



Propeller



CFD



CFD



EOL

Space Shuttle



1940



Space Shuttle



Space Shuttle



Earth



1
00:00:01,033 --> 00:00:07,033
[musical tones]
[electronic sounds data]

2
00:00:17,100 --> 00:00:22,266
- So welcome to the
2015 NASA Ames Summer Series.

3
00:00:22,266 --> 00:00:25,600
NASA, and in particular,
NASA Ames,

4
00:00:25,600 --> 00:00:29,866
changes the way we see
and interact with the world.

5
00:00:29,866 --> 00:00:32,666
As a research
and technology center,

6
00:00:32,666 --> 00:00:36,666
NASA Ames develops
novel concepts and approaches

7
00:00:36,666 --> 00:00:40,466
to advance NASA's missions.

8
00:00:40,466 --> 00:00:45,000
This cannot be achieved
without a great team

9
00:00:45,000 --> 00:00:48,133
balanced by a great leadership.

10
00:00:48,133 --> 00:00:52,800
Today's talk entitled
"NASA Ames' Role in the Future

11
00:00:52,800 --> 00:00:55,566

of Exploration, Science,
and Aeronautics"

12

00:00:55,566 --> 00:01:00,166
will be given by our NASA Ames
Deputy Center Director,

13

00:01:00,166 --> 00:01:03,566
Dr. Tom Edwards.

14

00:01:03,566 --> 00:01:07,500
Dr. Edwards is a graduate
of Princeton University

15

00:01:07,500 --> 00:01:11,200
with a Bachelor's in mechanical
and aerospace engineering.

16

00:01:11,200 --> 00:01:14,400
He also received a Master's
and a PhD degrees

17

00:01:14,400 --> 00:01:16,333
in aeronautics and astronautics

18

00:01:16,333 --> 00:01:20,166
from Stanford University.

19

00:01:20,166 --> 00:01:23,566
Also he has a Master's
of science and management

20

00:01:23,566 --> 00:01:26,166
from Stanford
Graduate School of Business

21

00:01:26,166 --> 00:01:29,633
and is a Sloan Fellow.

22

00:01:29,633 --> 00:01:33,900

He began his career at NASA
in 1983

23

00:01:33,900 --> 00:01:36,600

just after finishing
the Bachelor's.

24

00:01:36,600 --> 00:01:39,300

He has had experience both
on the technical

25

00:01:39,300 --> 00:01:42,333

and management ladder

26

00:01:42,333 --> 00:01:44,133

within the Center,

27

00:01:44,133 --> 00:01:45,633

and prior to becoming a deputy,

28

00:01:45,633 --> 00:01:49,000

he was the
Director of Aeronautics at Ames.

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00:01:49,000 --> 00:01:51,300

Please join me in welcoming

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00:01:51,300 --> 00:01:53,166

Dr. Thomas Edwards.

31

00:01:53,166 --> 00:01:56,166

[applause]

32

00:02:00,366 --> 00:02:02,233

- Thank you very much,

33

00:02:02,233 --> 00:02:04,500

and thank you all

for coming today.

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00:02:04,500 --> 00:02:07,533

I know there's a lot of things
going on at the Center today

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00:02:07,533 --> 00:02:09,866

and I appreciate
that you took the time

36

00:02:09,866 --> 00:02:11,800

to come and listen to me.

37

00:02:11,800 --> 00:02:16,233

I also want to thank Jacob
for this opportunity.

38

00:02:16,233 --> 00:02:19,300

If those of you
who have been coming to

39

00:02:19,300 --> 00:02:21,300

the colloquia
through the summer

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00:02:21,300 --> 00:02:23,966

you've gotten to hear
from astronauts,

41

00:02:23,966 --> 00:02:27,800

scientists,
project managers,

42

00:02:27,800 --> 00:02:29,533

and authors.

43

00:02:29,533 --> 00:02:32,733

Fascinating people, and so
the grand finale is a manager.

44

00:02:32,733 --> 00:02:34,133

[laughter]

45

00:02:34,133 --> 00:02:36,266

- And so it took a fair bit
of courage on your part

46

00:02:36,266 --> 00:02:38,333

to come and hear,

47

00:02:38,333 --> 00:02:41,966

but I look forward to sharing
with you a little bit about

48

00:02:41,966 --> 00:02:46,400

how I view this lofty title
of the future

49

00:02:46,400 --> 00:02:50,566

of Ames' role
in the Agency's missions.

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00:02:50,566 --> 00:02:53,833

As you probably know,
many of you probably know

51

00:02:53,833 --> 00:02:58,100

both me and the Center Director,
Dr. Eugene Tu,

52

00:02:58,100 --> 00:03:00,333

are relatively new
to our positions.

53

00:03:00,333 --> 00:03:03,233

We have been
in our positions for

54

00:03:03,233 --> 00:03:07,000

just a little over
three months now,

55

00:03:07,000 --> 00:03:08,400
both of us.

56

00:03:08,400 --> 00:03:11,033
And while we're fairly new
to those positions,

57

00:03:11,033 --> 00:03:14,033
we're fairly long
to the Center itself,

58

00:03:14,033 --> 00:03:17,700
so we have a general pretty good
idea of what's going on here.

59

00:03:17,700 --> 00:03:19,233
But we are in new roles,

60

00:03:19,233 --> 00:03:22,066
and it's somewhat audacious
to think that

61

00:03:22,066 --> 00:03:24,533
we've got the future
figured out already.

62

00:03:24,533 --> 00:03:29,933
So this is really just a preview
of what's to come,

63

00:03:29,933 --> 00:03:32,266
where we see things headed,

64

00:03:32,266 --> 00:03:35,800
and looking forward
to working with you

65

00:03:35,800 --> 00:03:38,133

on really defining the future

66

00:03:38,133 --> 00:03:41,666

and looking at how

Ames and our assets

67

00:03:41,666 --> 00:03:44,800

best fit into the future

of where the Agency is going.

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00:03:44,800 --> 00:03:46,866

So with that,

69

00:03:46,866 --> 00:03:50,000

I'd like to give you

a little bit of an introduction

70

00:03:50,000 --> 00:03:52,133

to what Ames is doing,

71

00:03:52,133 --> 00:03:54,500

and you'll see

that my central thesis

72

00:03:54,500 --> 00:03:58,733

is that Ames

really is the future of science,

73

00:03:58,733 --> 00:04:00,600

exploration,

and aeronautics.

74

00:04:00,600 --> 00:04:03,433

And the reason

I say that is that

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00:04:03,433 --> 00:04:06,366

here at Ames, more than

any other Center in the Agency,

76

00:04:06,366 --> 00:04:09,300

we conduct fundamental,
groundbreaking,

77

00:04:09,300 --> 00:04:11,900

innovative research.

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00:04:11,900 --> 00:04:15,500

For that reason, sometimes
we're viewed as unconventional,

79

00:04:15,500 --> 00:04:17,600

possibly even controversial,

80

00:04:17,600 --> 00:04:20,433

and we're also looking at

81

00:04:20,433 --> 00:04:22,266

the next generation
of technologies

82

00:04:22,266 --> 00:04:26,066

that will enable or help us
understand things

83

00:04:26,066 --> 00:04:28,000

that are really beyond
the current day

84

00:04:28,000 --> 00:04:30,033

operational time horizons.

85

00:04:30,033 --> 00:04:33,966

So we are out there
really working in the future

86

00:04:33,966 --> 00:04:36,500

and the rest of the Agency
is catching up to us

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00:04:36,500 --> 00:04:39,066

in many ways
and that's a heritage

88

00:04:39,066 --> 00:04:40,733

we've had
for a very long time

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00:04:40,733 --> 00:04:45,166

and I think it's good for us
to proceed with in the future.

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00:04:45,166 --> 00:04:47,900

So to start with,
let's think a little bit about

91

00:04:47,900 --> 00:04:50,833

what the Agency
espouses as its future.

92

00:04:50,833 --> 00:04:54,633

And there are these really
inspirational taglines here

93

00:04:54,633 --> 00:04:57,900

that the Agency has put out
as part of its vision.

94

00:04:57,900 --> 00:05:00,966

to "Reach new heights,"
"Reveal the unknown,"

95

00:05:00,966 --> 00:05:03,266

and "Benefit all humankind."

96

00:05:03,266 --> 00:05:06,500

That's really incredible,

and that's inspirational stuff.

97

00:05:06,500 --> 00:05:09,233

It's part of what
makes it really fun and cool

98

00:05:09,233 --> 00:05:11,466

to say that you work for NASA

99

00:05:11,466 --> 00:05:15,766

and to come through the gate
every day and be part of this.

100

00:05:15,766 --> 00:05:20,100

That said, those are
fairly lofty statements.

101

00:05:20,100 --> 00:05:22,500

What does it really mean?

102

00:05:22,500 --> 00:05:24,033

So that's what
I want to talk about here

103

00:05:24,033 --> 00:05:26,433

and get a little bit more
specific about it.

104

00:05:26,433 --> 00:05:29,200

We've got all these
very altruistic goals,

105

00:05:29,200 --> 00:05:30,466

but what does that mean?

106

00:05:30,466 --> 00:05:33,800

What do we do about that,
and where are we going?

107

00:05:33,800 --> 00:05:38,366

So the next level of vision
that the Agency has espoused

108

00:05:38,366 --> 00:05:42,800

are embodied
in these nice posters

109

00:05:42,800 --> 00:05:46,033

with sayings that
kind of capture the major areas

110

00:05:46,033 --> 00:05:48,900

of emphasis for the Agency.

111

00:05:48,900 --> 00:05:50,200

They're a little bit hard
to see,

112

00:05:50,200 --> 00:05:53,266

so I'll go around
and touch on each one

113

00:05:53,266 --> 00:05:56,366

and you'll see how
they kind of fit together

114

00:05:56,366 --> 00:05:59,166

and they also describe
those very nice statements

115

00:05:59,166 --> 00:06:01,100

on the previous chart.

116

00:06:01,100 --> 00:06:03,766

In the upper left is
"Aeronautics."

117

00:06:03,766 --> 00:06:05,266

That's the first "A" in NASA.

118

00:06:05,266 --> 00:06:07,966

It's where I spent
most of my career

119

00:06:07,966 --> 00:06:10,566

working as a researcher
and as a manager.

120

00:06:10,566 --> 00:06:13,733

And the tagline there is

121

00:06:13,733 --> 00:06:15,366

"With you when you fly."

122

00:06:15,366 --> 00:06:17,366

You'll hear a little bit
more about what that means

123

00:06:17,366 --> 00:06:18,866

in a minute,

124

00:06:18,866 --> 00:06:21,533

but, essentially, there is NASA
technology

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00:06:21,533 --> 00:06:23,800

in every aspect
of air transportation

126

00:06:23,800 --> 00:06:28,033

and in aircraft,
and so when you are flying,

127

00:06:28,033 --> 00:06:30,700

you are benefitting
from NASA technology.

128

00:06:30,700 --> 00:06:33,866

The next one
in the middle says

129
00:06:33,866 --> 00:06:35,600
"Earth Right Now,"

130
00:06:35,600 --> 00:06:39,333
and the tagline there is
"Your planet is changing.

131
00:06:39,333 --> 00:06:40,800
We're on it."

132
00:06:40,800 --> 00:06:42,133
Nice little
double entendre there.

133
00:06:42,133 --> 00:06:43,366
I like that.

134
00:06:43,366 --> 00:06:47,300
And we have our own planet
to understand,

135
00:06:47,300 --> 00:06:49,500
just like we
want to understand planets

136
00:06:49,500 --> 00:06:51,100
in the rest of the universe,

137
00:06:51,100 --> 00:06:53,366
but we first should
understand our own planet,

138
00:06:53,366 --> 00:06:55,900
especially because
it pertains very directly to

139

00:06:55,900 --> 00:06:58,233
our quality of life
and our way of life here.

140
00:06:58,233 --> 00:07:02,700
And so a major emphasis
is to look at our own planet.

141
00:07:04,333 --> 00:07:06,200
Then on the upper right,

142
00:07:06,200 --> 00:07:09,366
there's the
"International Space Station.

143
00:07:09,366 --> 00:07:11,466
Off the Earth for the Earth."

144
00:07:11,466 --> 00:07:14,133
And you'll hear a little
bit more about the way

145
00:07:14,133 --> 00:07:15,900
that that research platform
in space

146
00:07:15,900 --> 00:07:18,000
is using
its unique environment

147
00:07:18,000 --> 00:07:21,700
to understand
the way humans evolve

148
00:07:21,700 --> 00:07:24,066
and how we adapt
to varying conditions

149
00:07:24,066 --> 00:07:27,833
and how life can survive

in microgravity

150

00:07:27,833 --> 00:07:30,066

and that will benefit
life on Earth

151

00:07:30,066 --> 00:07:32,900

as well as in our
exploration activities.

152

00:07:32,900 --> 00:07:35,366

Continuing around clockwise,

153

00:07:35,366 --> 00:07:37,766

we've got
"Solar System and Beyond,"

154

00:07:37,766 --> 00:07:40,900

and that one says,
"We're out there."

155

00:07:40,900 --> 00:07:44,400

And you can just think
of any number of missions

156

00:07:44,400 --> 00:07:46,366

that have been profiled recently

157

00:07:46,366 --> 00:07:48,900

that are understanding
the solar system,

158

00:07:48,900 --> 00:07:51,033

most recently New Horizons.

159

00:07:51,033 --> 00:07:54,600

We had a major event here
to celebrate the flyby

160

00:07:54,600 --> 00:07:58,366
that the "New Horizons"
spacecraft did of Pluto.

161
00:07:58,366 --> 00:08:01,666
Coming back around,
there's "Mars,"

162
00:08:01,666 --> 00:08:04,600
and this is really
the centerpiece

163
00:08:04,600 --> 00:08:07,133
in a lot of ways,
"NASA's Journey to Mars,"

164
00:08:07,133 --> 00:08:09,066
so I'm gonna come back
to that in just a minute.

165
00:08:09,066 --> 00:08:12,800
But that currently
is the driving focus

166
00:08:12,800 --> 00:08:15,666
for a lot of NASA's work
in technology

167
00:08:15,666 --> 00:08:17,966
and in exploration.

168
00:08:17,966 --> 00:08:20,533
And finally, we've got
"Space Technology."

169
00:08:20,533 --> 00:08:24,366
And the tagline there is,
"Technology Drives Exploration."

170
00:08:24,366 --> 00:08:27,600

So we are--we are
a technology organization.

171
00:08:27,600 --> 00:08:30,233
NASA thrives on technology.

172
00:08:30,233 --> 00:08:34,100
We need new technology
always to push the frontiers

173
00:08:34,100 --> 00:08:37,300
and to enable the capabilities
that we need

174
00:08:37,300 --> 00:08:40,866
to do evermore ambitious
space missions.

175
00:08:40,866 --> 00:08:43,200
So that's a quick profile.

176
00:08:43,200 --> 00:08:45,833
Now, what I'm going to do
in this talk is

177
00:08:45,833 --> 00:08:49,100
relate this back to the things
that Ames does

178
00:08:49,100 --> 00:08:51,733
and look at how we are
contributing to the future

179
00:08:51,733 --> 00:08:53,700
in each one of these areas

180
00:08:53,700 --> 00:08:57,300
as we conduct the research
here at the Center.

181
00:08:57,300 --> 00:08:59,366
Before I do that,

182
00:08:59,366 --> 00:09:03,933
I just want to zero in a little
bit on that Mars mission,

183
00:09:03,933 --> 00:09:05,466
The Journey to Mars.

184
00:09:05,466 --> 00:09:09,466
And in fact, it really doesn't
matter a whole lot

185
00:09:09,466 --> 00:09:13,100
whether our
ultimate destination is Mars.

186
00:09:13,100 --> 00:09:16,266
It sets a focus
for us that drives

187
00:09:16,266 --> 00:09:18,400
a lot of technology
that will be relevant

188
00:09:18,400 --> 00:09:20,900
to any destination
that we go to.

189
00:09:20,900 --> 00:09:24,266
And so it's--A lot of times we
use things called

190
00:09:24,266 --> 00:09:26,400
Design Reference Missions

191
00:09:26,400 --> 00:09:28,400
to really define requirements

192

00:09:28,400 --> 00:09:30,166
and to drive technology needs

193

00:09:30,166 --> 00:09:32,533
and this would be
an example of that

194

00:09:32,533 --> 00:09:36,566
where we're setting a goal
of putting humans on Mars

195

00:09:36,566 --> 00:09:38,333
in the 2030s,

196

00:09:38,333 --> 00:09:40,200
and seeing,
what is it going to take

197

00:09:40,200 --> 00:09:41,966
to make that all happen?

198

00:09:41,966 --> 00:09:44,566
And it starts on the far left.

199

00:09:44,566 --> 00:09:46,866
in a regime that we call
Earth Reliant.

200

00:09:46,866 --> 00:09:48,833
This is the regime

201

00:09:48,833 --> 00:09:50,533
that's within
the Earth's atmosphere

202

00:09:50,533 --> 00:09:53,533
as well as up to low Earth orbit

203

00:09:53,533 --> 00:09:57,166

where we can exist
in those environments,

204

00:09:57,166 --> 00:10:00,333

but we rely intrinsically
on regular

205

00:10:00,333 --> 00:10:03,066

and routine support
from Earth.

206

00:10:03,066 --> 00:10:05,933

So we see things
like the Space Station,

207

00:10:05,933 --> 00:10:09,500

obviously,
is an active area of research,

208

00:10:09,500 --> 00:10:12,266

and we are bringing up
astronauts and supplies

209

00:10:12,266 --> 00:10:15,166

on a continuing basis
multiple times per year

210

00:10:15,166 --> 00:10:17,733

to provide
them what they need,

211

00:10:17,733 --> 00:10:19,033

to set up the experiments,

212

00:10:19,033 --> 00:10:22,500

to bring the experiments
and the data back.

213

00:10:22,500 --> 00:10:25,866

And we are learning a lot
but we are completely reliant

214

00:10:25,866 --> 00:10:30,100

on regular launch access
to those areas.

215

00:10:30,100 --> 00:10:33,733

In addition to that, we've got
commercial cargo and crew.

216

00:10:33,733 --> 00:10:37,133

Now, we're trying to hand off
the domain

217

00:10:37,133 --> 00:10:39,800

of low Earth orbit
to the commercial sector

218

00:10:39,800 --> 00:10:42,433

where there are a lot of
commercial potential.

219

00:10:42,433 --> 00:10:45,766

There's also the ability
to commercialize

220

00:10:45,766 --> 00:10:49,033

the space transportation
business to low Earth orbit,

221

00:10:49,033 --> 00:10:51,533

and we are in the process
of doing that

222

00:10:51,533 --> 00:10:54,400

with companies like
Orbital Sciences and SpaceX

223

00:10:54,400 --> 00:10:57,500
that are now providing
launch capabilities to Station

224
00:10:57,500 --> 00:11:00,866
and they will also be able
to provide launch services

225
00:11:00,866 --> 00:11:04,466
to anyone who wants
to access low Earth orbit.

226
00:11:04,466 --> 00:11:08,700
So we've learned a lot
and we've accomplished a lot

227
00:11:08,700 --> 00:11:10,666
in the Earth Reliant.

228
00:11:10,666 --> 00:11:13,566
Now, we're starting to turn
our focus to that middle ground

229
00:11:13,566 --> 00:11:15,133
called a Proving Ground.

230
00:11:15,133 --> 00:11:16,933
Now,
this is where you're getting

231
00:11:16,933 --> 00:11:18,566
a little bit farther out there,

232
00:11:18,566 --> 00:11:21,633
where it's more challenging
to both send

233
00:11:21,633 --> 00:11:24,200
spacecraft, people, payloads,

234

00:11:24,200 --> 00:11:26,366
and also to exist out there.

235

00:11:26,366 --> 00:11:29,133
Outside of the radiation belts

236

00:11:29,133 --> 00:11:33,133
into the environment that
is characteristic of deep space

237

00:11:33,133 --> 00:11:35,766
with radiation,
the potential for solar flares,

238

00:11:35,766 --> 00:11:37,800
longer duration missions,

239

00:11:37,800 --> 00:11:41,733
and the--now, the first time
that the time delay

240

00:11:41,733 --> 00:11:44,066
of communications
starts to become

241

00:11:44,066 --> 00:11:46,900
an important impediment
to how you operate,

242

00:11:46,900 --> 00:11:51,066
from anywhere from seconds
of time delay

243

00:11:51,066 --> 00:11:52,600
communicating with the Moon

244

00:11:52,600 --> 00:11:56,666
to tens of minutes
if we are to look at scenarios

245

00:11:56,666 --> 00:11:58,733
approaching Mars.

246

00:11:58,733 --> 00:12:01,600
And in this regime,
we really need to have

247

00:12:01,600 --> 00:12:03,566
our spacecraft
and our astronauts

248

00:12:03,566 --> 00:12:05,700
be more independent.

249

00:12:05,700 --> 00:12:08,366
And yet,
in this Proving Ground,

250

00:12:08,366 --> 00:12:10,866
we can,
in extreme situations,

251

00:12:10,866 --> 00:12:13,866
turn control or reliance
back to Earth

252

00:12:13,866 --> 00:12:15,766
or we can get back to Earth

253

00:12:15,766 --> 00:12:18,466
in a relatively
short amount of time.

254

00:12:18,466 --> 00:12:21,300
In this regime, we can test out
the technologies

255

00:12:21,300 --> 00:12:25,366

that will be necessary for us
to become Earth independent.

256

00:12:25,366 --> 00:12:28,733

So things like
novel propulsion systems

257

00:12:28,733 --> 00:12:32,633

and also the--the crew--

258

00:12:32,633 --> 00:12:37,200

crew cargo spacecraft
that are going to be necessary

259

00:12:37,200 --> 00:12:40,500

to exist for longer durations
in space.

260

00:12:40,500 --> 00:12:44,000

And finally, we get
to the Earth Independent regime

261

00:12:44,000 --> 00:12:46,966

where we really need
a self-sufficient capability

262

00:12:46,966 --> 00:12:49,400

to sustain astronauts,

263

00:12:49,400 --> 00:12:52,266

to be able to operate
effectively

264

00:12:52,266 --> 00:12:56,066

on planetary surfaces
as well as in orbit,

265

00:12:56,066 --> 00:13:00,166

to fix things
that break ourselves,

266

00:13:00,166 --> 00:13:04,333
rather than having to
go back home for spare parts.

267

00:13:04,333 --> 00:13:08,633
And looking at all
the various support systems,

268

00:13:08,633 --> 00:13:11,266
habitats,
transportation vehicles,

269

00:13:11,266 --> 00:13:13,400
communication systems,
and so forth,

270

00:13:13,400 --> 00:13:16,466
that will sustain life
in an independent manner.

271

00:13:16,466 --> 00:13:19,233
So I took a bit of time
to go through this,

272

00:13:19,233 --> 00:13:22,633
because this really does explain
many of the things that

273

00:13:22,633 --> 00:13:26,066
we are doing within NASA
and particularly here at Ames.

274

00:13:26,066 --> 00:13:30,200
So now, let's turn and look at,
what do we do here at Ames

275

00:13:30,200 --> 00:13:32,733
that we really take pride in

276

00:13:32,733 --> 00:13:34,600

and that we think
contributes strongly

277

00:13:34,600 --> 00:13:36,700

to the future of the Agency?

278

00:13:36,700 --> 00:13:39,833

And we've grouped them
into these eight areas.

279

00:13:39,833 --> 00:13:41,900

They're fairly broad,
but they do--

280

00:13:41,900 --> 00:13:44,666

They don't cover the spectrum
of everything NASA does,

281

00:13:44,666 --> 00:13:47,833

and they certainly exploit
the unique capabilities

282

00:13:47,833 --> 00:13:49,866

that we have here at Ames

283

00:13:49,866 --> 00:13:53,866

as well as by virtue
of the community that we live in

284

00:13:53,866 --> 00:13:55,333

here in Silicon Valley.

285

00:13:55,333 --> 00:13:57,566

And I'll have
a little bit more to say,

286

00:13:57,566 --> 00:13:59,900

so I won't take too long

on each one of these.

287

00:13:59,900 --> 00:14:02,000

Air Traffic Management
is one of our

288

00:14:02,000 --> 00:14:05,166

main heritages
here in aeronautics.

289

00:14:05,166 --> 00:14:07,733

We're making incredible
contributions there.

290

00:14:07,733 --> 00:14:09,700

In Entry Systems,

291

00:14:09,700 --> 00:14:13,133

we've been working
in Entry Systems for decades,

292

00:14:13,133 --> 00:14:16,333

and we are still
the Agency leader

293

00:14:16,333 --> 00:14:20,166

in developing and testing
new technologies.

294

00:14:20,166 --> 00:14:22,133

Obviously,
our location has given us

295

00:14:22,133 --> 00:14:25,000

a great advantage in developing
new computing systems

296

00:14:25,000 --> 00:14:28,900

and information technologies
that have been used to benefit

297

00:14:28,900 --> 00:14:30,866
all of NASA's missions.

298

00:14:30,866 --> 00:14:34,233
Intelligent and Adaptive Systems
is another area that--

299

00:14:34,233 --> 00:14:37,700
that really was an outgrowth
of our capabilities in computing

300

00:14:37,700 --> 00:14:39,833
and has been applied

301

00:14:39,833 --> 00:14:42,200
to building more
and more intelligence

302

00:14:42,200 --> 00:14:44,500
into the machines
that serve us,

303

00:14:44,500 --> 00:14:47,466
whether they are aircraft
or they're spacecraft

304

00:14:47,466 --> 00:14:52,000
or planetary
exploration vehicles.

305

00:14:52,000 --> 00:14:54,900
Low-Cost Space Missions,

306

00:14:54,900 --> 00:14:56,333
and this is important.

307

00:14:56,333 --> 00:14:59,833
It leverages our--

the spirit of innovation

308

00:14:59,833 --> 00:15:02,166

that we have
here in Silicon Valley

309

00:15:02,166 --> 00:15:04,433

and asking the question,

310

00:15:04,433 --> 00:15:07,000

"Can we do the same thing
for less?"

311

00:15:07,000 --> 00:15:10,700

Now, in many cases,
space is expensive,

312

00:15:10,700 --> 00:15:12,900

sometimes very, very expensive,

313

00:15:12,900 --> 00:15:15,333

but through some creativity

314

00:15:15,333 --> 00:15:18,133

and through looking
at unique combinations

315

00:15:18,133 --> 00:15:20,833

of technology capabilities,
we can ask,

316

00:15:20,833 --> 00:15:24,066

"Well, couldn't we do the same
thing for a whole lot less?"

317

00:15:24,066 --> 00:15:26,500

And, of course,
when you do that,

318

00:15:26,500 --> 00:15:28,100
you're accepting more risk.

319
00:15:28,100 --> 00:15:32,333
And so what we are pioneering
for the Agency

320
00:15:32,333 --> 00:15:37,033
is developing low-cost
novel space missions,

321
00:15:37,033 --> 00:15:40,833
admittedly accepting
additional risk,

322
00:15:40,833 --> 00:15:42,533
but the payoff is there that

323
00:15:42,533 --> 00:15:44,433
we're willing to take the risk

324
00:15:44,433 --> 00:15:47,800
in order for a big payoff
that we can do science

325
00:15:47,800 --> 00:15:50,333
and exploration
more inexpensively,

326
00:15:50,333 --> 00:15:52,566
more quickly,
and we can take advantage

327
00:15:52,566 --> 00:15:55,633
of higher technology
because of the shorter cycles.

328
00:15:55,633 --> 00:15:58,566
So this is a new area
that's really taken root

329

00:15:58,566 --> 00:16:00,400
within the Agency.

330

00:16:00,400 --> 00:16:02,400
Aerosciences
is a very broad area

331

00:16:02,400 --> 00:16:05,800
that applies to using the--

332

00:16:05,800 --> 00:16:08,866
both the experimental
and computational capabilities

333

00:16:08,866 --> 00:16:10,333
that we have here at the Center

334

00:16:10,333 --> 00:16:14,100
to model and simulate
all types of vehicles

335

00:16:14,100 --> 00:16:16,300
from aircraft to spacecraft

336

00:16:16,300 --> 00:16:19,666
and to use the understanding
of physics

337

00:16:19,666 --> 00:16:23,366
and the capabilities
of digital computing

338

00:16:23,366 --> 00:16:27,066
to perform design trades
and optimize vehicles

339

00:16:27,066 --> 00:16:29,900
much better than we

ever used to be able to.

340

00:16:29,900 --> 00:16:32,066

Astrobiology and Life Science,

341

00:16:32,066 --> 00:16:34,633

another area that we

pioneered for the Agency,

342

00:16:34,633 --> 00:16:36,900

looking at the origins of life

343

00:16:36,900 --> 00:16:39,700

and the existence of life

elsewhere in the universe.

344

00:16:39,700 --> 00:16:43,000

And, finally,

in Space and Earth Sciences.

345

00:16:43,000 --> 00:16:46,066

We have astronomers,

we have Earth scientists

346

00:16:46,066 --> 00:16:49,300

who are Agency leaders

347

00:16:49,300 --> 00:16:51,200

in unique missions

348

00:16:51,200 --> 00:16:53,033

that help us

understand our planet

349

00:16:53,033 --> 00:16:55,933

and also the existence

of other planets

350

00:16:55,933 --> 00:16:59,633

and understanding the universe
in the broader context.

351

00:16:59,633 --> 00:17:03,033

So these are
the general eight areas

352

00:17:03,033 --> 00:17:05,033

that we put forward

353

00:17:05,033 --> 00:17:08,033

as where we can make
unique novel contributions

354

00:17:08,033 --> 00:17:11,033

to the Agency and really propel
the Agency forward

355

00:17:11,033 --> 00:17:12,966

in its missions.

356

00:17:12,966 --> 00:17:15,533

There's a relationship then
between these eight

357

00:17:15,533 --> 00:17:19,833

and the broad visions
that the Agency has put out,

358

00:17:19,833 --> 00:17:22,800

and so I want to kind of
step through some of those

359

00:17:22,800 --> 00:17:25,300

and give you
a little bit better idea

360

00:17:25,300 --> 00:17:28,533

of how we're contributing
in each of those areas.

361

00:17:28,533 --> 00:17:31,600

So let me start with
the aeronautics theme.

362

00:17:31,600 --> 00:17:34,233

We said, we're
"With you when you fly."

363

00:17:34,233 --> 00:17:37,333

And these--this is just a list

364

00:17:37,333 --> 00:17:39,766

along with some graphics
of some of the key areas.

365

00:17:39,766 --> 00:17:42,033

I'll just touch on each one
very briefly

366

00:17:42,033 --> 00:17:44,900

and then I'll go into a little
bit more detail on one of them

367

00:17:44,900 --> 00:17:47,600

to give you a flavor of
how we're contributing.

368

00:17:47,600 --> 00:17:50,666

In Transformative Aeronautics
Concepts we're looking

369

00:17:50,666 --> 00:17:53,666

at changing the paradigm
of air transportation.

370

00:17:53,666 --> 00:17:57,600

Right now, we get on
a large aircraft

371

00:17:57,600 --> 00:18:00,700

that looks essentially the same
as it did 40 years ago.

372

00:18:00,700 --> 00:18:02,600

It's an aluminum tube
with wings.

373

00:18:02,600 --> 00:18:05,266

A lot has changed since then,

374

00:18:05,266 --> 00:18:08,133

but the paradigm is very static.

375

00:18:08,133 --> 00:18:10,366

Now, we're at an age
where we're starting to look

376

00:18:10,366 --> 00:18:14,133

at whether things like personal
air transportation is possible,

377

00:18:14,133 --> 00:18:17,800

whether we can
stop using fossil fuels

378

00:18:17,800 --> 00:18:20,333

and make electric aircraft work.

379

00:18:20,333 --> 00:18:22,533

These are transformative,

380

00:18:22,533 --> 00:18:25,733

and so we are
looking at that here at Ames.

381

00:18:25,733 --> 00:18:28,833

We are also looking
at the Operations & Safety.

382

00:18:28,833 --> 00:18:30,233

I'll say a little bit more.

383

00:18:30,233 --> 00:18:32,666

This gets to the air
transportation system,

384

00:18:32,666 --> 00:18:36,466

but we also use
our data analysis capabilities

385

00:18:36,466 --> 00:18:38,533

to understand
the aviation system

386

00:18:38,533 --> 00:18:41,233

and where there might
be emergent safety concerns

387

00:18:41,233 --> 00:18:46,700

and solve those problems
before they result in accidents.

388

00:18:46,700 --> 00:18:50,166

UAS, Unmanned Aerial Systems,
Airspace Integration

389

00:18:50,166 --> 00:18:51,966

is a really big deal here.

390

00:18:51,966 --> 00:18:54,533

And any of you
who were here last week

391

00:18:54,533 --> 00:18:56,633

might have noticed
a major event we had

392

00:18:56,633 --> 00:18:58,500
down by Hangar One,

393

00:18:58,500 --> 00:19:00,733
which was a convention

394

00:19:00,733 --> 00:19:04,500
to address the very fascinating
and complex issues

395

00:19:04,500 --> 00:19:06,200
associated with this.

396

00:19:06,200 --> 00:19:10,500
Concerns not only about
how to fly and regulate drones,

397

00:19:10,500 --> 00:19:13,700
but also, what are the concerns
about insurance

398

00:19:13,700 --> 00:19:15,866
and privacy and security
and safety?

399

00:19:15,866 --> 00:19:18,300
It was a fantastic event,

400

00:19:18,300 --> 00:19:20,166
brought the community together,

401

00:19:20,166 --> 00:19:21,533
and I think
it's going to help us

402

00:19:21,533 --> 00:19:23,866
make a lot of progress there.

403

00:19:23,866 --> 00:19:28,200

I mentioned about High Fidelity
Modeling & Simulations.

404

00:19:28,200 --> 00:19:30,300

We continue
to have a heritage there,

405

00:19:30,300 --> 00:19:33,833

and really, the fundamental
understanding of fluid physics

406

00:19:33,833 --> 00:19:39,766

and acoustics to design
evermore capable aircraft.

407

00:19:39,766 --> 00:19:41,866

Wind tunnels, you can't drive
around the Center

408

00:19:41,866 --> 00:19:43,566

without seeing
a few wind tunnels,

409

00:19:43,566 --> 00:19:45,633

including the largest
wind tunnel in the world,

410

00:19:45,633 --> 00:19:49,533

and also one of the busiest
and most productive wind tunnels

411

00:19:49,533 --> 00:19:52,133

right across the street
from the largest wind tunnel.

412

00:19:52,133 --> 00:19:53,866

It's the one
with the white shell

413

00:19:53,866 --> 00:19:55,566

and the NASA meatball
on it.

414
00:19:55,566 --> 00:19:58,066
That's the most productive
transonic wind tunnel

415
00:19:58,066 --> 00:20:00,533
in the country,
and just about every aircraft

416
00:20:00,533 --> 00:20:02,533
that flies
in the transonic regime

417
00:20:02,533 --> 00:20:03,966
goes through that tunnel.

418
00:20:03,966 --> 00:20:05,533
Flight simulators,

419
00:20:05,533 --> 00:20:08,300
also to assess
pilot handling capabilities.

420
00:20:08,300 --> 00:20:11,700
We have three major
flight simulation assets here.

421
00:20:11,700 --> 00:20:13,200
And then we have

422
00:20:13,200 --> 00:20:15,500
the NASA Aeronautics
Research Institute.

423
00:20:15,500 --> 00:20:18,200
It's one of our
three virtual institutes

424
00:20:18,200 --> 00:20:19,933
here at the Center.

425
00:20:19,933 --> 00:20:21,700
Virtual institutes
are a novel construct,

426
00:20:21,700 --> 00:20:24,866
and I'll say a little bit more
about that in a minute.

427
00:20:24,866 --> 00:20:28,200
This is what enables us
to network and connect

428
00:20:28,200 --> 00:20:30,033
with the broader community,

429
00:20:30,033 --> 00:20:32,933
academia and industry,

430
00:20:32,933 --> 00:20:35,666
as well as partners
around the world,

431
00:20:35,666 --> 00:20:37,800
to bring
the best minds together

432
00:20:37,800 --> 00:20:39,966
to address problems.

433
00:20:39,966 --> 00:20:42,366
In the area of
Air Transportation,

434
00:20:42,366 --> 00:20:45,000
Air Traffic Management,
we've combined our knowledge

435

00:20:45,000 --> 00:20:47,333
of how aircraft fly.

436

00:20:47,333 --> 00:20:51,000
We had our heritage
in aircraft control,

437

00:20:51,000 --> 00:20:52,466
so we have a detailed
understanding

438

00:20:52,466 --> 00:20:54,300
of how aircraft fly.

439

00:20:54,300 --> 00:20:56,600
Together with
a number of other disciplines

440

00:20:56,600 --> 00:20:59,400
including information technology

441

00:20:59,400 --> 00:21:01,866
as well as human factors

442

00:21:01,866 --> 00:21:03,366
and operations research

443

00:21:03,366 --> 00:21:06,700
to look at when you have
multiple aircraft in the sky,

444

00:21:06,700 --> 00:21:09,500
what is the best way
to manage those flights

445

00:21:09,500 --> 00:21:11,200
so that everybody
gets where they want to

446

00:21:11,200 --> 00:21:14,166
safely in minimum time.

447

00:21:14,166 --> 00:21:17,233
And as a result of this work
over the past decades,

448

00:21:17,233 --> 00:21:20,933
we have developed
decision support tools

449

00:21:20,933 --> 00:21:24,066
for both pilots and for
air traffic controllers

450

00:21:24,066 --> 00:21:25,800
that help them manage

451

00:21:25,800 --> 00:21:27,400
the efficient
flow of the airspace.

452

00:21:27,400 --> 00:21:29,166
Now, looking to the future,

453

00:21:29,166 --> 00:21:32,000
we're looking to ever higher
levels of automation

454

00:21:32,000 --> 00:21:35,700
and that potentially
someday leading to autonomous

455

00:21:35,700 --> 00:21:37,366
flight management systems,

456

00:21:37,366 --> 00:21:41,700
both on aircraft as well as

sort of a central manager that--

457

00:21:41,700 --> 00:21:44,300
that handles all the traffic
going around

458

00:21:44,300 --> 00:21:47,100
the United States
and abroad.

459

00:21:47,100 --> 00:21:50,633
So this has been
an area of huge success for us.

460

00:21:50,633 --> 00:21:54,033
We have transferred
our technology to the FAA,

461

00:21:54,033 --> 00:21:56,733
who has deployed it,
and now when you fly

462

00:21:56,733 --> 00:21:59,000
anywhere in the United States,

463

00:21:59,000 --> 00:22:02,666
your flight is being aided
and controlled by technology

464

00:22:02,666 --> 00:22:04,700
developed right here
at Ames Research Center,

465

00:22:04,700 --> 00:22:08,366
helping you get to where
you're going with minimum delay.

466

00:22:08,366 --> 00:22:10,933
I'm not promising you
that you won't have delays,

467

00:22:10,933 --> 00:22:13,533

I'm just saying
it's less than it used to be.

468

00:22:13,533 --> 00:22:15,766

And the problem
is getting harder,

469

00:22:15,766 --> 00:22:18,100

because there's more and more
traffic in the air

470

00:22:18,100 --> 00:22:21,000

and there are also
new constraints

471

00:22:21,000 --> 00:22:24,200

that we have to deal with,
like noise constraints

472

00:22:24,200 --> 00:22:27,733

and having to deal with
carbon emissions

473

00:22:27,733 --> 00:22:29,200

and minimizing that.

474

00:22:29,200 --> 00:22:32,833

So
it's an ever-growing problem

475

00:22:32,833 --> 00:22:35,266

but we've also got some
breakthrough technology

476

00:22:35,266 --> 00:22:37,800

that should help us
solve those.

477

00:22:37,800 --> 00:22:40,400

In the area of Earth Science,

478

00:22:40,400 --> 00:22:42,200

really, a lot of different
things going on.

479

00:22:42,200 --> 00:22:44,633

I'll highlight
the Earth Exchange

480

00:22:44,633 --> 00:22:46,933

as one of the major
contributions we make

481

00:22:46,933 --> 00:22:50,033

where we're using our
high-end computing capabilities

482

00:22:50,033 --> 00:22:52,333

and data storage and management

483

00:22:52,333 --> 00:22:55,566

to bring in the, literally,
terabytes of data

484

00:22:55,566 --> 00:22:58,600

coming from satellites
and airborne platforms

485

00:22:58,600 --> 00:23:01,966

on a daily basis
to bring it all together

486

00:23:01,966 --> 00:23:04,066

and put it
into a manageable format

487

00:23:04,066 --> 00:23:06,833

so that scientists
around the country

488

00:23:06,833 --> 00:23:09,733

can access it
and use it to analyze,

489

00:23:09,733 --> 00:23:11,633

to answer
scientific questions,

490

00:23:11,633 --> 00:23:15,166

and help us deal
with the challenging problems

491

00:23:15,166 --> 00:23:17,366

of Earth climate.

492

00:23:17,366 --> 00:23:20,633

Airborne Science
is particularly one that

493

00:23:20,633 --> 00:23:23,966

we have played a strong role
and will continue to.

494

00:23:23,966 --> 00:23:29,466

And the future is really looking
at novel unmanned platforms

495

00:23:29,466 --> 00:23:33,500

that we have a unique capability
here to look at those

496

00:23:33,500 --> 00:23:37,266

either as single platforms
that are doing surveys

497

00:23:37,266 --> 00:23:42,400

or to use swarms to really

understand the complexities

498

00:23:42,400 --> 00:23:45,566

of the system

that we're interested in,

499

00:23:45,566 --> 00:23:47,700

whether it's

a volcanic ash plume

500

00:23:47,700 --> 00:23:51,266

or sea temperatures

and things like that.

501

00:23:51,266 --> 00:23:55,300

Sustainability then feeds off

of these to look at,

502

00:23:55,300 --> 00:23:57,666

how do we manage

the Earth as an ecosystem,

503

00:23:57,666 --> 00:24:01,500

and how do we use that knowledge

to build a better ecosystem?

504

00:24:01,500 --> 00:24:05,100

And we're also pioneering

the use of small satellites

505

00:24:05,100 --> 00:24:07,500

and advanced computing

506

00:24:07,500 --> 00:24:10,633

to benefit the understanding

of our home planet.

507

00:24:10,633 --> 00:24:13,633

So this is one of our big UAS.

508

00:24:13,633 --> 00:24:15,333

This is actually down
at Armstrong.

509

00:24:15,333 --> 00:24:16,733

Armstrong Flight Research Center

510

00:24:16,733 --> 00:24:19,433

down in the desert
of Southern California

511

00:24:19,433 --> 00:24:20,766

operates the aircraft.

512

00:24:20,766 --> 00:24:23,333

We do a lot
of the science payloads

513

00:24:23,333 --> 00:24:26,266

and the definition
of the missions.

514

00:24:26,266 --> 00:24:28,933

So that's one of the big ones,
and then on the small end,

515

00:24:28,933 --> 00:24:32,633

we've got aircraft that are
no bigger than your arm span

516

00:24:32,633 --> 00:24:35,600

that can fly very easily
and carry small instruments

517

00:24:35,600 --> 00:24:38,766

to conduct novel missions.

518

00:24:38,766 --> 00:24:40,266

International Space Station.

519

00:24:40,266 --> 00:24:42,933

We have a large and growing
program in Life Science.

520

00:24:42,933 --> 00:24:45,333

This is,
as I said earlier,

521

00:24:45,333 --> 00:24:48,800

both about helping us
understand life here on Earth,

522

00:24:48,800 --> 00:24:54,233

but equally importantly,
understanding the life in space.

523

00:24:54,233 --> 00:24:58,700

the effects of radiation
and microgravity on life

524

00:24:58,700 --> 00:25:01,533

and what we might
need to be concerned about

525

00:25:01,533 --> 00:25:04,400

for longer term
deep space missions.

526

00:25:04,400 --> 00:25:08,633

And so we have developed
a capability

527

00:25:08,633 --> 00:25:11,100

to deliver life science
experiments

528

00:25:11,100 --> 00:25:12,300

to the Space Station,

529

00:25:12,300 --> 00:25:14,900

have them
conducted very efficiently,

530

00:25:14,900 --> 00:25:17,033

and bring down the results.

531

00:25:17,033 --> 00:25:18,533

That's a vibrant program.

532

00:25:18,533 --> 00:25:20,533

We've also got
Robotic Free-flyers.

533

00:25:20,533 --> 00:25:23,400

I'll say a little bit more
about it in a minute.

534

00:25:23,400 --> 00:25:26,366

Efficient Crew Operations
I'll just touch on briefly too.

535

00:25:26,366 --> 00:25:29,300

That builds off of our work

536

00:25:29,300 --> 00:25:32,800

in intelligent systems
and autonomy.

537

00:25:32,800 --> 00:25:36,366

And what we're doing here
is helping Johnson Space Center

538

00:25:36,366 --> 00:25:38,300

manage crew time,

539

00:25:38,300 --> 00:25:40,766

and it turns out
that on the Space Station,

540

00:25:40,766 --> 00:25:43,766
crew time is the limiting factor
in many cases

541

00:25:43,766 --> 00:25:47,233
for how much science can
get done on the Space Station,

542

00:25:47,233 --> 00:25:51,833
because the astronauts on board
are busy from dawn to dusk,

543

00:25:51,833 --> 00:25:54,233
and they have a lot of those
during a day,

544

00:25:54,233 --> 00:25:58,133
running experiments
and managing them

545

00:25:58,133 --> 00:26:00,200
and taking data,

546

00:26:00,200 --> 00:26:02,500
and so the scheduling
becomes a huge challenge.

547

00:26:02,500 --> 00:26:05,066
We've developed
some automation technology

548

00:26:05,066 --> 00:26:07,666
that is being used
by Johnson Space Center

549

00:26:07,666 --> 00:26:09,933
to optimize the crew time

550

00:26:09,933 --> 00:26:12,333
so that we can get as much
science through the Station

551
00:26:12,333 --> 00:26:16,133
as possible, and that's been
a big success story.

552
00:26:16,133 --> 00:26:20,400
SPHERES is the free-flyer
that I referred to a second ago

553
00:26:20,400 --> 00:26:22,633
and you can see
it's a very clever acronym

554
00:26:22,633 --> 00:26:26,400
for a little ball
that's a robot

555
00:26:26,400 --> 00:26:29,100
and it helps the astronauts
on board the Station

556
00:26:29,100 --> 00:26:31,433
with routine tasks

557
00:26:31,433 --> 00:26:33,800
that can be performed
by a computer.

558
00:26:33,800 --> 00:26:38,333
But the computer actually drives
itself around the Station,

559
00:26:38,333 --> 00:26:40,966
gets where it needs to be,

560
00:26:40,966 --> 00:26:42,866
and does the function

that it needs to do

561

00:26:42,866 --> 00:26:44,200

all by itself.

562

00:26:44,200 --> 00:26:45,633

It's an autonomous system.

563

00:26:45,633 --> 00:26:48,566

It's driven

by little carbon dioxide

564

00:26:48,566 --> 00:26:51,633

pressure jets

to move it around

565

00:26:51,633 --> 00:26:54,633

and I think this guy

is actually trying to juggle,

566

00:26:54,633 --> 00:26:58,133

which is sort of a perplexing

concept in zero gravity,

567

00:26:58,133 --> 00:27:02,366

but in any event,

this idea was started here,

568

00:27:02,366 --> 00:27:03,833

and we actually

built these systems

569

00:27:03,833 --> 00:27:06,466

and the embedded computing

is actually

570

00:27:06,466 --> 00:27:09,200

right out of a very

high-end smartphone

571
00:27:09,200 --> 00:27:13,133
that drives
the whole assistant there.

572
00:27:13,133 --> 00:27:15,100
And so that's something
that the astronauts have

573
00:27:15,100 --> 00:27:17,300
come to know and love.

574
00:27:17,300 --> 00:27:19,900
In Space Technology,

575
00:27:19,900 --> 00:27:23,266
we're also looking at
how we can advance capabilities

576
00:27:23,266 --> 00:27:26,166
that are going to get us
to that Proving Ground

577
00:27:26,166 --> 00:27:28,333
and into Earth independent.

578
00:27:28,333 --> 00:27:31,366
We have partnered
with a company

579
00:27:31,366 --> 00:27:33,133
right out here
in the Research Park

580
00:27:33,133 --> 00:27:36,433
to put the first 3-D printer
on board the station.

581
00:27:36,433 --> 00:27:38,500
And we're starting

to look at how we could

582

00:27:38,500 --> 00:27:40,733

build spare parts and parts
that we need,

583

00:27:40,733 --> 00:27:42,900

unique parts,
in space rather than

584

00:27:42,900 --> 00:27:44,500

having to carry everything up.

585

00:27:44,500 --> 00:27:47,166

Heat Shields,
I'll say a little bit more.

586

00:27:47,166 --> 00:27:50,833

That's really one of our most
famous contributions

587

00:27:50,833 --> 00:27:53,366

in space technology,

588

00:27:53,366 --> 00:27:55,900

but we're also contributing--

589

00:27:55,900 --> 00:27:59,800

We've done a lot of autonomy
work for Mars Science Laboratory

590

00:27:59,800 --> 00:28:03,033

and the "Curiosity Rover"
to help it also

591

00:28:03,033 --> 00:28:05,066

be as productive as it can

592

00:28:05,066 --> 00:28:07,366

in collecting science.

593

00:28:07,366 --> 00:28:11,033

And then we're looking
at this intriguing area

594

00:28:11,033 --> 00:28:12,433

of Synthetic Biology.

595

00:28:12,433 --> 00:28:15,066

Can we use
our understanding of biology

596

00:28:15,066 --> 00:28:18,000

to serve our purposes better

597

00:28:18,000 --> 00:28:20,500

in terms of producing elements

598

00:28:20,500 --> 00:28:22,766

and compounds that we need

599

00:28:22,766 --> 00:28:25,133

rather than having to synthesize
them here on Earth

600

00:28:25,133 --> 00:28:26,900

and take them with us,

601

00:28:26,900 --> 00:28:30,700

to use the best of biology
to further our sustainability

602

00:28:30,700 --> 00:28:33,266

and our needs in space.

603

00:28:33,266 --> 00:28:37,033

And then again, we've kind
of done the path-finding work

604

00:28:37,033 --> 00:28:40,633

on small satellites,
like the ones shown here.

605

00:28:40,633 --> 00:28:44,866

So in Heat Shields,
we have developed the materials

606

00:28:44,866 --> 00:28:48,900

on the heat shields used
for just about every spacecraft

607

00:28:48,900 --> 00:28:51,333

that has entered
an atmosphere.

608

00:28:51,333 --> 00:28:55,566

Every heat shield
has had its materials tested

609

00:28:55,566 --> 00:28:57,666

here in facilities that we have.

610

00:28:57,666 --> 00:29:00,533

This mass
of wires here is actually

611

00:29:00,533 --> 00:29:02,800

a facility called an arc jet

612

00:29:02,800 --> 00:29:06,966

testing materials at
the temperatures and speeds

613

00:29:06,966 --> 00:29:08,866

associated with entry from--

614

00:29:08,866 --> 00:29:10,933

either from return from the Moon

615

00:29:10,933 --> 00:29:13,533

or from deeper space.

616

00:29:13,533 --> 00:29:16,333

And we've invented
some of the materials

617

00:29:16,333 --> 00:29:18,400

that have proven
to be the most capable.

618

00:29:18,400 --> 00:29:20,666

This material called PICA

619

00:29:20,666 --> 00:29:23,466

enabled the Mars Science
Laboratory mission.

620

00:29:23,466 --> 00:29:26,633

It was the heat shield material
of choice.

621

00:29:26,633 --> 00:29:30,433

It was invented here and tested
and developed and proven.

622

00:29:30,433 --> 00:29:32,800

So we have a long heritage,

623

00:29:32,800 --> 00:29:36,100

and we're very proud
of what we contribute there.

624

00:29:36,100 --> 00:29:37,966

So Mars,
where we're headed.

625

00:29:37,966 --> 00:29:41,500

We've got
a long heritage of work

626

00:29:41,500 --> 00:29:44,700

looking at the climate
and the environment on Mars.

627

00:29:44,700 --> 00:29:47,233

Very important to life on Mars.

628

00:29:47,233 --> 00:29:48,633

A quick show of hands.

629

00:29:48,633 --> 00:29:51,533

How many of you have read
"The Martian"?

630

00:29:51,533 --> 00:29:53,100

Okay.

631

00:29:53,100 --> 00:29:54,766

How many of you are gonna
go see the movie?

632

00:29:54,766 --> 00:29:56,266

Probably all of you,
I hope so.

633

00:29:56,266 --> 00:29:58,300

I personally think that should
be required reading

634

00:29:58,300 --> 00:30:00,800

for everybody
who works at NASA.

635

00:30:00,800 --> 00:30:04,166

It is fiction,
but it is very good fiction.

636

00:30:04,166 --> 00:30:07,333

And it actually
helps you understand

637

00:30:07,333 --> 00:30:10,800

a lot about the challenges
of getting to Mars with people.

638

00:30:10,800 --> 00:30:13,966

And so understanding
the environment, obviously,

639

00:30:13,966 --> 00:30:18,066

the story starts with a story
about the environment.

640

00:30:18,066 --> 00:30:20,133

And so it's very important to
understand that

641

00:30:20,133 --> 00:30:23,666

so that we know what
we're going to deal with.

642

00:30:23,666 --> 00:30:27,100

Astrobiology,
understanding, what do we even

643

00:30:27,100 --> 00:30:29,100

look for if we're looking
for life?

644

00:30:29,100 --> 00:30:30,666

What are the markers?

645

00:30:30,666 --> 00:30:32,466

What are the precursors?

646

00:30:32,466 --> 00:30:34,766

What are the fossil records
going to look like

647

00:30:34,766 --> 00:30:36,766

in a completely different
environment?

648

00:30:36,766 --> 00:30:41,066

And so our understanding
of astrobiology will inform

649

00:30:41,066 --> 00:30:43,833

the types of activities
we want to conduct

650

00:30:43,833 --> 00:30:46,066

when we get there.

651

00:30:46,066 --> 00:30:48,600

Obviously, we're not going to do
it all with people,

652

00:30:48,600 --> 00:30:51,400

we're going to need
teams of robots

653

00:30:51,400 --> 00:30:53,800

and astronauts
working together.

654

00:30:53,800 --> 00:30:56,333

Right now, we've done
each one separately.

655

00:30:56,333 --> 00:30:58,000

What we really need
to figure out

656

00:30:58,000 --> 00:31:01,366

is how to deploy a team,
mixed initiative team,

657

00:31:01,366 --> 00:31:02,900
of humans and robots

658

00:31:02,900 --> 00:31:05,033
that can accomplish
a mission objective

659

00:31:05,033 --> 00:31:08,933
very efficiently and in
a very coordinated fashion.

660

00:31:08,933 --> 00:31:12,866
And of course, the heat shields
just need to keep getting better

661

00:31:12,866 --> 00:31:15,033
because the entry speeds
are higher

662

00:31:15,033 --> 00:31:17,733
and the payload masses
are higher.

663

00:31:17,733 --> 00:31:21,500
And so getting heavy payloads
to the surface of Mars

664

00:31:21,500 --> 00:31:23,500
is one of the pacing items

665

00:31:23,500 --> 00:31:27,166
in enabling
the manned Mars mission.

666

00:31:27,166 --> 00:31:29,433
It will require capabilities

667

00:31:29,433 --> 00:31:33,700

beyond anything
that we have now.

668

00:31:33,700 --> 00:31:37,033

And furthermore, so I mentioned
about the autonomy

669

00:31:37,033 --> 00:31:40,900

that we're contributing
to the Mars Science Laboratory

670

00:31:40,900 --> 00:31:44,500

and helping JPL schedule
the science operations

671

00:31:44,500 --> 00:31:46,100

of the Rover.

672

00:31:46,100 --> 00:31:47,566

Great success story there,

673

00:31:47,566 --> 00:31:50,066

and we'll certainly be using
that as we go forward

674

00:31:50,066 --> 00:31:52,866

with future missions,
like Mars 2020.

675

00:31:52,866 --> 00:31:56,300

In addition to that, we have
very creative scientists here

676

00:31:56,300 --> 00:32:00,133

who develop instruments
to meet unique requirements

677

00:32:00,133 --> 00:32:03,766

and one of them here
is the one we call CheMin,

678

00:32:03,766 --> 00:32:08,466
which is an X-ray diffraction
spectroscopy.

679

00:32:08,466 --> 00:32:10,866
That alone is not unique.

680

00:32:10,866 --> 00:32:12,833
Those devices have existed,

681

00:32:12,833 --> 00:32:14,866
but all
the previously existing

682

00:32:14,866 --> 00:32:17,000
X-ray diffraction
spectroscopy

683

00:32:17,000 --> 00:32:18,833
were far too big and heavy

684

00:32:18,833 --> 00:32:20,666
and required too much power

685

00:32:20,666 --> 00:32:22,933
to make it onto a payload.

686

00:32:22,933 --> 00:32:25,466
What our scientists
figured out is

687

00:32:25,466 --> 00:32:27,033
how to miniaturize that

688

00:32:27,033 --> 00:32:29,133
to the point that

we could put one of these

689

00:32:29,133 --> 00:32:31,966
on the Curiosity Rover.

690

00:32:31,966 --> 00:32:35,166
And we won that proposal,

691

00:32:35,166 --> 00:32:36,866
built the device,

692

00:32:36,866 --> 00:32:39,166
and it is up on Mars
working right now

693

00:32:39,166 --> 00:32:42,166
on determining
the chemical constituents

694

00:32:42,166 --> 00:32:44,833
of the Martian regolith

695

00:32:44,833 --> 00:32:47,233
to determine if
there are markers

696

00:32:47,233 --> 00:32:50,333
of things like the existence
of liquid water

697

00:32:50,333 --> 00:32:54,233
and any compounds that might be
associated with

698

00:32:54,233 --> 00:32:56,733
precursors of organic life.

699

00:32:56,733 --> 00:33:01,033
So that's a heritage that

we will also be continuing.

700

00:33:01,033 --> 00:33:04,800

Finally, getting in
to the Solar System and Beyond.

701

00:33:04,800 --> 00:33:06,200

We've got
a number of missions that

702

00:33:06,200 --> 00:33:08,533

we're very proud
to have lead here

703

00:33:08,533 --> 00:33:10,333

and look forward to a future

704

00:33:10,333 --> 00:33:12,466

that continues to contribute.

705

00:33:12,466 --> 00:33:15,300

Kepler I'll say a little bit
more about in a minute,

706

00:33:15,300 --> 00:33:19,566

very exciting planet--
exoplanet hunting vehicle.

707

00:33:19,566 --> 00:33:22,033

SOFIA is the aircraft
shown here,

708

00:33:22,033 --> 00:33:25,800

the Stratospheric Observatory
for Infrared Astronomy.

709

00:33:25,800 --> 00:33:28,166

Cut a huge hole in a 747,

710

00:33:28,166 --> 00:33:29,733
hope nothing goes wrong.

711
00:33:29,733 --> 00:33:31,200
Actually,
we did the engineering

712
00:33:31,200 --> 00:33:33,033
to make sure
nothing would go wrong.

713
00:33:33,033 --> 00:33:36,000
Put a big telescope in there
and do infrared astronomy

714
00:33:36,000 --> 00:33:38,200
from the stratosphere,

715
00:33:38,200 --> 00:33:41,766
where you're above
99% of the Earth's water,

716
00:33:41,766 --> 00:33:43,666
which absorbs infrared,

717
00:33:43,666 --> 00:33:46,033
and so you can make observations

718
00:33:46,033 --> 00:33:48,933
that are space quality
observations

719
00:33:48,933 --> 00:33:51,833
from an aircraft
that can return home

720
00:33:51,833 --> 00:33:55,166
every morning
to be refurbished, resupplied,

721
00:33:55,166 --> 00:33:57,800
and we can bring on
new scientists.

722
00:33:57,800 --> 00:34:00,466
So this is a very active
and productive aircraft.

723
00:34:00,466 --> 00:34:01,833
It flies out of Armstrong.

724
00:34:01,833 --> 00:34:03,566
The science team is here,

725
00:34:03,566 --> 00:34:07,033
and just as of the beginning
of the next fiscal year,

726
00:34:07,033 --> 00:34:09,700
we will be operating
the entire program

727
00:34:09,700 --> 00:34:11,933
from Ames Research Center.

728
00:34:11,933 --> 00:34:15,700
And then the rest of the list
are things that have

729
00:34:15,700 --> 00:34:19,200
already mentioned that
impact all of our missions

730
00:34:19,200 --> 00:34:22,733
and heat shields
and the robotics.

731
00:34:22,733 --> 00:34:25,233
And then down toward

the bottom of the list, there's

732

00:34:25,233 --> 00:34:30,333
the Solar System Exploration
and Research Virtual Institute

733

00:34:30,333 --> 00:34:32,933
and the NASA
Astrobiology Institute.

734

00:34:32,933 --> 00:34:36,366
Those are the other
two virtual institutes

735

00:34:36,366 --> 00:34:39,366
that are contributing
to our capability

736

00:34:39,366 --> 00:34:43,633
to bring the entire world
community together.

737

00:34:43,633 --> 00:34:45,066
Kepler,

738

00:34:45,066 --> 00:34:46,800
this is the exoplanet hunter.

739

00:34:46,800 --> 00:34:48,600
You may have heard
a lot about it already,

740

00:34:48,600 --> 00:34:52,133
so I won't belabor the point,
except to say that

741

00:34:52,133 --> 00:34:55,566
it's a tremendously successful
mission.

742
00:34:55,566 --> 00:34:57,700
Doing transit photometry,

743
00:34:57,700 --> 00:34:59,733
staring at one little region
of space

744
00:34:59,733 --> 00:35:03,300
to look for variations
in the brightness of stars

745
00:35:03,300 --> 00:35:05,833
that might be associated
with a planet

746
00:35:05,833 --> 00:35:07,633
transitting in front of
the star.

747
00:35:07,633 --> 00:35:10,333
And through a lot of
independent observation

748
00:35:10,333 --> 00:35:12,366
and data reduction,

749
00:35:12,366 --> 00:35:15,333
we can identify
and conclusively determine

750
00:35:15,333 --> 00:35:18,066
the size, the orbit,

751
00:35:18,066 --> 00:35:20,700
and composition of many of
those planets.

752
00:35:20,700 --> 00:35:24,700
Now, our creativity

came into play recently

753

00:35:24,700 --> 00:35:28,533
when the nominal Kepler mission
suffered a failure

754

00:35:28,533 --> 00:35:30,166
of two of its gyros.

755

00:35:30,166 --> 00:35:32,400
It has four gyros,
one was redundant,

756

00:35:32,400 --> 00:35:36,066
so we had three gyros to control
the three spin axes.

757

00:35:36,066 --> 00:35:40,933
And due to a defect,
two of the gyros failed early.

758

00:35:40,933 --> 00:35:42,966
Well, with only
two working gyros,

759

00:35:42,966 --> 00:35:46,166
you can't stabilize
all three axes

760

00:35:46,166 --> 00:35:48,266
of the spacecraft,

761

00:35:48,266 --> 00:35:51,266
and it looked like the mission
might be lost at that point,

762

00:35:51,266 --> 00:35:53,666
because it is
a critical requirement

763
00:35:53,666 --> 00:35:55,966
for extremely stabile pointing

764
00:35:55,966 --> 00:35:58,533
for this spacecraft to
achieve its mission.

765
00:35:58,533 --> 00:36:00,666
Through a lot of creativity,

766
00:36:00,666 --> 00:36:02,633
our engineers and scientists
here figured out

767
00:36:02,633 --> 00:36:05,266
how to do this with two gyros,

768
00:36:05,266 --> 00:36:07,633
still stabilize the spacecraft

769
00:36:07,633 --> 00:36:09,266
and continue its mission.

770
00:36:09,266 --> 00:36:11,166
That's why we call it K2 now,

771
00:36:11,166 --> 00:36:13,200
and it is continuing.

772
00:36:13,200 --> 00:36:16,600
It's lost just a little bit
of scientific productivity

773
00:36:16,600 --> 00:36:18,933
but the mission goes on.

774
00:36:18,933 --> 00:36:24,066
And K2 is now continuing to find

lots and lots of exoplanets

775

00:36:24,066 --> 00:36:27,400
that give us a lot
of inspiration about

776

00:36:27,400 --> 00:36:30,633
where we might go looking for
precursors of life elsewhere.

777

00:36:32,600 --> 00:36:34,233
Partnerships are a big deal.

778

00:36:34,233 --> 00:36:36,333
I've mentioned
the community here,

779

00:36:36,333 --> 00:36:39,200
and we really benefit from

780

00:36:39,200 --> 00:36:41,500
all kinds of near neighbors

781

00:36:41,500 --> 00:36:44,333
who have either
related interests

782

00:36:44,333 --> 00:36:46,933
or synergistic interests
with us,

783

00:36:46,933 --> 00:36:48,733
and you can see
many of them here.

784

00:36:48,733 --> 00:36:51,466
It includes the great
universities we have here,

785

00:36:51,466 --> 00:36:54,966
the large companies,
the nonconventional ones

786
00:36:54,966 --> 00:36:57,100
that are working in high tech,

787
00:36:57,100 --> 00:36:59,966
as well as government partners.

788
00:36:59,966 --> 00:37:02,266
So through this combination

789
00:37:02,266 --> 00:37:05,333
here within
just our neighborhood,

790
00:37:05,333 --> 00:37:08,100
we can work together
with lots of people

791
00:37:08,100 --> 00:37:10,400
who help us be creative
and innovative.

792
00:37:10,400 --> 00:37:11,800
In the Research Park,

793
00:37:11,800 --> 00:37:15,200
we've got over a hundred
entities represented,

794
00:37:15,200 --> 00:37:17,766
some of them here
that are working with us

795
00:37:17,766 --> 00:37:19,566
to accomplish our goals

796

00:37:19,566 --> 00:37:21,966
and also pursue their own goals.

797
00:37:21,966 --> 00:37:23,866
And looking more broadly,

798
00:37:23,866 --> 00:37:26,533
and I'll point out this one
virtual institute

799
00:37:26,533 --> 00:37:27,866
as a particular example,

800
00:37:27,866 --> 00:37:30,000
we can network internationally

801
00:37:30,000 --> 00:37:31,766
with these virtual institutes

802
00:37:31,766 --> 00:37:35,233
that really are not a physical,
large institution

803
00:37:35,233 --> 00:37:38,800
but rather networking
through social media

804
00:37:38,800 --> 00:37:41,733
and internet connections
and video connections

805
00:37:41,733 --> 00:37:44,300
to bring the greatest minds
together

806
00:37:44,300 --> 00:37:46,433
and build diverse teams
very quickly

807

00:37:46,433 --> 00:37:48,366
to address
fundamental problems.

808
00:37:48,366 --> 00:37:50,566
And in the case of
the Astrobiology Institute,

809
00:37:50,566 --> 00:37:52,833
how cool would it be to say

810
00:37:52,833 --> 00:37:54,766
you're working on questions
like these?

811
00:37:54,766 --> 00:37:57,266
What is the origin
and nature of life?

812
00:37:57,266 --> 00:37:59,800
Where else does it exist
in the universe?

813
00:37:59,800 --> 00:38:01,200
Where should we go look?

814
00:38:01,200 --> 00:38:04,633
What was the habitability
of early Earth?

815
00:38:04,633 --> 00:38:07,666
Profound questions
and the Astrobiology Institute

816
00:38:07,666 --> 00:38:09,433
is helping us with those.

817
00:38:09,433 --> 00:38:11,233
The other two virtual
institutes,

818

00:38:11,233 --> 00:38:13,966

Solar System Exploration
and Aeronautics

819

00:38:13,966 --> 00:38:16,933

are similarly approaching
profound questions

820

00:38:16,933 --> 00:38:20,500

in their areas
and using that same capability

821

00:38:20,500 --> 00:38:23,133

to bring
the entire community together.

822

00:38:23,133 --> 00:38:26,700

So now put your binoculars on

823

00:38:26,700 --> 00:38:28,533

and let's look
even farther ahead.

824

00:38:28,533 --> 00:38:31,433

I just brainstormed
a short list here

825

00:38:31,433 --> 00:38:35,633

of where I see
the major themes of Ames

826

00:38:35,633 --> 00:38:38,133

contributing to the future
of the Agency

827

00:38:38,133 --> 00:38:40,700

and where we might go
in the future.

828

00:38:40,700 --> 00:38:42,933

So I've said it
a few times already,

829

00:38:42,933 --> 00:38:45,066

autonomy is a big deal.

830

00:38:45,066 --> 00:38:47,833

It is one of the major enablers

831

00:38:47,833 --> 00:38:51,533

for aviation, aeronautics,
space exploration,

832

00:38:51,533 --> 00:38:53,033

life in space,

833

00:38:53,033 --> 00:38:55,100

and we have
a great capability here

834

00:38:55,100 --> 00:38:58,200

that it will be used
in greater focus

835

00:38:58,200 --> 00:39:00,333

to these--
all of these missions,

836

00:39:00,333 --> 00:39:04,400

and specifically
in the aeronautics arena,

837

00:39:04,400 --> 00:39:06,800

pilotless flight.

838

00:39:06,800 --> 00:39:09,533

Drones will be delivering
your Chinese food

839

00:39:09,533 --> 00:39:11,566
in years to come.

840

00:39:11,566 --> 00:39:13,333
I guarantee you that.

841

00:39:13,333 --> 00:39:16,133
We're gonna figure that out.
Everybody wants it, right?

842

00:39:16,133 --> 00:39:18,533
[laughter]

843

00:39:18,533 --> 00:39:19,966
So drones are the--

844

00:39:19,966 --> 00:39:22,233
one instantiation
of pilotless flight,

845

00:39:22,233 --> 00:39:25,400
but the next one
would be passenger aircraft

846

00:39:25,400 --> 00:39:27,033
or cargo aircraft.

847

00:39:27,033 --> 00:39:30,833
FedEx would like to experiment
with this with us.

848

00:39:30,833 --> 00:39:32,200
So they would be
a great partner.

849

00:39:32,200 --> 00:39:35,266
Looking at cargo applications
of pilotless flight,

850

00:39:35,266 --> 00:39:38,700
and eventually I do think
that we're gonna take a look

851

00:39:38,700 --> 00:39:41,600
at pilotless flight
for passenger aircraft.

852

00:39:41,600 --> 00:39:44,166
Using our Earth Science
capabilities,

853

00:39:44,166 --> 00:39:47,966
climate change impacts
are going to be very important,

854

00:39:47,966 --> 00:39:51,800
sea level rise,
temperature rise,

855

00:39:51,800 --> 00:39:54,133
drought, all of these things

856

00:39:54,133 --> 00:39:57,000
are very important
for us to understand

857

00:39:57,000 --> 00:40:00,133
so that we not only can
continue to live comfortably

858

00:40:00,133 --> 00:40:02,266
where we are,
but we can ensure

859

00:40:02,266 --> 00:40:06,066
that everyone on the planet
has a quality of life.

860

00:40:06,066 --> 00:40:09,266

Supporting the commercialization
of low Earth orbit.

861

00:40:09,266 --> 00:40:11,766

Had very good success stories
so far,

862

00:40:11,766 --> 00:40:13,866

and I think we're right
on the cusp

863

00:40:13,866 --> 00:40:16,366

of lots of commercial
opportunities.

864

00:40:16,366 --> 00:40:19,133

Not just tourism,
but commercial applications.

865

00:40:19,133 --> 00:40:22,466

If it's developing
unique materials

866

00:40:22,466 --> 00:40:25,866

and also potentially
pharmaceuticals

867

00:40:25,866 --> 00:40:28,133

in microgravity
that we can't really do here

868

00:40:28,133 --> 00:40:30,666

in the gravity environment.

869

00:40:30,666 --> 00:40:32,933

Robotic space science
and exploration.

870

00:40:32,933 --> 00:40:36,966

I think I've said enough about
that already to explain that.

871

00:40:36,966 --> 00:40:38,600

We're headed for Mars.

872

00:40:38,600 --> 00:40:40,800

Looking forward to it.

We want to help.

873

00:40:40,800 --> 00:40:43,566

Quantum computing
is an intriguing area

874

00:40:43,566 --> 00:40:45,166

that could be extremely
revolutionary

875

00:40:45,166 --> 00:40:47,633

and it might take
a hundred years to get there.

876

00:40:47,633 --> 00:40:52,566

But once we do, it could
change the way we do computing.

877

00:40:52,566 --> 00:40:54,933

I encourage you
to look into it more.

878

00:40:54,933 --> 00:40:57,966

I am highly under-qualified
to comment on it.

879

00:40:57,966 --> 00:41:00,933

It's physics that
I only briefly understood

880

00:41:00,933 --> 00:41:03,066

when I was in college,

881

00:41:03,066 --> 00:41:05,600

but it's a fascinating area.

882

00:41:05,600 --> 00:41:08,666

Data analytics

is a big growth area

883

00:41:08,666 --> 00:41:11,000

and that's where we can really

leverage our local community

884

00:41:11,000 --> 00:41:13,733

to be the leader

for the Agency.

885

00:41:13,733 --> 00:41:17,466

Space biology,

a major importance to us

886

00:41:17,466 --> 00:41:19,466

in understanding where

to look for life

887

00:41:19,466 --> 00:41:21,400

as well as how to live.

888

00:41:21,400 --> 00:41:23,366

And, you know,

just finally,

889

00:41:23,366 --> 00:41:25,200

we want to be

the innovation Center.

890

00:41:25,200 --> 00:41:27,266

We are already,

891

00:41:27,266 --> 00:41:29,500
and we want to keep doing it.

892
00:41:29,500 --> 00:41:32,233
75 years, this is another
3-hours talk here

893
00:41:32,233 --> 00:41:34,300
that I could give.

894
00:41:34,300 --> 00:41:37,166
You can look back 50, 60 years
or more,

895
00:41:37,166 --> 00:41:39,900
and point
to examples where Ames

896
00:41:39,900 --> 00:41:42,966
has had the culture
of innovation

897
00:41:42,966 --> 00:41:46,000
that has enabled
all kinds of capabilities

898
00:41:46,000 --> 00:41:48,100
that have become
absolutely crucial

899
00:41:48,100 --> 00:41:50,400
to the success of the Agency.

900
00:41:50,400 --> 00:41:53,233
So I think that, you know,
this is our legacy.

901
00:41:53,233 --> 00:41:56,500
We've got a great future.
Let's go make it happen.

902

00:41:56,500 --> 00:41:59,200

Thanks very much
for your attention.

903

00:41:59,200 --> 00:42:02,266

[applause]

904

00:42:03,966 --> 00:42:06,366

- Thank you, Tom,
for an excellent talk.

905

00:42:06,366 --> 00:42:08,466

We have time for questions.

906

00:42:08,466 --> 00:42:10,433

If you have a question,
please raise your hand,

907

00:42:10,433 --> 00:42:13,500

wait for the microphone,
and ask just one question.

908

00:42:13,500 --> 00:42:15,566

Thank you.

909

00:42:15,566 --> 00:42:17,900

- Hi. Is it on?

910

00:42:17,900 --> 00:42:21,866

I was wondering, is it possible
they could commercialize

911

00:42:21,866 --> 00:42:25,000

the SPHERE that was floating
around in the--

912

00:42:25,000 --> 00:42:28,133

in the spacecraft?

913

00:42:28,133 --> 00:42:29,966

I mean, as much as I like
the Roomba,

914

00:42:29,966 --> 00:42:31,766

I would love to see
that SPHERE

915

00:42:31,766 --> 00:42:34,766

floating around my house
doing jobs.

916

00:42:34,766 --> 00:42:36,766

- We're gonna have to work
a little bit harder on

917

00:42:36,766 --> 00:42:39,666

how to levitate
in that situation.

918

00:42:39,666 --> 00:42:41,500

I mean, it's not
a pejorative thing.

919

00:42:41,500 --> 00:42:43,133

We could figure that out,

920

00:42:43,133 --> 00:42:45,300

and that would be
a nice personal assistant

921

00:42:45,300 --> 00:42:46,966

to have around your home.

922

00:42:46,966 --> 00:42:49,966

To have it float next to you
is either going to require it

923

00:42:49,966 --> 00:42:51,966
to be lighter than air,

924
00:42:51,966 --> 00:42:54,200
and we have a little bit
of experience in that,

925
00:42:54,200 --> 00:42:56,900
or figure out how to
repel the force of gravity,

926
00:42:56,900 --> 00:42:58,633
but absolutely,

927
00:42:58,633 --> 00:43:00,700
and we do look for
commercialization partners

928
00:43:00,700 --> 00:43:02,366
when these things come along

929
00:43:02,366 --> 00:43:04,166
so that we can take
what we've done

930
00:43:04,166 --> 00:43:07,866
and let life on Earth be
better as a result.

931
00:43:10,133 --> 00:43:12,300
- So it was
just announced that

932
00:43:12,300 --> 00:43:14,466
Mike Suffredini's
leaving, right?

933
00:43:14,466 --> 00:43:17,333
And it impacts
quite a few things

934

00:43:17,333 --> 00:43:18,966
that we're doing, right?

935

00:43:18,966 --> 00:43:21,733
But specifically, you know,
from my own knothole,

936

00:43:21,733 --> 00:43:24,800
the Human Systems Integration
work that we do.

937

00:43:24,800 --> 00:43:26,166
And you mentioned the--

938

00:43:26,166 --> 00:43:28,266
you know, we did the--

939

00:43:28,266 --> 00:43:32,400
the mission planning systems
for MSL and all the other ones

940

00:43:32,400 --> 00:43:37,933
and that got transitioned with
a lot of direct input from Mike

941

00:43:37,933 --> 00:43:41,300
to--first mission control
planning of correctivity,

942

00:43:41,300 --> 00:43:43,666
but now, just this week it got
radiated up to the Space Station

943

00:43:43,666 --> 00:43:45,833
for the first test
on Station to look,

944

00:43:45,833 --> 00:43:47,833

not only at crew efficiency,

945

00:43:47,833 --> 00:43:50,566

but at enabling
deep space missions

946

00:43:50,566 --> 00:43:51,733

where you can't
talk to Earth, right?

947

00:43:51,733 --> 00:43:53,366

"Can crew plan
their own time?"

948

00:43:53,366 --> 00:43:57,233

And I guess I do worry
a little bit about that change.

949

00:43:57,233 --> 00:43:59,033

So I don't know--It's sort of
a crystal ball question,

950

00:43:59,033 --> 00:44:00,733

but I don't know
anything about

951

00:44:00,733 --> 00:44:03,266

the person who's taking over.

952

00:44:03,266 --> 00:44:05,866

You know, what's the--
Do you guys have any intel?

953

00:44:05,866 --> 00:44:07,833

- I can't tell you too much.

954

00:44:07,833 --> 00:44:09,966

It's very new information.

955

00:44:09,966 --> 00:44:12,466

I have met the gentleman once.

956

00:44:12,466 --> 00:44:15,566

He was a Deputy Center Director
up until recently,

957

00:44:15,566 --> 00:44:18,533

and so he was part
of my peer community.

958

00:44:18,533 --> 00:44:22,033

And I--We just hope we have
good knowledge transfer

959

00:44:22,033 --> 00:44:24,966

from Suffredini to--to Kirk,

960

00:44:24,966 --> 00:44:28,800

and that they've recognized
our contribution.

961

00:44:28,800 --> 00:44:31,033

And we also have good
relationships,

962

00:44:31,033 --> 00:44:34,166

so I think it's time for us
to start talking to the new guy

963

00:44:34,166 --> 00:44:36,766

about all the great stuff
we have done and what we can do.

964

00:44:48,366 --> 00:44:51,366

Everybody knows there's
a free lunch, don't they?

965

00:44:51,366 --> 00:44:54,100

[laughter]

966

00:44:54,100 --> 00:44:55,100

- Okay, so--

967

00:44:55,100 --> 00:44:56,566

- There's one more up--

968

00:44:56,566 --> 00:44:58,000

- Right.

969

00:44:58,000 --> 00:44:59,766

- The question is about
partnerships,

970

00:44:59,766 --> 00:45:02,366

and from your experience
of doing partnerships

971

00:45:02,366 --> 00:45:04,033

with the commercial sector,

972

00:45:04,033 --> 00:45:05,633

I wonder if there are any
that stick out to you

973

00:45:05,633 --> 00:45:07,600

as really good,
strong partnerships,

974

00:45:07,600 --> 00:45:09,100

and what do you
think are the principles

975

00:45:09,100 --> 00:45:11,233

of a good partnership if
you're looking to do a new one?

976

00:45:11,233 --> 00:45:15,300

- Mm-hmm, good question.

Thank you.

977

00:45:15,300 --> 00:45:19,033

You know, we have a great opportunity here to partner,

978

00:45:19,033 --> 00:45:21,466

because we have the NASA Research Park,

979

00:45:21,466 --> 00:45:24,466

so not only can we strike a deal,

980

00:45:24,466 --> 00:45:26,333

but we can collocate here

981

00:45:26,333 --> 00:45:29,633

and that's something that we are somewhat unique

982

00:45:29,633 --> 00:45:32,666

within the Agency in our ability to do.

983

00:45:32,666 --> 00:45:35,800

So we have used that to good effect so far,

984

00:45:35,800 --> 00:45:39,333

and we really want to focus now on the future

985

00:45:39,333 --> 00:45:42,533

on being very strategic about who we bring

986

00:45:42,533 --> 00:45:46,033

this limited resource in to do unique things

987

00:45:46,033 --> 00:45:48,033

that you could only do
with colocation.

988

00:45:48,033 --> 00:45:52,633

Clearly, any partnership
flourishes on mutual benefit.

989

00:45:52,633 --> 00:45:54,900

We know where we're going.

990

00:45:54,900 --> 00:45:58,133

We want to understand
where our partners are going

991

00:45:58,133 --> 00:46:00,133

and where that
intersection occurs.

992

00:46:00,133 --> 00:46:04,600

Sometimes it's a fortuitous
alignment of capabilities.

993

00:46:04,600 --> 00:46:07,566

For example, in high tech,

994

00:46:07,566 --> 00:46:10,933

data analytic capabilities
benefit commercial interests,

995

00:46:10,933 --> 00:46:13,200

they also benefit
NASA interests.

996

00:46:13,200 --> 00:46:15,833

And so we can work together
on things like

997

00:46:15,833 --> 00:46:19,300
self-driving cars
or autonomy technologies

998
00:46:19,300 --> 00:46:20,700
or data mining

999
00:46:20,700 --> 00:46:22,900
and we both come away
with something

1000
00:46:22,900 --> 00:46:24,666
that's very successful.

1001
00:46:24,666 --> 00:46:28,300
Others flourish based on
a technology transfer,

1002
00:46:28,300 --> 00:46:30,900
where we work together
to accomplish something

1003
00:46:30,900 --> 00:46:34,333
that's fairly focused
on the NASA mission,

1004
00:46:34,333 --> 00:46:36,966
but once that capability
is established,

1005
00:46:36,966 --> 00:46:39,633
it can be diversified
into commercial products.

1006
00:46:39,633 --> 00:46:42,266
And so those are really
two of the key attributes

1007
00:46:42,266 --> 00:46:44,066
that we're--we look for,

1008

00:46:44,066 --> 00:46:47,800

that we have a partner
who's willing to acknowledge

1009

00:46:47,800 --> 00:46:49,033

and work with us
on our mission,

1010

00:46:49,033 --> 00:46:51,500

and we will do the same
with them.

1011

00:46:51,500 --> 00:46:53,100

Kind of a generic answer,

1012

00:46:53,100 --> 00:46:56,000

but I think that all those
that I showed you there

1013

00:46:56,000 --> 00:46:58,966

are examples of
where we could explain

1014

00:46:58,966 --> 00:47:00,900

what we got and what they got,

1015

00:47:00,900 --> 00:47:03,900

and that's a pattern
we continue to follow.

1016

00:47:06,366 --> 00:47:07,466

- We have a question.

1017

00:47:07,466 --> 00:47:09,800

- Okay, so hi, Tom.

1018

00:47:09,800 --> 00:47:13,466

So thanks very much for--for

sharing your insights there.

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00:47:13,466 --> 00:47:16,800

My question is--
revolves around the idea

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00:47:16,800 --> 00:47:19,400

of how to be
an innovative Center

1021

00:47:19,400 --> 00:47:22,233

in a conservative Agency.

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00:47:22,233 --> 00:47:26,966

And so part of being
innovation means--

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00:47:26,966 --> 00:47:29,966

or having innovation means that
you've got to accept failures.

1024

00:47:29,966 --> 00:47:33,466

Accepting failures is not
something that NASA does well

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00:47:33,466 --> 00:47:34,933

as an Agency,

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00:47:34,933 --> 00:47:37,500

and so you have to end up
walking kind of a tightrope.

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00:47:37,500 --> 00:47:39,766

And I wondered
if you could tell us

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00:47:39,766 --> 00:47:43,133

a little bit about how you think
that's gonna work in the future.

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00:47:45,300 --> 00:47:47,200

- Thank you for that incredibly difficult question, Tony.

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00:47:47,200 --> 00:47:50,200

[laughter]

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00:47:51,633 --> 00:47:53,700

- I think that there is--

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00:47:53,700 --> 00:47:55,666

It is possible

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00:47:55,666 --> 00:47:58,866

to be both aligned and innovative.

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00:47:58,866 --> 00:48:02,466

That's--the discussion that we had with Headquarters

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00:48:02,466 --> 00:48:05,233

when Eugene and I were kind of coming on board is,

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00:48:05,233 --> 00:48:07,966

you know, what-- what do we do here?

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00:48:07,966 --> 00:48:11,966

Do we, you know-- do you want us to be more,

1038

00:48:11,966 --> 00:48:13,700

you know, straight and narrow,

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00:48:13,700 --> 00:48:16,633

or do you want us to just

always be out there?

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00:48:16,633 --> 00:48:20,066

And the discussion lead to,
we want both.

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00:48:20,066 --> 00:48:21,666

We want alignment,

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00:48:21,666 --> 00:48:24,166

and alignment means that we are
clearly supportive

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00:48:24,166 --> 00:48:26,266

of NASA's overall direction,

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00:48:26,266 --> 00:48:28,333

but at the same time,
be innovative.

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00:48:28,333 --> 00:48:32,266

And I can share with you that
we both were implored

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00:48:32,266 --> 00:48:37,000

early on not to have
the pendulum swing too far back.

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00:48:37,000 --> 00:48:40,633

They--they really see Ames
as the innovation Center,

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00:48:40,633 --> 00:48:42,933

and they want us out there

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00:48:42,933 --> 00:48:46,500

and there is a more
vigorous dialogue these days

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00:48:46,500 --> 00:48:49,533
about what it means
to accept risk.

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00:48:49,533 --> 00:48:52,466
So we want to be responsible
in the way we accept risk.

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00:48:52,466 --> 00:48:55,100
We don't want to imperil
people's safety

1053
00:48:55,100 --> 00:48:59,100
and we don't want to spend
the taxpayers' money foolishly.

1054
00:48:59,100 --> 00:49:01,966
We want to
deliberately take risks

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00:49:01,966 --> 00:49:05,033
where they are warranted,
where they have a high payoff,

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00:49:05,033 --> 00:49:08,866
and that we would acknowledge
that when you take high risks

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00:49:08,866 --> 00:49:10,500
you're going to have failures.

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00:49:10,500 --> 00:49:11,900
So the dialogue is increasing,

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00:49:11,900 --> 00:49:14,400
and that's a little bit
promising

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00:49:14,400 --> 00:49:16,866
that we need

to test that premise

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00:49:16,866 --> 00:49:20,300
and know that we're gonna fail
once in a while

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00:49:20,300 --> 00:49:22,266
and that should not have
negative repercussions.

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00:49:22,266 --> 00:49:25,266
So how do we do that?

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00:49:25,266 --> 00:49:28,966
Eugene and I are working
with the Center leadership

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00:49:28,966 --> 00:49:31,533
to make sure
that we're aligned.

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00:49:31,533 --> 00:49:34,666
So we're kind of going through
all of our capability areas

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00:49:34,666 --> 00:49:36,633
that I went through
and the missions

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00:49:36,633 --> 00:49:39,600
and seeing that we have
a relevance

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00:49:39,600 --> 00:49:41,633
to those NASA missions.

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00:49:41,633 --> 00:49:43,833
That's gonna take care of
the alignment part.

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00:49:43,833 --> 00:49:46,866

Now, we need to keep the focus
on the innovation part

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00:49:46,866 --> 00:49:49,466

but be able to
trace that back to these

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00:49:49,466 --> 00:49:51,766

aligned missions
that we're going after.

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00:49:51,766 --> 00:49:53,833

So we're doing
a lot of things,

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00:49:53,833 --> 00:49:57,300

working with outreach
and education,

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00:49:57,300 --> 00:49:59,600

bringing interns
in to keep us, you know,

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00:49:59,600 --> 00:50:02,133

really refreshed
and energized,

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00:50:02,133 --> 00:50:05,333

and we're just going to be
looking at all the mechanisms

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00:50:05,333 --> 00:50:07,766

that we can pursue
to foster innovation.

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00:50:07,766 --> 00:50:10,200

Hopefully,
we'll bring those together,

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00:50:10,200 --> 00:50:12,566

and we need all of your help
to make that happen,

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00:50:12,566 --> 00:50:16,866

because any one person will tend
to get stuck in their ways.

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00:50:16,866 --> 00:50:20,900

So we've always been a little
controversial as a Center.

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00:50:20,900 --> 00:50:23,700

We're gonna keep doing that,

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00:50:23,700 --> 00:50:27,166

but we're just gonna show
how it matters to the Agency.

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00:50:27,166 --> 00:50:28,733

Mm-hmm?

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00:50:28,733 --> 00:50:31,333

- My question kind of--you kind
of answered a little bit of it

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00:50:31,333 --> 00:50:33,433

with the last question.

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00:50:33,433 --> 00:50:35,966

With--with the future
of the Center,

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00:50:35,966 --> 00:50:38,866

what kind of ways are you
kind of guaranteeing,

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00:50:38,866 --> 00:50:41,766

like, for bringing in new--

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00:50:41,766 --> 00:50:43,900

like, fresh minds out of,
like, the universities

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00:50:43,900 --> 00:50:45,133

and things like that

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00:50:45,133 --> 00:50:46,766

to kind of help promote
a more--

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00:50:46,766 --> 00:50:48,766

more innovativeness
on the Center?

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00:50:48,766 --> 00:50:51,066

I know that, you know,
a lot of times

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00:50:51,066 --> 00:50:54,366

whenever you go--whenever
we're exiting university,

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00:50:54,366 --> 00:50:56,933

like, three to five years
of experience, but where do--

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00:50:56,933 --> 00:50:59,900

Do you expect to offer
more opportunities

1100

00:50:59,900 --> 00:51:02,066

for people who maybe don't have
three to five years

1101

00:51:02,066 --> 00:51:03,900

of experience as well?

1102

00:51:03,900 --> 00:51:05,900
- Mm-hmm.

1103
00:51:05,900 --> 00:51:07,933
I'm very empathetic to that.

1104
00:51:07,933 --> 00:51:11,533
I have recent college grads
who apply for jobs

1105
00:51:11,533 --> 00:51:13,133
and the first question
often is,

1106
00:51:13,133 --> 00:51:14,633
well, what experience
do you have?

1107
00:51:14,633 --> 00:51:16,566
And you're kind of like,
"What do you expect?"

1108
00:51:16,566 --> 00:51:19,000
I just got out of college.
How do I have experience?"

1109
00:51:19,000 --> 00:51:22,466
I would respond to that
first by saying

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00:51:22,466 --> 00:51:26,266
part of the--as we are working
to align the Center,

1111
00:51:26,266 --> 00:51:27,733
one of the areas
that we're looking at

1112
00:51:27,733 --> 00:51:31,366
is trying to envision

the workforce of the future.

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00:51:31,366 --> 00:51:34,033

So we're talking about
the future now.

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00:51:34,033 --> 00:51:37,300

And let's say we're talking
about the Mars mission,

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00:51:37,300 --> 00:51:40,466

that a lot of technology work
for that mission

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00:51:40,466 --> 00:51:42,700

is going to be done
in the 2020s.

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00:51:42,700 --> 00:51:46,100

We need a workforce
in ten years or so

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00:51:46,100 --> 00:51:48,100

that is going to have
the capabilities

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00:51:48,100 --> 00:51:49,766

and attributes we want

1120

00:51:49,766 --> 00:51:52,666

to make our contributions
to that Mars mission.

1121

00:51:52,666 --> 00:51:54,100

So we're first--

1122

00:51:54,100 --> 00:51:56,066

we're starting with
a little kind of envisioning.

1123

00:51:56,066 --> 00:51:57,666

What does that
workforce look like?

1124

00:51:57,666 --> 00:51:59,733

And then
looking at where we are,

1125

00:51:59,733 --> 00:52:01,766

and what does it take
to get there?

1126

00:52:01,766 --> 00:52:04,766

It's going to take
a lot of mentoring

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00:52:04,766 --> 00:52:06,166

and knowledge transfer

1128

00:52:06,166 --> 00:52:09,333

as we pass capabilities
from one generation to the next.

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00:52:09,333 --> 00:52:12,966

We're going to need to be
very deliberate

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00:52:12,966 --> 00:52:15,233

about the skill sets
and interests

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00:52:15,233 --> 00:52:17,566

that we're going after,

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00:52:17,566 --> 00:52:19,966

so that we reinforce
our capabilities

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00:52:19,966 --> 00:52:21,300

that we want to preserve,

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00:52:21,300 --> 00:52:23,400

where we establish
new capabilities

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00:52:23,400 --> 00:52:25,833

that we believe are needed
for the future,

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00:52:25,833 --> 00:52:28,600

and that will guide us
in our recruiting

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00:52:28,600 --> 00:52:31,200

and our hiring strategies
that we go forward with.

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00:52:31,200 --> 00:52:34,100

So that--that's sort of
the big picture philosophy

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00:52:34,100 --> 00:52:35,466

and logic behind it.

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00:52:35,466 --> 00:52:38,333

And with that information
in hand,

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00:52:38,333 --> 00:52:41,000

then we can very explicitly
figure out

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00:52:41,000 --> 00:52:43,166

where to go for recruiting.

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00:52:43,166 --> 00:52:46,133

We want a diverse
and capable workforce,

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00:52:46,133 --> 00:52:48,800

and so we're going to have
a better idea of

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00:52:48,800 --> 00:52:53,166

where to go to get the workforce
attributes we want.

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00:52:53,166 --> 00:52:55,933

The senior management
is going to be able

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00:52:55,933 --> 00:52:58,466

to evaluate the opportunities
better so that we--

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00:52:58,466 --> 00:53:00,933

We don't get to hire
all that much,

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00:53:00,933 --> 00:53:03,433

so when we do hire,
we want to be really confident

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00:53:03,433 --> 00:53:04,933

that it's going to work.

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00:53:04,933 --> 00:53:07,866

So we're gonna be able to match
the overall strategy

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00:53:07,866 --> 00:53:09,700

with the approach
that we're taking

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00:53:09,700 --> 00:53:12,333

on any specific situation.

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00:53:12,333 --> 00:53:14,733

In addition to that,

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00:53:14,733 --> 00:53:18,200

we are delighted to host
800 to 1,000 students

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00:53:18,200 --> 00:53:19,966

here every summer,

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00:53:19,966 --> 00:53:23,166

and that's something
that has created opportunities

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00:53:23,166 --> 00:53:25,900

for the students in the future,
and also for us,

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00:53:25,900 --> 00:53:29,333

to see what's that workforce
going to look like

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00:53:29,333 --> 00:53:31,800

and understand
how we get ready for it.

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00:53:31,800 --> 00:53:33,933

And so we definitely will
continue doing that

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00:53:33,933 --> 00:53:36,300

as well as other
outreach opportunities

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00:53:36,300 --> 00:53:38,566

so that our message
gets out there,

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00:53:38,566 --> 00:53:41,266

and the people who think they
want to get on board with us

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00:53:41,266 --> 00:53:45,966

can self-identify also.

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00:53:45,966 --> 00:53:49,666

- So please join me in
thanking Dr. Tom Edwards

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00:53:49,666 --> 00:53:51,166

again for an excellent talk.

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00:53:51,166 --> 00:53:53,633

[applause]