or treat things that
will

769
00:38:50,020 --> 00:38:53,220
give support to, say a chief medical officer,
on

770
00:38:53,220 --> 00:38:54,660
board a spacecraft.

771
00:38:54,660 --> 00:38:58,410
- We are also, when it is non-human, when
is a

772
00:38:58,410 --> 00:39:01,280
spacecraft far away, we will put the spacecraft
in

773
00:39:01,280 --> 00:39:05,560
safety mode. If it detects that there are
something wrong, we do have system checks

774
00:39:05,560 --> 00:39:09,020
that are checking for the health of the vehicle and

775
00:39:09,020 --> 00:39:10,980
that that will go to safe mode and wait for that

776
00:39:10,980 --> 00:39:15,550
call from humans to tell it what to do next and

777
00:39:15,550 --> 00:39:17,360
how we
can continue on with the mission or do we

778

00:39:17,360 --> 00:39:20,099
have to
abort. Then we are also looking at bringing

779
00:39:20,099 --> 00:39:23,250
some of that intelligence to the spacecraft itself.

780
00:39:23,250 --> 00:39:26,359
So it can figure out what is wrong, what are

781
00:39:26,359 --> 00:39:29,650
my capabilities and make that decision without

782
00:39:29,650 --> 00:39:31,200
waiting from the call from home.

783
00:39:31,200 --> 00:39:34,060
- Cool. - Yeah. Done a little bit of that
on the

784
00:39:34,060 --> 00:39:35,060
aircraft too.

785
00:39:35,060 --> 00:39:36,060
- Interesting.

786
00:39:36,060 --> 00:39:38,780
- Lots of parallels between the different
domains

787
00:39:38,780 --> 00:39:45,440
- One question, this is related to autonomy.
Obviously, nowadays you think people think

788
00:39:45,440 --> 00:39:49,310
about like the drones that go in swarms or self-driving

789
00:39:49,310 --> 00:39:56,140
cars, and you know, like my favourite sub-reddits

are like R slash self-driving cars and everybody

790
00:39:56,140 --> 00:39:58,700
is looking forward to this future where I
can call

791
00:39:58,700 --> 00:40:04,970
my car and it will come. Of all the talk that
happens with self-driving and autonomous systems,

792
00:40:04,970 --> 00:40:09,540
what is your guys' opinion of the gap probably
between what's really going to happen and

793
00:40:09,540 --> 00:40:12,089
then
what's like more science fiction and hopeful

794
00:40:12,089 --> 00:40:16,190
thinking. So kind of like, what is the stuff
that

795
00:40:16,190 --> 00:40:17,651
you can see or that excites you?

796
00:40:17,651 --> 00:40:20,500
- Yeah. You want to take that one?

797
00:40:20,500 --> 00:40:21,500
- You go first.

798
00:40:21,500 --> 00:40:23,099
- I don't know.

799
00:40:23,099 --> 00:40:27,740
- You want to go hopeful or buzz kill?

800
00:40:27,740 --> 00:40:33,849
- Yeah. It can go either way. I'm really excited.

This is a really exciting time, especially

801
00:40:33,849 --> 00:40:35,810
given the career that I have chosen. People see

802
00:40:35,810 --> 00:40:39,510
all these changes and the investments and the

803
00:40:39,510 --> 00:40:41,710
thousands of people who are working these
really

804
00:40:41,710 --> 00:40:45,550
challenging problems. And I honestly don't
know

805
00:40:45,550 --> 00:40:49,220
where it's going. I am eager to find out.
I'm very

806
00:40:49,220 --> 00:40:54,040
fortunate and proud to be part of it. And
it's

807
00:40:54,040 --> 00:40:55,390
going to be a fun lifetime.

808
00:40:55,390 --> 00:40:58,040
- Good time to be alive.

809
00:40:58,040 --> 00:40:59,040
- Yeah.

810
00:40:59,040 --> 00:41:01,460
- I will tell you I believe the future is
full of

811
00:41:01,460 --> 00:41:07,910
robots and self-driving cars and self-flying

planes but I guarantee you that those robots

812
00:41:07,910 --> 00:41:10,579
and cars and planes will be doing things that

813
00:41:10,579 --> 00:41:13,020
we just don't imagine today. I mean, you roll the

814
00:41:13,020 --> 00:41:15,640
clock back even 10, 15 years ago you asked people,

815
00:41:15,640 --> 00:41:18,020
why do you have a cell phone? And people say "Oh,

816
00:41:18,020 --> 00:41:20,160
it's make phone calls." And you ask the same
thing

817
00:41:20,160 --> 00:41:21,940
to people today, they are like "Phone calls?
I

818
00:41:21,940 --> 00:41:24,410
don't make phone calls. I send text messages.
I

819
00:41:24,410 --> 00:41:30,440
watch videos." So the things you carry around,
they are not phones. They can be used as phones

820
00:41:30,440 --> 00:41:33,010
but they do different things. And I think
if we

821
00:41:33,010 --> 00:41:35,510
think "Oh, I'm making a self-driving car because
I

822
00:41:35,510 --> 00:41:36,990

want to be in a vehicle where I don't have
to

823
00:41:36,990 --> 00:41:39,760
drive," it may do that but I think it might
do

824
00:41:39,760 --> 00:41:42,270
something else in the future. Maybe it will
bring

825
00:41:42,270 --> 00:41:45,310
us groceries. Maybe it will entertain us.
You get

826
00:41:45,310 --> 00:41:47,270
in the car and it's a place you go to - instead
of

827
00:41:47,270 --> 00:41:50,170
going to the movies you get in the car and
have

828
00:41:50,170 --> 00:41:53,760
fun for some reason. But the point is, that
I

829
00:41:53,760 --> 00:41:57,680
think that we don't yet see what's going to
happen

830
00:41:57,680 --> 00:41:59,890
with all the robots and cars and planes in
our

831
00:41:59,890 --> 00:42:02,549
lives but I'm sure they're going to be there.

832
00:42:02,549 --> 00:42:05,700
- Awesome. Cool. Can I divert us?

833
00:42:05,700 --> 00:42:07,880
- Yeah. Let's go into the chat.

834
00:42:07,880 --> 00:42:10,380
- Quick one for Matt. From [Realtoring] Where
can

835
00:42:10,380 --> 00:42:15,000
I get that cool NASA Silicon Valley shirt?

836
00:42:15,000 --> 00:42:18,470
- This was a special order one but we do have
a

837
00:42:18,470 --> 00:42:20,660
little store over here at NASA Ames, over
at the

838
00:42:20,660 --> 00:42:22,950
little visitor center and I've been talking
to

839
00:42:22,950 --> 00:42:24,730
Kenny, the guy who runs it. Hopefully we will get

840
00:42:24,730 --> 00:42:28,369
more copies of the shirt to come out. This
is

841
00:42:28,369 --> 00:42:36,930
where I dance that fancy line between a federal
government entity and like endorsing stores.

842
00:42:36,930 --> 00:42:39,900
- Well, maybe some day they will visit us
and -

843
00:42:39,900 --> 00:42:44,900

- Come and visit… Come to NASA Ames in Silicon Valley. There is a visitor center tent. There's

844
00:42:44,900 --> 00:42:46,010
a bunch of… there's a little store you can

845
00:42:46,010 --> 00:42:47,010
buy stuff there.

846
00:42:47,010 --> 00:42:51,050
- Now, here is a question about hacking. This is

847
00:42:51,050 --> 00:42:58,109
from, sorry, [Markusalaya]. How safe are the self-driving cars and robots now from hacking?

848
00:42:58,109 --> 00:43:00,390
Or are they at a really early stage of security

849
00:43:00,390 --> 00:43:01,390
levels?

850
00:43:01,390 --> 00:43:03,670
- Well, I used to think my computer was safe from

851
00:43:03,670 --> 00:43:06,440
hacking until just a few weeks ago and …

852
00:43:06,440 --> 00:43:07,740
- [Laughter\} Oh, no…

853
00:43:07,740 --> 00:43:09,609
- We learned that every computing device in the

854
00:43:09,609 --> 00:43:14,460
world is susceptible to things. I think it's a

855
00:43:14,460 --> 00:43:19,520
real good question of how you have confidence
that

856
00:43:19,520 --> 00:43:22,250
your car, your robot is not hackable. I think
it

857
00:43:22,250 --> 00:43:24,020
will go beyond that. Anything you hook up
to the

858
00:43:24,020 --> 00:43:25,810
internet these days, you might worry about.
I

859
00:43:25,810 --> 00:43:30,130
look at all the people who all the different
devices that control your lights and thermostats

860
00:43:30,130 --> 00:43:32,730
or your often ovens remotely, and you think
"Well,

861
00:43:32,730 --> 00:43:34,200
are they safe or can somebody going to be
able to

862
00:43:34,200 --> 00:43:36,700
tap into them?" All the people that now have
all

863
00:43:36,700 --> 00:43:41,010
these home speakers that you can talk to and
ask

864
00:43:41,010 --> 00:43:43,630
them to do things and not just tell jokes
and

865
00:43:43,630 --> 00:43:46,099
stuff. And all that is really then tied into
the

866
00:43:46,099 --> 00:43:48,930
question of how do you make them secure. And
I

867
00:43:48,930 --> 00:43:52,300
know it's a really very important area, if
we want

868
00:43:52,300 --> 00:43:55,530
to trust the systems and rely upon them. Trust
is

869
00:43:55,530 --> 00:44:00,490
something that I think as humans, has to be
earned. When we work together as humans, when

870
00:44:00,490 --> 00:44:02,390
I
first meet somebody I'm like yeah, can I really

871
00:44:02,390 --> 00:44:04,859
trust them with my life? Maybe not so much.
But

872
00:44:04,859 --> 00:44:09,540
over time, as you work with them, and you
understand what they can do, and especially

873
00:44:09,540 --> 00:44:12,180
that they show you over and over again they can

874
00:44:12,180 --> 00:44:14,430
be relied upon, then you trust them more. And

875

00:44:14,430 --> 00:44:17,319
I think to some, extent robots and cars are

876
00:44:17,319 --> 00:44:22,200
going to have - self-driving cars and that sort of

877
00:44:22,200 --> 00:44:23,200
same category.

878
00:44:23,200 --> 00:44:24,200
- Fair enough.

879
00:44:24,200 --> 00:44:25,200
- As we go forward with our space industry,
it is

880
00:44:25,200 --> 00:44:27,450
not going to be just government out there.
And

881
00:44:27,450 --> 00:44:29,880
just a few communication companies. We're going

882
00:44:29,880 --> 00:44:33,500
to find that industry can really utilise space
in

883
00:44:33,500 --> 00:44:37,160
ways that we cannot imagine right now. And
as many

884
00:44:37,160 --> 00:44:39,720
people become spacefaring, they will have
the

885
00:44:39,720 --> 00:44:45,220
capabilities to reach out to different spacecraft.
Right now, we sort of rely on the fact that

886

00:44:45,220 --> 00:44:47,480
not many people are able to communicate with our

887
00:44:47,480 --> 00:44:50,230
spacecraft and our robots and if they could
even

888
00:44:50,230 --> 00:44:52,920
communicate to them, that they wouldn't know
how

889
00:44:52,920 --> 00:45:00,650
to be understandable and be able to give them
something that would be - would hack the system.

890
00:45:00,650 --> 00:45:04,820
But as we go forward, it's going to be something
we have to address. Because cyber security,

891
00:45:04,820 --> 00:45:08,420
for all the spacefaring industry, is going to

892
00:45:08,420 --> 00:45:11,090
be real
and we will have to follow suit, other industries

893
00:45:11,090 --> 00:45:13,230
have done this before and we will do the same.

894
00:45:13,230 --> 00:45:17,020
- It's not just space too, obviously aviation
in

895
00:45:17,020 --> 00:45:19,660
general too as that becomes more connected.

896
00:45:19,660 --> 00:45:20,660
- Right.

897

00:45:20,660 --> 00:45:23,119
- All the aircraft that are flown, whether large

898
00:45:23,119 --> 00:45:26,589
transport aircraft, airline companies, or general

899
00:45:26,589 --> 00:45:31,920
aviation pilots, people want to rely on connected services just like we all do when we are just

900
00:45:31,920 --> 00:45:34,461
walking around our neighbourhood or at home. And

901
00:45:34,461 --> 00:45:37,310
so, they need networking but that means is that

902
00:45:37,310 --> 00:45:41,080
networking safe, is it secure? Is it reliable?

903
00:45:41,080 --> 00:45:42,080
- Right.

904
00:45:42,080 --> 00:45:44,200
- That's a real big I think challenge for everybody.

905
00:45:44,200 --> 00:45:46,599
- It is true. We are moving away from voice and in

906
00:45:46,599 --> 00:45:49,710
our cockpits to data and that's that will be a

907
00:45:49,710 --> 00:45:52,000
problem if we don't address it soon.

908
00:45:52,000 --> 00:45:55,109
- So folks, if you are just joining us now,
you

909
00:45:55,109 --> 00:45:58,830
are watching NASA in Silicon Valley Live.
The new

910
00:45:58,830 --> 00:46:05,480
conversational show we are Trying out on Twitch
dot TV slash NASA. We are chat being self-driving

911
00:46:05,480 --> 00:46:07,470
planes and robots and automobiles with Terry
Fong

912
00:46:07,470 --> 00:46:12,180
and Diana Acosta. We are heading into the
last 15

913
00:46:12,180 --> 00:46:14,859
minutes, give or take, we're going to jump
into

914
00:46:14,859 --> 00:46:17,170
rapid fire questions. I think we have got
a ton of

915
00:46:17,170 --> 00:46:19,369
them and we want to get as many questions
from the

916
00:46:19,369 --> 00:46:22,190
chat as humanly possible. So yeah, let's do
this.

917
00:46:22,190 --> 00:46:23,230
Let's go on through.

918
00:46:23,230 --> 00:46:25,440
- The challenge before you is to answer in one

919
00:46:25,440 --> 00:46:30,140
liners or as concisely as you feel you can manage.

920
00:46:30,140 --> 00:46:32,829
- [RainarTheConqueror] asking, will AI ever power

921
00:46:32,829 --> 00:46:35,070
any kind of functionality on the international space station

922
00:46:35,070 --> 00:46:36,900
- Yes.

923
00:46:36,900 --> 00:46:37,900
- Is it already?

924
00:46:37,900 --> 00:46:38,900
- No.

925
00:46:41,619 --> 00:46:40,619
- In research, yes.

926
00:46:41,619 --> 00:46:42,619
- Yeah? Yeah…

927
00:46:42,619 --> 00:46:44,440
- Do you want to take a little line to talk about

928
00:46:44,440 --> 00:46:45,440
that?

929

00:46:45,440 --> 00:46:51,990
- So, we have done research on the different
systems for the ISS. Being able specifically

930
00:46:51,990 --> 00:46:56,230
to
monitor the life support systems: water, the

931
00:46:56,230 --> 00:47:01,660
cleanliness of the water and how well that's
working. So, we have utilized AI in that.

932
00:47:01,660 --> 00:47:03,049
For research purposes.

933
00:47:03,049 --> 00:47:09,700
- Congratulations. OK. Let me find a good
one.

934
00:47:09,700 --> 00:47:14,660
This is vast. What do you think the next
significant breakthrough in space exploration

935
00:47:14,660 --> 00:47:15,660
will be?

936
00:47:15,660 --> 00:47:19,309
- Boy, the next breakthrough in space exploration?

937
00:47:19,309 --> 00:47:22,940
- Yeah. That's tough.

938
00:47:22,940 --> 00:47:24,759
- Sending humans back to the moon.

939
00:47:24,759 --> 00:47:27,319
- That will be exciting.

940
00:47:27,319 --> 00:47:28,319

- Yeah.

941
00:47:28,319 --> 00:47:31,630
- No less vast. [Robbie1896] are we alone
in the

942
00:47:31,630 --> 00:47:32,630
universe?

943
00:47:32,630 --> 00:47:34,190
- [Humming musically] Dun, dun, dunnnn…

944
00:47:34,190 --> 00:47:39,920
- I would say watch the podcast or the live
video

945
00:47:39,920 --> 00:47:41,140
from last time.

946
00:47:41,140 --> 00:47:42,140
- Oh yeah.

947
00:47:42,140 --> 00:47:43,840
- With Jim Green and Greg Schmidt.

948
00:47:43,840 --> 00:47:47,490
- Those are the science experts and they addressed
that question a little bit.

949
00:47:47,490 --> 00:47:49,640
- Yeah, they talked about that in detail.
You can

950
00:47:49,640 --> 00:47:53,550
check it out our YouTube.com/NASAAmes or I
think

951
00:47:53,550 --> 00:47:55,940
it's actually on demand on Twitch.TV as well.

952
00:47:55,940 --> 00:47:59,160
- Now seriously, I have several questions asking

953
00:47:59,160 --> 00:48:01,750
about their careers, their future careers and what

954
00:48:01,750 --> 00:48:07,069
you guys might advise. So [montrealchrislee] "What

955
00:48:07,069 --> 00:48:09,280
the hell should I do to get an internship at NASA

956
00:48:09,280 --> 00:48:13,500
as a software engineer?" Or more broadly, what

957
00:48:13,500 --> 00:48:17,590
can anybody do to work with you guys or with other

958
00:48:17,590 --> 00:48:18,750
teams here?

959
00:48:18,750 --> 00:48:20,471
- I think it is really important for people to

960
00:48:20,471 --> 00:48:24,210
understand that NASA is a place that's very open

961
00:48:24,210 --> 00:48:30,619
and very welcoming to people who want to get experience at NASA, to do internships here,

962
00:48:30,619 --> 00:48:32,790
to
work with NASA people. One way you can get

963
00:48:32,790 --> 00:48:34,690
involved is that NASA releases a fair amount
of

964
00:48:34,690 --> 00:48:37,339
software open source. So you can actually
download

965
00:48:37,339 --> 00:48:44,170
code from NASA. And we actually do take back
contributions in various projects. Another

966
00:48:44,170 --> 00:48:47,200
way, is that every single NASA center across the United

967
00:48:47,200 --> 00:48:54,400
States has a very strong program for summer
internships. Here at NASA Ames, we typically

968
00:48:54,400 --> 00:48:57,670
get like 800, 900 students every summer, which

969
00:48:57,670 --> 00:49:00,640
is a large number. And there are lots of ways to

970
00:49:00,640 --> 00:49:02,480
get involved from the high school level all the

971
00:49:02,480 --> 00:49:06,280
way through to grad school level. So just contact

972
00:49:06,280 --> 00:49:09,280
NASA centers and get an internship.

973

00:49:09,280 --> 00:49:16,030
- That's intern.nasa.gov. That's the one stop shop. Go in there to do all the applications

974
00:49:16,030 --> 00:49:17,470
and stuff.

975
00:49:17,470 --> 00:49:20,540
- Alright. Moving on. [Gralic] asks how long does

976
00:49:20,540 --> 00:49:22,980
it take for a program like Superball to go from

977
00:49:22,980 --> 00:49:26,490
idea to actual prototype? How much does it cost?

978
00:49:26,490 --> 00:49:32,410
Also, Matt how does your hair look so darn good?

979
00:49:32,410 --> 00:49:34,140
- Maybe talk to us about Superball first.

980
00:49:34,140 --> 00:49:37,200
- I want to hear about Matt's hair. I mean, no,

981
00:49:37,200 --> 00:49:38,200
but -

982
00:49:38,200 --> 00:49:41,890
- I do I what my wife tells me to. [Laughter]

983
00:49:41,890 --> 00:49:43,880
- Superball is something we have been working on

984
00:49:43,880 --> 00:49:49,570
for the past maybe four years or so. But that's
because we have been continually coming up

985
00:49:49,570 --> 00:49:52,750
with new designs for it. The first concept, from

986
00:49:52,750 --> 00:49:56,920
sort of like paper… "paper." All right, computer.

987
00:49:56,920 --> 00:49:59,710
From computer sketch to actual hardware, just a

988
00:49:59,710 --> 00:50:02,369
couple of months. But once you build it, there's

989
00:50:02,369 --> 00:50:05,550
a lot more to actually make it work in a really,

990
00:50:05,550 --> 00:50:08,360
you know, high performance, reliable way. That

991
00:50:08,360 --> 00:50:11,650
takes a lot of time ,in terms of controls and modelling

992
00:50:11,650 --> 00:50:14,920
and simulation and testing. And the testing
of

993
00:50:14,920 --> 00:50:17,290
course, is the most fun part. But you have
to

994
00:50:17,290 --> 00:50:18,290
build it.

995
00:50:18,290 --> 00:50:20,329
- Yeah first of all. That's shorter than I

might

996
00:50:20,329 --> 00:50:25,810
have thought to get started. Tell me if you
guys

997
00:50:25,810 --> 00:50:28,140
know enough about the field of physics to
answer

998
00:50:28,140 --> 00:50:32,410
this one. [VonetarWolf] wanted to know how
successful is a career in physics, like

999
00:50:32,410 --> 00:50:34,710
theoretical or astrophysics? Assuming you
have a

1000
00:50:34,710 --> 00:50:37,569
graduate degree, versus a career in aeronautics..

1001
00:50:37,569 --> 00:50:39,359
[crosstalk]

1002
00:50:39,359 --> 00:50:47,660
- I feel strangely qualified to answer that
because my bachelor's degree is actually in

1003
00:50:47,660 --> 00:50:51,680
aeronautics, not robots and my wife has a
PhD in

1004
00:50:51,680 --> 00:50:52,700
particle physics.

1005
00:50:52,700 --> 00:50:53,700
- Cool. [Laughter]

1006
00:50:53,700 --> 00:50:58,360

- So, I will tell you that of all the fields
in

1007
00:50:58,360 --> 00:51:00,690
science of course, now I'm going to get all
the

1008
00:51:00,690 --> 00:51:04,630
strange comments from people who aren't
physicists. I think physics is the most universal

1009
00:51:04,630 --> 00:51:06,869
field. Just about every single physicist that
I

1010
00:51:06,869 --> 00:51:09,970
know can get a job in almost anything they
want.

1011
00:51:09,970 --> 00:51:14,220
Partially because they have more math background
than anybody else and everything is driven

1012
00:51:14,220 --> 00:51:17,820
by math. So, I think that, for people who are

1013
00:51:17,820 --> 00:51:21,941
studying physics, really the sky is the limit.
For

1014
00:51:21,941 --> 00:51:25,589
me, I was trained as somebody in aeronautics
but

1015
00:51:25,589 --> 00:51:31,380
then, when I got to grad school, I got interested
in robots and computers and that sort of took

1016
00:51:31,380 --> 00:51:33,950
me

down a different path. You know, and aeronautics

1017
00:51:33,950 --> 00:51:38,680
too, is actually a good starting point, because
it's very interdisciplinary. You learn about

1018
00:51:38,680 --> 00:51:42,599
lots
of different things. It's sort of a classic

1019
00:51:42,599 --> 00:51:45,770
systems engineering discipline. And it is
not

1020
00:51:45,770 --> 00:51:48,619
just, oh, you are going to make planes. You
going

1021
00:51:48,619 --> 00:51:52,140
to make planes. You're going to make spacecraft,
you will do math and physics and all kinds

1022
00:51:52,140 --> 00:51:53,140
of stuff.

1023
00:51:53,140 --> 00:51:54,340
- Is that how you see it too, Diana?

1024
00:51:54,340 --> 00:51:56,130
- I see it that way as well.

1025
00:51:56,130 --> 00:51:58,810
- That's nice. Interdisciplinary. Here is
a quick

1026
00:51:58,810 --> 00:52:03,960
one. [Shocarscon] is asking "Which programming
languages do you use?"

1027

00:52:03,960 --> 00:52:09,110
- So, in robotic, we rely a lot on C, C plus
plus

1028
00:52:09,110 --> 00:52:14,180
and Java. I would say for some of the systems,
there is a lot of work that's been done in

1029
00:52:14,180 --> 00:52:15,510
Python, as well.

1030
00:52:15,510 --> 00:52:17,900
- Same for you?

1031
00:52:17,900 --> 00:52:19,500
- C, Python.

1032
00:52:19,500 --> 00:52:22,369
- Alright. Things I myself have never learned.
Do

1033
00:52:22,369 --> 00:52:24,349
you know any programming.

1034
00:52:24,349 --> 00:52:30,369
- I - I took - my - the intro to my computer
sciences, this is like in 1999, like first

1035
00:52:30,369 --> 00:52:34,119
year of college and fiddled around making little like

1036
00:52:34,119 --> 00:52:36,750
windows and programs and stuff. And the thing
that

1037
00:52:36,750 --> 00:52:39,359
struck me was how similar it felt to like
learning

1038

00:52:39,359 --> 00:52:41,859
another language. It is like learning Spanish
and

1039
00:52:41,859 --> 00:52:46,329
French and you quickly realise, that I could
follow instructions, but then it quickly went

1040
00:52:46,329 --> 00:52:48,420
to the point where I'm like, I don't even have

1041
00:52:48,420 --> 00:52:54,839
the vocabulary for this. And so yeah, that was

1042
00:52:54,839 --> 00:52:57,069
the end of my computer science career.

1043
00:52:57,069 --> 00:53:03,390
- That's OK, Matt. Back to self-driving cars.
[NickGares] asks, what do you think the adoption

1044
00:53:03,390 --> 00:53:06,930
rate for self-driving cars will bein the next
decade and will they ever reach the price

1045
00:53:06,930 --> 00:53:08,730
point of manual cars?

1046
00:53:08,730 --> 00:53:11,119
- Wow, so two part question there. So, first
part

1047
00:53:11,119 --> 00:53:14,030
here is adoption rate, I think it depends
on where

1048
00:53:14,030 --> 00:53:17,781
you live in the US. I think that if you're
in an

1049
00:53:17,781 --> 00:53:23,540
area where you have the "good weather," like
Silicon Valley, it is a lot easier because

1050
00:53:23,540 --> 00:53:26,212
there
is a lot, you know, fewer things that we have

1051
00:53:26,212 --> 00:53:28,069
to deal with, like thunderstorms and snow and

1052
00:53:28,069 --> 00:53:30,410
stuff like that. So, I think it will be easier to

1053
00:53:30,410 --> 00:53:33,530
have driving cars out in places like California,

1054
00:53:33,530 --> 00:53:37,490
Arizona, New Mexico first. Will they get down
to

1055
00:53:37,490 --> 00:53:43,750
the price point of normal cars? Well, it depends.
A lot of cars these days are just really becoming

1056
00:53:43,750 --> 00:53:47,069
software platforms. You know, all the Teslas
out

1057
00:53:47,069 --> 00:53:50,910
there these days. I mean, they get software
upgrades. You flip a switch and they go from

1058
00:53:50,910 --> 00:53:53,859
manual driving to self-driving. It is not
like, so

1059
00:53:53,859 --> 00:53:56,290
much a question of an add on. I mean, the

cars

1060
00:53:56,290 --> 00:53:58,170
themselves will be ready to be self-driving
--.

1061
00:53:58,170 --> 00:54:04,530
- That's interesting. Cool. Diana quick.
[Wordsworth] asks "What is your favourite

1062
00:54:04,530 --> 00:54:06,240
science
fact or theory?"

1063
00:54:06,240 --> 00:54:09,390
- [Laughter] The pressure…

1064
00:54:09,390 --> 00:54:12,410
- No pressure. I'm stumped.

1065
00:54:12,410 --> 00:54:13,769
- OK. That's good.

1066
00:54:13,769 --> 00:54:14,769
- Yeah.

1067
00:54:14,769 --> 00:54:16,050
- Ponder that and if something comes to you,
you

1068
00:54:16,050 --> 00:54:18,299
just jump in and let us know.

1069
00:54:18,299 --> 00:54:20,710
- Terry, [JCBaby] asks "Star Wars or Star
Trek?"

1070
00:54:20,710 --> 00:54:21,980
- Star Trek.

1071
00:54:21,980 --> 00:54:24,670
- He didn't hesitate. He did not hesitate!
You

1072
00:54:24,670 --> 00:54:27,400
guys?

1073
00:54:27,400 --> 00:54:30,859
- I know way more about Star Wars than any
like -

1074
00:54:30,859 --> 00:54:34,020
than I should. But way more. I know way more
about

1075
00:54:34,020 --> 00:54:41,490
Star Wars and read more stuff than necessarily
Star Trek. So, that's probably my world.

1076
00:54:41,490 --> 00:54:43,010
- Alright. Firefly.

1077
00:54:43,010 --> 00:54:44,530
- Firefly. [Laughter]

1078
00:54:44,530 --> 00:54:46,050
- Nicely done.

1079
00:54:46,050 --> 00:54:49,230
- A shout out to R slash Prequel memes. They
know

1080
00:54:49,230 --> 00:54:50,680
what I'm talking about.

1081
00:54:50,680 --> 00:54:54,230
- Terry [keekz] is asking who came up with
the

1082
00:54:54,230 --> 00:54:55,539
name Superball?

1083
00:54:55,539 --> 00:55:00,900
- Superball! Actually, that was a former
researcher here at NASA Ames with a really

1084
00:55:00,900 --> 00:55:05,069
great name, Vytas Sunspiral. You can find him working

1085
00:55:05,069 --> 00:55:08,729
at a start up company in Emmeryville these day.

1086
00:55:08,729 --> 00:55:15,299
- Let me see. We had a question about robotic
surgeons. Do you guys feel you could handle

1087
00:55:15,299 --> 00:55:15,799
that?

1088
00:55:15,799 --> 00:55:17,870
[mellowcanuk] was one asking about robotic

1089
00:55:17,870 --> 00:55:20,490
surgeons will be used in space or the moon.
Is

1090
00:55:20,490 --> 00:55:23,089
that something you hear about? Are you involved
in something like that?

1091
00:55:23,089 --> 00:55:24,799
- We hear about those things and I think that
goes

1092
00:55:24,799 --> 00:55:26,740
back earlier to what I was saying about, you
know,

1093
00:55:26,740 --> 00:55:28,869
what's needed for a chief medical officer
or

1094
00:55:28,869 --> 00:55:32,960
somebody who has to do medicine in space.
And I

1095
00:55:32,960 --> 00:55:36,569
think that robot surgery is certainly going
to be

1096
00:55:36,569 --> 00:55:39,920
sort of like one of the tools in that person's
toolbox.

1097
00:55:39,920 --> 00:55:42,130
- OK. Because actually do we have robot surgery
on

1098
00:55:42,130 --> 00:55:43,749
earth right now?

1099
00:55:43,749 --> 00:55:45,180
- We do. Yeah.

1100
00:55:45,180 --> 00:55:48,920
- That sounded so far out to me, but no, actually
that exists.

1101
00:55:48,920 --> 00:55:50,690
- It's used very widely.

1102
00:55:50,690 --> 00:55:51,690
- Interesting.

1103
00:55:51,690 --> 00:55:54,130
- Yeah, the idea of surgery in space though

makes

1104
00:55:54,130 --> 00:55:57,880
me a little squeamish. We have gravity here,
to

1105
00:55:57,880 --> 00:56:02,440
make sure our blood goes in certain ways when
we're… we have an injury. But in space,

1106
00:56:02,440 --> 00:56:03,509
not so much. So -

1107
00:56:03,509 --> 00:56:04,509
- Yep. Well.

1108
00:56:04,509 --> 00:56:08,020
- It's a little a little more complicated
in space

1109
00:56:08,020 --> 00:56:09,599
than it would be on a different continent.

1110
00:56:09,599 --> 00:56:11,689
- A lot of things are, aren't they?

1111
00:56:11,689 --> 00:56:14,690
- We going to get close to wrapping up. What
do

1112
00:56:14,690 --> 00:56:16,650
you think? Have we got one more?

1113
00:56:16,650 --> 00:56:17,650
- Oh my goodness.

1114
00:56:17,650 --> 00:56:19,170
- Let's get a ready good one.

1115
00:56:19,170 --> 00:56:22,140
- There's kind of too many.

1116
00:56:22,140 --> 00:56:26,640
- Well we didn't get anybody's favourite science fact or theory, which I'm disappointed about.

1117
00:56:26,640 --> 00:56:29,300
- What's yours favorite fact or theory? Yeah, Abby!

1118
00:56:29,300 --> 00:56:30,300
- I don't know.

1119
00:56:30,300 --> 00:56:32,940
- What is your favourite space fact or theory?

1120
00:56:32,940 --> 00:56:34,829
- I ask the questions around here, OK.

1121
00:56:34,829 --> 00:56:36,819
- Or why don't people in their chat put down their

1122
00:56:36,819 --> 00:56:40,230
favourite theory? I would love to see that.

1123
00:56:40,230 --> 00:56:42,680
- If Terry or Diana think of one we will have them

1124
00:56:42,680 --> 00:56:45,730
add it to the chat towards the end.

1125
00:56:45,730 --> 00:56:47,690
- This is a question that's quite different from

1126

00:56:47,690 --> 00:56:52,850
the others in terms of uses for AI. [BearskinRug].
How do you think AI could help us manage our

1127
00:56:52,850 --> 00:56:56,099
natural resources? Is that an area you guys
know

1128
00:56:56,099 --> 00:56:59,990
about? Is that something AI is busy working
on?

1129
00:56:59,990 --> 00:57:06,130
- There already is an AI or big data techniques,
machine learning, to look at our natural

1130
00:57:06,130 --> 00:57:08,290
resources, especially that the big data we
are

1131
00:57:08,290 --> 00:57:13,730
collecting from satellites, of the different
rainforests and such. We are watching how

1132
00:57:13,730 --> 00:57:16,760
those are changing, not just in terms of the green

1133
00:57:16,760 --> 00:57:19,890
also the temperature and other scientific data.

1134
00:57:19,890 --> 00:57:23,569
And the oceans, as well. So, we are collecting a lot

1135
00:57:23,569 --> 00:57:26,369
of information and processing it with AI and

1136
00:57:26,369 --> 00:57:28,560
then that informs the humans to make decisions

1137

00:57:28,560 --> 00:57:32,069
that are can be regulatory in nature or other.

1138
00:57:32,069 --> 00:57:37,910
- Neat. AI is kind of everywhere, isn't it?

1139
00:57:37,910 --> 00:57:40,109
- Robots are everywhere.

1140
00:57:40,109 --> 00:57:41,569
- Algorithms, math.

1141
00:57:41,569 --> 00:57:42,569
- Math.

1142
00:57:42,569 --> 00:57:43,569
- Awesome.

1143
00:57:43,569 --> 00:57:46,810
- Excellent. So, well thank so you much guys.
For

1144
00:57:46,810 --> 00:57:51,400
folks, this has been NASA in Silicon Valley
Live.

1145
00:57:51,400 --> 00:57:54,500
Huge thanks to Terry Fong and Diana Acosta
for

1146
00:57:54,500 --> 00:57:59,900
joining us today. For folks listening or watching
on demand, we are on all the major social

1147
00:57:59,900 --> 00:58:03,799
media
platforms under NASAAmes and using the hashtag

1148
00:58:03,799 --> 00:58:09,460

#NASASiliconValley. We even have a phone number, analog, where you can call in and leave comments

1149
00:58:09,460 --> 00:58:13,200
and feedback. Don't ask for a call back because it

1150
00:58:13,200 --> 00:58:19,631
will not happen. But we can add your comments into the chat or into future episodes. That

1151
00:58:19,631 --> 00:58:25,880
number is 650-604-1400. We will be back next week.

1152
00:58:25,880 --> 00:58:30,109
This is Friday, February 2. At 2 p.m., Pacific

1153
00:58:30,109 --> 00:58:32,420
time. And that's where we will be doing a special

1154
00:58:32,420 --> 00:58:36,471
"Let's play space video games" episode that we have

1155
00:58:36,471 --> 00:58:39,319
been working on. So, get ready for that. That is

1156
00:58:39,319 --> 00:58:41,690
going to be a lot of fun. But if you haven't already

1157
00:58:41,690 --> 00:58:44,589
go ahead click like, share, subscribe, whatever

1158
00:58:44,589 --> 00:58:47,690
it is
that you need to do on the screen or the podcast

1159
00:58:47,690 --> 00:58:55,450
app, so you can check out out next week. Don't bother sending us tips or subs because this

1160
00:58:55,450 --> 00:58:58,329
Twitch show is brought to you by your taxpayer dollars.

1161
00:58:58,329 --> 00:59:01,980
For all the of our international fans, you
are

1162
00:59:01,980 --> 00:59:08,570
welcome. In a shout out to the international
science community that provides so much as

1163
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well. But we are a NASA podcast, but we are not

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the only NASA podcast. So, shout out to our friends

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who do "This Week at NASA," "Houston, We Have a Podcast."

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and "Gravity Assist." Thank you so much and we