WEBVTT

1
00:00:00.465 --> 00:00:02.205
All right, two quick admin notes.

2
00:00:02.425 --> 00:00:04.485
Uh, Pinto, we found your day planner.

3
00:00:04.595 --> 00:00:06.245
It's sitting in the back. Uh,

4
00:00:06.245 --> 00:00:07.365
if you'd like to go retrieve it.

5
00:00:07.785 --> 00:00:11.005
And yesterday, somebody found this bezel type thing.

6
00:00:11.145 --> 00:00:12.605
If anybody's missing something,

7
00:00:13.255 --> 00:00:14.525
we'll have it sitting in the back.

8
00:00:14.685 --> 00:00:15.685
I really have no idea what it is.

9
00:00:16.585 --> 00:00:17.925
If nobody collects it, we'll get rid of it

10
00:00:19.105 --> 00:00:20.105
Was in the front.

11
00:00:20.715 --> 00:00:22.445
What was that? It was in the front row.

12
00:00:22.625 --> 00:00:23.645
It was in the front row.

13
00:00:24.505 --> 00:00:27.285
So if anybody's missing this little piece

14
00:00:27.285 --> 00:00:29.485
of plexiglass embezzle, we have it for you.

15
00:00:30.915 --> 00:00:35.245
Okay. Next up we have Mr. Dave Roberts, uh, from Nav Air.

16
00:00:35.245 --> 00:00:37.565
He's gonna talk to us about test risk management

17
00:00:38.025 --> 00:00:40.085
and unmanned aerial systems perspective.

18
00:00:40.475 --> 00:00:41.685
Dave stage is yours.

19
00:00:50.155 --> 00:00:53.405
Good morning everyone. Wow.

20
00:00:53.465 --> 00:00:55.685
So, uh, I get to talk about unmanned systems to a bunch

21
00:00:55.685 --> 00:00:57.805
of test pilots of man's systems, right?

22
00:00:58.545 --> 00:00:59.725
Not trying to put anybody have a job,

23
00:00:59.745 --> 00:01:01.285
but I think we're all gonna be playing with these things

24
00:01:01.385 --> 00:01:02.485
to some degree in the future.

25
00:01:02.665 --> 00:01:04.125
So I might as well talk about some

26
00:01:04.125 --> 00:01:06.205
of the is interesting issues that go along with that.

27
00:01:08.485 --> 00:01:11.765

I thought about renaming the brief baking risk management

28
00:01:11.765 --> 00:01:12.685
into de flight test planning because

29
00:01:12.725 --> 00:01:13.805
I thought that was a great quote.

30
00:01:14.005 --> 00:01:15.805
I think that was from Pat Moran.

31
00:01:16.385 --> 00:01:18.805
Um, so my brief is gonna be a lot about the test planning

32
00:01:19.155 --> 00:01:21.565
that goes into UAS, uh, flight test projects

33
00:01:22.025 --> 00:01:24.005
and how the risk management is weed throughout that.

34
00:01:26.985 --> 00:01:28.005
So just an overview.

35
00:01:28.465 --> 00:01:30.365
I'm gonna go through the design, some of the challenges

36
00:01:30.365 --> 00:01:33.125
that go with that in terms of risk management, some

37
00:01:33.125 --> 00:01:35.205
of the uniqueness that goes with the UAS test design.

38
00:01:35.825 --> 00:01:37.365
And spend a little time on what some

39
00:01:37.365 --> 00:01:39.085
of the things our teams are leveraging today

40
00:01:39.085 --> 00:01:40.245
and what they could leverage in the future.

41
00:01:41.725 --> 00:01:43.885
I came up with a little model for test design

42
00:01:43.945 --> 00:01:45.925
and I call it calm, excuse me.

43
00:01:46.405 --> 00:01:48.605
Consider assess, exploit

44
00:01:49.145 --> 00:01:51.405
and then manage a test risk.

45
00:01:53.305 --> 00:01:55.445
So let's start with what's the first thing we

46
00:01:55.445 --> 00:01:56.565
look at with UHS?

47
00:01:56.875 --> 00:01:59.845
Well, first of all, they vary greatly in size complexity.

48
00:02:01.585 --> 00:02:03.635
This chart gives you a rough idea

49
00:02:03.975 --> 00:02:04.995
of how they're broken down.

50
00:02:04.995 --> 00:02:06.995
So it's a jointly agreed sort of way

51
00:02:06.995 --> 00:02:09.995
to characterize from uh, gross weight altitude,

52
00:02:10.375 --> 00:02:11.795
max altitude and max speed.

53
00:02:11.855 --> 00:02:14.155
But on the larger size, you've got your global hawks,

54
00:02:14.155 --> 00:02:17.835

your reapers tritons on the small,

55
00:02:17.835 --> 00:02:19.915
you've got your two pound wasp hand launched.

56
00:02:20.735 --> 00:02:23.275
Um, and in the middle you've got your scanned eagles,

57
00:02:23.305 --> 00:02:24.715
your blackjack, uh,

58
00:02:24.715 --> 00:02:27.035
which is our RQ 21 system down the Marine Corps flying.

59
00:02:28.295 --> 00:02:29.315
So just to give you a feel

60
00:02:29.315 --> 00:02:31.955
for when I talk about groups, that's what I mean.

61
00:02:32.055 --> 00:02:34.355
So of course now you've got a group.

62
00:02:34.705 --> 00:02:35.875
What kind of airplane is it?

63
00:02:36.095 --> 00:02:39.515
Is it rotary wing, fixed wing later than there?

64
00:02:39.535 --> 00:02:41.995
Yes, we do have unmanned ible type systems out there.

65
00:02:43.055 --> 00:02:45.315
Uh, what's the propulsion type electric,

66
00:02:45.425 --> 00:02:46.795
some sort of hydrocarbon fuel.

67
00:02:46.795 --> 00:02:50.355
Is it a hydrogen fuel cell? The gamuts all over the place.

68
00:02:50.355 --> 00:02:51.155
So these are all things to

69
00:02:51.275 --> 00:02:52.235
consider when you're designing it.

70
00:02:52.575 --> 00:02:54.035
And of course when you're managing the risk

71
00:02:54.785 --> 00:02:55.955
from the test team perspective,

72
00:02:56.015 --> 00:02:58.235
the test leadership is accepting the test risk

73
00:02:59.155 --> 00:03:00.255
and also from the range safety.

74
00:03:00.255 --> 00:03:01.895
So I'm gonna put some emphasis on range safety

75
00:03:01.915 --> 00:03:04.455
and range safety officer and A TC in this brief.

76
00:03:04.615 --> 00:03:06.255
'cause I think it's a very important component

77
00:03:06.255 --> 00:03:07.495
of the overall safety picture.

78
00:03:09.115 --> 00:03:11.215
So design, command and control.

79
00:03:11.435 --> 00:03:12.775
How does command and control skiing work?

80
00:03:12.775 --> 00:03:14.455
Is it line of sight only for some of the small?

81
00:03:14.455 --> 00:03:15.495

That's pretty much how they work.

82
00:03:16.155 --> 00:03:19.575
Do you have beyond line of sight SCOM type setups?

83
00:03:21.205 --> 00:03:23.255
What kind of redundancy do you have in your data links?

84
00:03:24.905 --> 00:03:26.445
And then there's launching recovery,

85
00:03:26.775 --> 00:03:28.845
everything from hand launch to skid back

86
00:03:28.845 --> 00:03:30.285
and on the ground in front of your feet

87
00:03:30.585 --> 00:03:32.325
to conventional rolling tape off and landing.

88
00:03:32.905 --> 00:03:35.685
We have systems that catapult off a ship

89
00:03:35.685 --> 00:03:37.525
and then catch a vertical wire if you're familiar

90
00:03:37.525 --> 00:03:39.125
with scan Eagle or RQ 21.

91
00:03:39.545 --> 00:03:41.125
So the gamut is all over the place

92
00:03:41.225 --> 00:03:42.285
in terms of watch recovery.

93
00:03:43.235 --> 00:03:45.085
Many of the systems in the Navy have to work both land

94
00:03:45.105 --> 00:03:47.525
and ship base, but some are only good for land base.

95
00:03:49.975 --> 00:03:51.275
And then what's the conops of the system?

96
00:03:51.695 --> 00:03:55.195
And we talk about mixing in mission type

97
00:03:55.195 --> 00:03:56.235
threads into our testing.

98
00:03:56.345 --> 00:03:58.675
More and more Navy calls it CB t and E.

99
00:03:58.695 --> 00:04:00.035
But if you understand the mission,

100
00:04:00.035 --> 00:04:01.075
you can do a better design

101
00:04:01.075 --> 00:04:03.275
of designing your better job and designing your test.

102
00:04:03.335 --> 00:04:05.235
So is it just have an ISR mission?

103
00:04:05.545 --> 00:04:06.915
Does it have a common relay mission?

104
00:04:07.305 --> 00:04:08.635
Does the system also have some sort

105
00:04:08.635 --> 00:04:10.715
of weapons responsibility in terms of off, um,

106
00:04:10.925 --> 00:04:12.755
buddy targeting or actually delivery?

107
00:04:13.255 --> 00:04:14.795
So those things all need to be considered.

108
00:04:15.215 --> 00:04:16.915

And then the conops, is it a single ship?

109
00:04:17.005 --> 00:04:19.715
We're talking, when I say UAS, it's S'S system.

110
00:04:19.815 --> 00:04:21.715
So it could be multiple. So we talked about swarm

111
00:04:21.715 --> 00:04:22.875
in one of our exercises.

112
00:04:23.295 --> 00:04:25.475
The conops might be you're launching 20 of these things.

113
00:04:26.455 --> 00:04:29.835
So, and then you consider the level of autonomy.

114
00:04:30.525 --> 00:04:33.755
Right now most of our systems have gotten away from tele

115
00:04:34.355 --> 00:04:36.355
robotics, sort of RC plane control.

116
00:04:36.785 --> 00:04:39.035
Most of them are in the semi-autonomous sort of mode

117
00:04:40.365 --> 00:04:41.675
where we pre-program things.

118
00:04:42.255 --> 00:04:43.555
We tell it to do it, it goes

119
00:04:43.555 --> 00:04:44.875
and does lots of things automatically,

120
00:04:44.875 --> 00:04:47.635
but it's still very premeditated.

121
00:04:48.455 --> 00:04:50.315
And then when you move farther into higher autonomy,

122
00:04:51.055 --> 00:04:52.995
non-deterministic, and I'll talk about that in a little bit,

123
00:04:52.995 --> 00:04:54.915
where things can actually adapt to their environment,

124
00:04:56.715 --> 00:04:57.755
maturity of the system itself.

125
00:04:58.255 --> 00:04:59.755
Um, from the air vehicle perspective,

126
00:04:59.885 --> 00:05:01.635
especially on the small as we get things

127
00:05:01.635 --> 00:05:03.995
that are very new in terms of structures and propulsion.

128
00:05:04.575 --> 00:05:06.195
Can you manage that risk, um,

129
00:05:06.195 --> 00:05:08.315
at your test facility and can you accept it?

130
00:05:10.065 --> 00:05:12.315
Same thing for the mission. Maybe this air vehicle's already

131
00:05:12.315 --> 00:05:14.115
mature, but you're looking at a new payload

132
00:05:14.455 --> 00:05:15.355
and there's all kinds of

133
00:05:15.635 --> 00:05:16.755
interesting payloads that are going on.

134
00:05:16.755 --> 00:05:20.435
Small UAVs for both the um, tactical guys, you know,

135
00:05:20.435 --> 00:05:22.115

the guys pulling things outta their backpacks

136
00:05:22.115 --> 00:05:26.395
and throwing them to, you know, full up launching from

137
00:05:27.145 --> 00:05:29.155
Guam and we're controlling them from here in the

138
00:05:29.155 --> 00:05:32.355
United States software as well.

139
00:05:32.795 --> 00:05:34.675
Software maturity is all over the place.

140
00:05:35.455 --> 00:05:37.515
Try and get as much insight as you can into the software

141
00:05:37.835 --> 00:05:39.195
progression and where they are in

142
00:05:39.195 --> 00:05:40.435
their software testing program.

143
00:05:41.875 --> 00:05:45.235
Everyone's mentioned budget, schedule, urgency, uh, harp on

144
00:05:45.235 --> 00:05:46.235
that, but that's important.

145
00:05:46.655 --> 00:05:47.835
And then there's airworthiness.

146
00:05:48.415 --> 00:05:50.075
So all this fits into airworthiness.

147
00:05:50.945 --> 00:05:52.075
What level of airworthiness.

148
00:05:52.195 --> 00:05:54.515
A lot of people say, well there's no pink body in the ship.

149
00:05:55.405 --> 00:05:56.795
Lower level of airworthiness.

150
00:05:57.435 --> 00:06:00.965
True to some extent, but there's varying degrees of that.

151
00:06:01.545 --> 00:06:04.245
You know, does it need to be the same level of airworthiness

152
00:06:04.245 --> 00:06:06.685
as it F 18 or Boeing 7 37?

153
00:06:07.095 --> 00:06:08.925
Maybe, maybe not. Depends on where it's flying.

154
00:06:08.945 --> 00:06:11.645
If it's flying over LA I would argue it does.

155
00:06:12.595 --> 00:06:14.565
It's flying over the middle of the ocean. Maybe not.

156
00:06:14.985 --> 00:06:16.685
And also has to do with tolerance

157
00:06:16.685 --> 00:06:18.165
of the program for losing assets.

158
00:06:18.465 --> 00:06:21.685
Either the program or operationally of the commander.

159
00:06:21.685 --> 00:06:23.205
Can he afford to lose the assets

160
00:06:23.625 --> 00:06:26.245
or can he only afford to keep

161
00:06:26.245 --> 00:06:27.405
that thing in the air to do its mission?

162
00:06:32.555 --> 00:06:37.365

Okay, So assess build up.

163
00:06:37.365 --> 00:06:38.765
We talked about build up. That's a very good

164
00:06:38.765 --> 00:06:39.925
risk management technique.

165
00:06:40.345 --> 00:06:42.645
What's available in your arsenal in terms of simulation?

166
00:06:46.155 --> 00:06:48.445
Live virtual constructive methods are being

167
00:06:48.725 --> 00:06:49.845
emphasized more and more all the time.

168
00:06:51.375 --> 00:06:52.765
Gotta have good physics based models

169
00:06:52.785 --> 00:06:54.285
to really be confident in them.

170
00:06:54.545 --> 00:06:56.045
So your validation of verification

171
00:06:56.045 --> 00:06:57.085
schemes are very important.

172
00:06:57.915 --> 00:06:59.295
As you move into more ground tests,

173
00:06:59.295 --> 00:07:01.575
maybe some iron bird setups, hardware in the loop

174
00:07:02.285 --> 00:07:04.655
away from the sill, you start looking at other things

175
00:07:04.655 --> 00:07:08.575
that are very important in UAS design for test design, such

176
00:07:08.575 --> 00:07:11.255
as e cubed electromagnetic compatibility.

177
00:07:11.765 --> 00:07:13.895
Your data link is now a flight critical system.

178
00:07:13.895 --> 00:07:15.495
It's not just a radio comm anymore.

179
00:07:15.805 --> 00:07:17.415
It's actually what you're controlling the airplane with.

180
00:07:17.415 --> 00:07:19.615
We're setting up new commands for maybe a mission change.

181
00:07:20.995 --> 00:07:22.455
And then of course we move into flight tests,

182
00:07:22.455 --> 00:07:24.135
which we all really wanna talk about.

183
00:07:25.455 --> 00:07:26.655
Envelope, envelope expansion.

184
00:07:27.505 --> 00:07:29.175
These things might not have a very big envelope.

185
00:07:29.415 --> 00:07:31.575
Envelope expansion may be a short part of your test program.

186
00:07:32.035 --> 00:07:33.175
It could be very accelerated.

187
00:07:33.515 --> 00:07:34.775
You might need less test points.

188
00:07:35.635 --> 00:07:37.255
The test points may only need to be done once

189
00:07:37.855 --> 00:07:39.055

'cause it's, they're done very efficiently.

190
00:07:39.055 --> 00:07:40.575
So we'll talk about that a little bit in a minute.

191
00:07:43.525 --> 00:07:44.695
Some of your flight test commands are

192
00:07:44.695 --> 00:07:46.655
pre-programmed, many of them are today.

193
00:07:46.915 --> 00:07:49.655
But you have to put those in upfront and pay for it.

194
00:07:49.655 --> 00:07:51.255
So look at the cost benefit ratio.

195
00:07:51.675 --> 00:07:54.295
But if what we call a flight test only command can be very

196
00:07:54.455 --> 00:07:58.215
efficient way to get through a air vehicle program, A lot

197
00:07:58.215 --> 00:07:59.615
of times you'll have some adjustability

198
00:07:59.615 --> 00:08:00.775
in your control laws as well.

199
00:08:01.195 --> 00:08:03.495
You'll have some flexibility 'cause it's on man.

200
00:08:03.835 --> 00:08:05.495
And we can be efficient in our test program.

201
00:08:05.495 --> 00:08:07.895
Sometimes real time in flight to play with gains

202
00:08:07.895 --> 00:08:09.575
and things in various parts of the control system.

203
00:08:12.945 --> 00:08:14.995
Next thing you think about is, well what does the system do?

204
00:08:14.995 --> 00:08:18.875
If it does lose link lost com, what, how's it programmed?

205
00:08:18.875 --> 00:08:20.115
What's its lost link profile?

206
00:08:20.585 --> 00:08:22.235
Does it, um, find a way point

207
00:08:22.235 --> 00:08:24.915
and come back to a certain spot close to the field

208
00:08:25.365 --> 00:08:27.515
where you left loiter for a while?

209
00:08:27.615 --> 00:08:28.995
All that has to be understood ahead of time.

210
00:08:29.415 --> 00:08:31.795
And that, again, I'll keep weaving this throughout.

211
00:08:31.795 --> 00:08:34.155
The talk may be very arranged dependent.

212
00:08:34.175 --> 00:08:36.915
If you have offshore areas you can hang out.

213
00:08:36.935 --> 00:08:38.475
Or if you're over, um,

214
00:08:38.475 --> 00:08:39.795
the desert, it could be very different.

215
00:08:39.855 --> 00:08:43.515
Um, setup. What do you need for your, um,

216
00:08:43.515 --> 00:08:46.715

instrumentation in the accuracy required to get

217
00:08:46.715 --> 00:08:47.955
through this phase of the test rank

218
00:08:47.955 --> 00:08:49.435
program and move on to the next.

219
00:08:50.775 --> 00:08:52.675
So that's very critical On the small systems

220
00:08:52.865 --> 00:08:53.915
that becomes challenging.

221
00:08:54.255 --> 00:08:57.205
Miniaturization is really helping us get, um,

222
00:08:57.205 --> 00:09:00.485
instrumentation and data down, um,

223
00:09:01.545 --> 00:09:03.525
for future, uh, analysis.

224
00:09:04.065 --> 00:09:05.125
But sometimes all you're left

225
00:09:05.125 --> 00:09:07.205
with is the organic data link itself on the system

226
00:09:07.225 --> 00:09:08.365
and you get what you can out of that.

227
00:09:13.575 --> 00:09:17.425
Okay, how about the um, flight critical systems aspect?

228
00:09:17.895 --> 00:09:19.665
What we, you know, when you design a test burden,

229
00:09:19.665 --> 00:09:20.825
you think, well what is flight critical?

230
00:09:20.975 --> 00:09:22.225
What parameters am I gonna monitor?

231
00:09:22.375 --> 00:09:23.465
What are analysis critical?

232
00:09:23.465 --> 00:09:25.665
What are safety critical or test critical safety tests?

233
00:09:25.665 --> 00:09:26.825
However you like to describe it.

234
00:09:27.125 --> 00:09:29.905
Um, flight critical systems, again, as I mentioned earlier,

235
00:09:30.325 --> 00:09:32.705
may shift now in the US design

236
00:09:33.095 --> 00:09:34.385
your comm link is very important.

237
00:09:34.405 --> 00:09:35.505
You may need your radar

238
00:09:35.605 --> 00:09:38.385
or whatever type of sense you have for sense in a void

239
00:09:38.445 --> 00:09:41.225
or for landing in a spot when you lose your link,

240
00:09:41.245 --> 00:09:42.705
you don't nec know exactly where you are,

241
00:09:42.705 --> 00:09:43.785
but you need to find a spot that

242
00:09:43.785 --> 00:09:44.865
you're not gonna run into anything.

243
00:09:45.605 --> 00:09:47.465

So these are things that they're similar

244
00:09:47.485 --> 00:09:48.545
to everything else we've talked about,

245
00:09:48.925 --> 00:09:50.985
but you looking at it from a slightly different perspective.

246
00:09:52.405 --> 00:09:54.105
And lastly, when you assess

247
00:09:54.135 --> 00:09:55.545
what are the spectrum requirements,

248
00:09:55.935 --> 00:09:57.705
what bands do these systems operate in?

249
00:09:57.705 --> 00:10:01.505
Are they C band, are they kuban, it's satcom or even Omni.

250
00:10:02.205 --> 00:10:04.185
So you wanna make sure you understand what band you're in

251
00:10:04.185 --> 00:10:07.305
for performance, but also you're not stepping on someone

252
00:10:07.305 --> 00:10:09.665
else who maybe is in your flight test community area

253
00:10:10.045 --> 00:10:11.385
and that they're not stepping on you.

254
00:10:12.565 --> 00:10:15.385
And you also look for protection from outside people

255
00:10:15.385 --> 00:10:16.785
that are broadcasting possibly.

256
00:10:17.165 --> 00:10:19.345
So we actually have some spectrum monitoring capability

257
00:10:19.725 --> 00:10:22.025
around the Chesapeake Bay at PACS to help us with that.

258
00:10:24.735 --> 00:10:27.785
Okay, exploit, this is one of my favorite things

259
00:10:27.785 --> 00:10:30.105
to talk about because with us flight test design,

260
00:10:30.215 --> 00:10:31.985
there's a lot of things you can take advantage of.

261
00:10:33.355 --> 00:10:36.225
First of all, if they're not totally autonomous,

262
00:10:36.225 --> 00:10:37.985
which most aren't today, there's a lot.

263
00:10:38.255 --> 00:10:40.265
It's a bunch of algorithms that the system is following

264
00:10:40.265 --> 00:10:42.305
and then they're all dependent effects, then why?

265
00:10:42.645 --> 00:10:44.665
So things are pre-programmed.

266
00:10:44.845 --> 00:10:47.545
The responses to either a flight test command

267
00:10:47.545 --> 00:10:49.745
or response to an environmental change is consistent.

268
00:10:49.745 --> 00:10:52.025
It's gonna happen the same way every time.

269
00:10:52.745 --> 00:10:55.385
Maneuvers are repeatable and this drives it

270
00:10:55.565 --> 00:10:57.785

or reduces the requirement for phenomenal testing.

271
00:10:57.845 --> 00:10:59.545
In my mind, you can, there's no need

272
00:10:59.545 --> 00:11:01.985
to catch a wire six feet to the left, six feet to the right,

273
00:11:01.985 --> 00:11:04.345
catch a right in the middle 'cause it's gonna hit the spot

274
00:11:04.345 --> 00:11:06.665
the same time as long as the systems function properly.

275
00:11:08.805 --> 00:11:09.985
What's an HQR for?

276
00:11:09.985 --> 00:11:13.425
A USS dunno, it might not be something

277
00:11:13.425 --> 00:11:14.305
to worry about anymore, but

278
00:11:14.305 --> 00:11:15.305
um, it's something to think about.

279
00:11:18.405 --> 00:11:20.335
Another thing that's very interesting that you can exploit

280
00:11:21.565 --> 00:11:23.055
from a program manager's perspective,

281
00:11:23.155 --> 00:11:24.375
the range manager's perspective

282
00:11:24.375 --> 00:11:26.055
and the test team, it may be acceptable

283
00:11:26.055 --> 00:11:27.535
to lose an aircraft during a test point.

284
00:11:27.925 --> 00:11:30.295
Probability of loss is something we actually calculate,

285
00:11:32.055 --> 00:11:33.935
albeit statistically, which I would say is not completely

286
00:11:34.575 --> 00:11:37.535
relevant, but there is some usefulness of whether

287
00:11:37.535 --> 00:11:38.815
or not you may lose that system.

288
00:11:38.915 --> 00:11:42.655
And as I mentioned before, cost of the, of the system size,

289
00:11:42.835 --> 00:11:45.055
et cetera, all figure into that acceptance.

290
00:11:46.595 --> 00:11:48.375
How about the endurance? Some

291
00:11:48.375 --> 00:11:49.495
of these can fly for a long time.

292
00:11:49.825 --> 00:11:52.335
We've got a 135 pound vehicle that flies

293
00:11:52.335 --> 00:11:53.885
with a gallon and a half in gas.

294
00:11:53.945 --> 00:11:55.205
It can fly for 18 hours.

295
00:11:56.615 --> 00:11:58.595
Haw can fly for what, 20 some hours or more, right?

296
00:11:58.615 --> 00:11:59.755
You guys probably know better tonight.

297
00:12:00.375 --> 00:12:01.515

You can take a, a lot

298
00:12:01.515 --> 00:12:02.915
of, you can do a lot of things with that.

299
00:12:02.915 --> 00:12:05.355
Take advantage. You can combine mission systems tests.

300
00:12:05.415 --> 00:12:07.355
You can combine air vehicle tests in the same flight.

301
00:12:07.935 --> 00:12:09.195
You might need to be at one condition

302
00:12:09.195 --> 00:12:11.675
for some air vehicle work and you've gotta wait an hour till

303
00:12:11.675 --> 00:12:13.155
you burn down some fuel or maybe change

304
00:12:13.355 --> 00:12:14.555
altitudes or change locations.

305
00:12:14.815 --> 00:12:16.835
Hey, do some mission systems work while you're at it.

306
00:12:18.355 --> 00:12:20.895
Sounds great. It is. You need a couple things.

307
00:12:20.915 --> 00:12:23.095
You need the ability to monitor telemetry real time

308
00:12:23.635 --> 00:12:25.095
and the right people in the room to look at it

309
00:12:25.095 --> 00:12:27.695
to make decisions that yes we are

310
00:12:27.695 --> 00:12:28.935
good to go to the next test point.

311
00:12:29.435 --> 00:12:31.135
The second thing you need is you may,

312
00:12:31.135 --> 00:12:33.415
you may need two crews 'cause you're gonna be up there a long time.

313
00:12:33.415 --> 00:12:35.175
You're gonna start bumping into crew rest

314
00:12:35.175 --> 00:12:36.895
issues, that sort of thing.

315
00:12:37.275 --> 00:12:39.775
So again, it's, this is all part of the risk management

316
00:12:39.775 --> 00:12:41.775
that we're baking into our flight test planning.

317
00:12:43.335 --> 00:12:44.335
I mentioned envelope a little bit

318
00:12:44.335 --> 00:12:46.175
before, I'll talk about it again.

319
00:12:46.245 --> 00:12:48.815
It's usually small, it's usually point design.

320
00:12:49.955 --> 00:12:51.655
Um, your small tacticals even up

321
00:12:51.655 --> 00:12:54.215
to your mediums are usually only flying in the 80

322
00:12:54.235 --> 00:12:55.415
to 120 knot range.

323
00:12:55.675 --> 00:12:58.295
You don't need to have a big envelope from three

324
00:12:58.295 --> 00:13:00.095

to 500 knots or or supersonic

325
00:13:00.115 --> 00:13:01.375
and you don't need a bunch of different

326
00:13:01.685 --> 00:13:03.215
abilities for acceleration.

327
00:13:03.435 --> 00:13:06.735
You usually in negative half to one and a half G regime.

328
00:13:06.735 --> 00:13:08.455
And that's about it. Take

329
00:13:08.455 --> 00:13:09.655
advantage of that in your test program.

330
00:13:11.875 --> 00:13:14.255
How about operators? This is what might be near

331
00:13:14.255 --> 00:13:15.615
and dear to a lot of people's heart in here.

332
00:13:16.315 --> 00:13:18.015
The manned paradigm may be different.

333
00:13:18.015 --> 00:13:19.495
And actually we are making some changes

334
00:13:20.515 --> 00:13:22.655
in the opab instruction from the navy side about

335
00:13:22.655 --> 00:13:25.535
what it requires to fly an unmanned system.

336
00:13:26.715 --> 00:13:29.135
Why do I mention that? Well, for efficiency

337
00:13:30.315 --> 00:13:31.695
you might not need to keep a bunch

338
00:13:31.695 --> 00:13:33.775
of cat C test pilots on your staff.

339
00:13:34.175 --> 00:13:35.095
I would argue you need some

340
00:13:35.095 --> 00:13:36.175
but maybe you don't need as many.

341
00:13:36.605 --> 00:13:39.295
What does it mean to be to design and execute

342
00:13:39.435 --> 00:13:42.855
or be ready for a category C flight test for an man system?

343
00:13:43.195 --> 00:13:45.215
Not sure do you need the golden stick?

344
00:13:45.215 --> 00:13:47.615
Do you need the golden mouse pointer? You know, it depends.

345
00:13:48.075 --> 00:13:49.455
So a lot to think about.

346
00:13:49.575 --> 00:13:51.735
I mean there's a lot that goes into becoming a test po.

347
00:13:51.735 --> 00:13:53.255
Obviously I didn't go to test PO school,

348
00:13:53.275 --> 00:13:55.095
but the whole thought process

349
00:13:55.275 --> 00:13:57.415
and discipline of planning executing

350
00:13:57.415 --> 00:13:59.175
and you know, fly the flight, plan the flight.

351
00:13:59.675 --> 00:14:00.935

So something to think about

352
00:14:01.315 --> 00:14:05.615
but you can definitely exploit that, um, uh, pot potential.

353
00:14:07.885 --> 00:14:11.055
Okay. And the last thing I'll mention is along the whole

354
00:14:11.055 --> 00:14:14.255
thing, the operator, we use the term air vehicle operator.

355
00:14:14.295 --> 00:14:15.295
I think different services

356
00:14:15.315 --> 00:14:17.095
and industries call them different things,

357
00:14:17.155 --> 00:14:20.215
but you really are managing your operational risk while

358
00:14:20.215 --> 00:14:21.255
you're flying from the ground.

359
00:14:21.835 --> 00:14:25.215
So unique test strategy opportunities exist when you're

360
00:14:25.215 --> 00:14:26.655
trying to put together a program like this.

361
00:14:29.565 --> 00:14:31.535
Okay? Risk management, that's what we've been talking about.

362
00:14:32.015 --> 00:14:33.615
I won't belabor the test.

363
00:14:33.615 --> 00:14:36.175
Hazard analysis process is very similar for everyone

364
00:14:36.195 --> 00:14:38.015
who maybe use slightly different terms,

365
00:14:40.045 --> 00:14:41.105
but it's good to reinforce

366
00:14:41.105 --> 00:14:42.385
everything we've been talking about's.

367
00:14:42.385 --> 00:14:44.585
What these workshops are good for, um, one

368
00:14:44.585 --> 00:14:46.705
of the things is they reinforce best practices.

369
00:14:47.085 --> 00:14:50.025
So if we, if we zero down onto the residual test risk piece,

370
00:14:51.465 --> 00:14:53.445
I'd mentioned it, but really the risk

371
00:14:53.445 --> 00:14:54.765
is shifting to person on the ground.

372
00:14:55.145 --> 00:14:56.205
And we talked about that a little bit.

373
00:14:56.205 --> 00:14:58.445
It may depend on where you are in the test range. Agreed.

374
00:14:59.105 --> 00:15:01.845
But if things get outside the boundary, outside the space

375
00:15:01.905 --> 00:15:03.445
and there are still um,

376
00:15:03.445 --> 00:15:05.005
folks on the ground that could be in harm's way.

377
00:15:06.195 --> 00:15:08.165
Mid-air collision risk is still there.

378
00:15:08.555 --> 00:15:10.085

Potentially depending where you are.

379
00:15:10.585 --> 00:15:13.325
We do a lot of work with exclusive use airspace, but more

380
00:15:13.325 --> 00:15:15.285
and more throughout industry

381
00:15:15.285 --> 00:15:17.565
and DOD we're using national airspace through use

382
00:15:17.565 --> 00:15:19.485
of COAs and other agreements.

383
00:15:19.485 --> 00:15:23.525
Part 1 0 7, if everyone honors the rules, we should be good,

384
00:15:23.525 --> 00:15:25.965
but we have to be wary that everyone might not always honor

385
00:15:25.985 --> 00:15:28.325
the rules of the road.

386
00:15:31.245 --> 00:15:34.295
Some of the tools to manage these things on the range

387
00:15:34.295 --> 00:15:35.295
before I get into the range,

388
00:15:35.355 --> 00:15:36.975
you know there's different flight safety systems.

389
00:15:37.835 --> 00:15:39.855
The larger systems have organic,

390
00:15:39.915 --> 00:15:42.215
or excuse me, independent flight termination

391
00:15:42.215 --> 00:15:43.615
systems, a separate link.

392
00:15:43.635 --> 00:15:45.455
If the regular, regular link goes down,

393
00:15:45.475 --> 00:15:48.135
you still have ability to terminate flight if you need to.

394
00:15:48.715 --> 00:15:51.015
The smaller systems typically don't have room for those.

395
00:15:51.555 --> 00:15:55.215
So you rely on the organic termination schemes, usually part

396
00:15:55.215 --> 00:15:56.255
of the regular data link.

397
00:15:58.035 --> 00:15:59.455
But you're looking, you know, what are you looking at?

398
00:15:59.455 --> 00:16:01.375
Range containment starts getting near the boundary.

399
00:16:01.375 --> 00:16:03.895
You're gonna drop it, you'd like to turn it around.

400
00:16:03.955 --> 00:16:05.975
So a lot of systems are being miniaturized

401
00:16:06.395 --> 00:16:07.535
to give you some control.

402
00:16:07.535 --> 00:16:09.455
And I'll mention a few of those in the next slide.

403
00:16:09.575 --> 00:16:14.095
I think at the same time, the range needs to be able

404
00:16:14.095 --> 00:16:15.855
to monitor the radio

405
00:16:15.855 --> 00:16:17.575

frequency spectrum like I managed earlier.

406
00:16:17.595 --> 00:16:19.215
And we are doing that in a lot of cases.

407
00:16:20.595 --> 00:16:23.215
So the end up goal objective manage your

408
00:16:23.215 --> 00:16:24.295
risk to acceptable level.

409
00:16:26.845 --> 00:16:29.255
Well one of the reason ways you can do that is

410
00:16:29.255 --> 00:16:33.055
where do you fly where select the range that you first

411
00:16:33.355 --> 00:16:34.415
to get the data you need.

412
00:16:34.415 --> 00:16:36.535
Maybe you need certain targets, maybe you need a littoral,

413
00:16:37.025 --> 00:16:39.015
maybe you need to be in a hot dry environment.

414
00:16:39.195 --> 00:16:42.615
But if you can pick a range that's pick a small for example

415
00:16:43.315 --> 00:16:44.655
and you worry about it getting away,

416
00:16:44.655 --> 00:16:45.895
well put it in the middle of the desert

417
00:16:45.895 --> 00:16:47.375
that's surrounded by ring of mountains.

418
00:16:47.875 --> 00:16:49.495
If it goes away, eventually it's gonna hit a mountain.

419
00:16:49.565 --> 00:16:52.135
It's not gonna go, um, where it shouldn't.

420
00:16:52.435 --> 00:16:53.655
So there's different things you can do there.

421
00:16:54.435 --> 00:16:56.415
So you mix your requirements for the test

422
00:16:56.445 --> 00:16:58.255
with risk tolerance

423
00:16:58.275 --> 00:17:02.295
and the ability to, to help manage that risk test execution.

424
00:17:02.295 --> 00:17:03.095
The cost and schedule

425
00:17:03.515 --> 00:17:04.935
ranges are always dealing with that as well.

426
00:17:04.995 --> 00:17:07.615
So you're, you're always trying to fit in your system

427
00:17:08.125 --> 00:17:12.495
test program and priorities will always play a part in that.

428
00:17:14.075 --> 00:17:17.055
Anyway, my my get off the slide

429
00:17:17.055 --> 00:17:19.055
for this is your risk management

430
00:17:19.055 --> 00:17:21.095
and your selection are intimately intertwined.

431
00:17:23.455 --> 00:17:25.825
Alright, so what are some of the challenges?

432
00:17:27.115 --> 00:17:28.585

Focus on basically two areas.

433
00:17:28.725 --> 00:17:31.145
One I mentioned earlier is the semi-autonomous type

434
00:17:31.145 --> 00:17:33.825
of system, also known as a finite state machine.

435
00:17:35.615 --> 00:17:37.185
What does it do when it's lost linked?

436
00:17:37.245 --> 00:17:39.785
Um, nab like I mentioned, it's pretty much known

437
00:17:40.965 --> 00:17:41.925
'cause the people that programmed

438
00:17:41.925 --> 00:17:43.365
it had an idea when they did that.

439
00:17:43.365 --> 00:17:45.805
However, there are very interesting software

440
00:17:45.805 --> 00:17:48.125
and logic paths that sometimes collide

441
00:17:48.145 --> 00:17:49.925
or never match up as expected.

442
00:17:51.145 --> 00:17:53.245
And there's been some interesting, um, circumstances

443
00:17:53.245 --> 00:17:54.965
that come up as a result of that.

444
00:17:55.805 --> 00:17:56.885
A couple of neat examples.

445
00:17:57.385 --> 00:18:01.165
We have a UAV on a flight deck of a carrier at sea

446
00:18:01.845 --> 00:18:03.205
cruising along or it may be 20 knots

447
00:18:04.065 --> 00:18:06.645
and it's supposed to put the brakes on if it tries

448
00:18:06.645 --> 00:18:09.045
to exceed five knots while it's move around the flight deck.

449
00:18:10.115 --> 00:18:11.165
Brian's laughing over there.

450
00:18:12.065 --> 00:18:13.525
Um, airplane won't go anywhere

451
00:18:13.755 --> 00:18:15.925
because it's ground speed, five knots, ground speed.

452
00:18:15.925 --> 00:18:17.565
Well the ship's moving 20 knots over the

453
00:18:17.565 --> 00:18:18.805
bottom airplane will not move.

454
00:18:19.475 --> 00:18:21.125
Something somebody didn't think about when they were

455
00:18:21.125 --> 00:18:23.325
programming the um, the ability to do the taxi.

456
00:18:23.635 --> 00:18:26.485
Another interesting thing, there's another ship for example,

457
00:18:27.065 --> 00:18:31.885
um, just like a hornet coming in or tomcat to the deck

458
00:18:31.885 --> 00:18:33.445
and things aren't right, you're not matching

459
00:18:33.445 --> 00:18:34.485

up your motion with this.

460
00:18:34.585 --> 00:18:37.965
The deck you wave off or the LSO tells you to wave off.

461
00:18:38.595 --> 00:18:40.725
Well on a, some of the au autonomous systems we

462
00:18:40.725 --> 00:18:41.805
had are semi autonomous.

463
00:18:42.375 --> 00:18:44.925
We've had them actually wave off towards the ship

464
00:18:45.305 --> 00:18:48.365
and you find out later that, well the guy who programmed it

465
00:18:48.365 --> 00:18:49.845
or gal said we want

466
00:18:49.845 --> 00:18:51.605
to go back towards the closest way point.

467
00:18:51.755 --> 00:18:54.405
Well the closest way point is sometimes the wrong direction.

468
00:18:55.035 --> 00:18:57.005
Simulations and stuff never showed that.

469
00:18:57.545 --> 00:18:58.565
And similarly we've had ones

470
00:18:58.565 --> 00:19:01.085
where they turned the wrong direction because which way they

471
00:19:01.085 --> 00:19:03.885
turned off of uh, onto final

472
00:19:04.075 --> 00:19:06.645
that direction dictated they're gonna go the opposite way.

473
00:19:06.665 --> 00:19:09.205
So thing what the point is, um, some of the folks

474
00:19:09.205 --> 00:19:11.445
that are working on this are not aviators

475
00:19:11.445 --> 00:19:13.045
that understand the conops of

476
00:19:13.045 --> 00:19:14.285
where the system will be employed.

477
00:19:14.705 --> 00:19:17.205
So fold that into your risk as much as possible.

478
00:19:17.665 --> 00:19:19.485
And that's gonna get into what I'm gonna

479
00:19:19.485 --> 00:19:20.645
mention in the next slide.

480
00:19:21.265 --> 00:19:23.965
But before I do, um, some of those mishaps

481
00:19:24.105 --> 00:19:25.125
or near mishaps,

482
00:19:25.125 --> 00:19:27.085
there's some great taxonomy documents out there.

483
00:19:27.085 --> 00:19:29.605
The range commander's counsel has a fairly new one you can

484
00:19:29.605 --> 00:19:32.445
read about for different UAV mishaps, um,

485
00:19:32.825 --> 00:19:34.645
around the world actually from different services.

486
00:19:34.705 --> 00:19:36.045

And I can get anyone that reference

487
00:19:36.045 --> 00:19:41.045
interested not right

488
00:19:42.345 --> 00:19:44.245
Yes. Alright, so for higher levels of autonomy

489
00:19:45.475 --> 00:19:48.245
call different things, non-deterministic, adaptive

490
00:19:48.815 --> 00:19:51.605
autonomous, but basically they

491
00:19:51.605 --> 00:19:52.805
can adapt to their environment.

492
00:19:53.025 --> 00:19:54.685
You don't know exactly what they're gonna do,

493
00:19:54.745 --> 00:19:56.325
but they will do the mission

494
00:19:56.465 --> 00:19:58.205
or the task you're ask them to do,

495
00:19:58.225 --> 00:20:00.765
but you don't have exact feel for how it's going to do it.

496
00:20:01.515 --> 00:20:03.045
Very new fledgling field

497
00:20:03.665 --> 00:20:05.725
and it places some challenges on our ability

498
00:20:05.745 --> 00:20:07.365
to figure out a test program for 'em.

499
00:20:07.415 --> 00:20:09.005
We've got some very smart people working on

500
00:20:09.235 --> 00:20:10.485
ways to help us do that.

501
00:20:10.485 --> 00:20:12.205
And I'll mention some of the things that are going on.

502
00:20:12.545 --> 00:20:13.885
But you've gotta try and characterize

503
00:20:13.945 --> 00:20:15.725
and bound the behavior like you do

504
00:20:15.725 --> 00:20:17.005
for the finite state machines.

505
00:20:17.825 --> 00:20:19.365
You don't know exactly what it's gonna do.

506
00:20:19.755 --> 00:20:22.085
What do you, the question is what could it do?

507
00:20:23.145 --> 00:20:24.765
So the same things, boundary violations

508
00:20:24.765 --> 00:20:26.125
and then even unsafe maneuvers,

509
00:20:26.125 --> 00:20:28.725
which might put the air system into a, a condition

510
00:20:28.725 --> 00:20:30.325
or state that they can't recover from.

511
00:20:31.935 --> 00:20:33.485
We're doing some of this already, I mean,

512
00:20:33.825 --> 00:20:34.925
but we're doing it on systems

513
00:20:34.925 --> 00:20:36.685

that are slow and have lots of time.

514
00:20:37.195 --> 00:20:39.525
Planetary rovers, surface craft,

515
00:20:39.575 --> 00:20:41.005
subsurface craft are doing this.

516
00:20:41.005 --> 00:20:43.205
Now most of the research is using those types of vehicles

517
00:20:43.355 --> 00:20:44.445
because you have time

518
00:20:44.905 --> 00:20:46.445
to manage things when they don't go

519
00:20:46.445 --> 00:20:47.605
quite the way you want them to.

520
00:20:48.425 --> 00:20:49.605
And there's a lot of things out there.

521
00:20:49.825 --> 00:20:53.445
Uh, I can uh, give you references for if you're interested.

522
00:20:54.185 --> 00:20:56.645
So what about ring safety's role in all of this?

523
00:20:57.195 --> 00:20:58.245
Well first of all, they're there

524
00:20:58.245 --> 00:20:59.605
to help make sure they're part of your team.

525
00:21:00.395 --> 00:21:02.485
Ring safety. A lot of people, maybe that's not new,

526
00:21:02.485 --> 00:21:07.285
but at TC I'm a huge a advocate of going to brief the tower

527
00:21:07.825 --> 00:21:10.925
and the um, air ops officer, what's going on,

528
00:21:10.925 --> 00:21:13.325
what's going down and what can your system do if it does

529
00:21:13.325 --> 00:21:14.405
have some sort of anomaly?

530
00:21:14.485 --> 00:21:15.485
'cause they're not used to seeing these

531
00:21:15.485 --> 00:21:17.285
things, um, at the field.

532
00:21:19.725 --> 00:21:22.985
So help them understand the system, help them understand

533
00:21:22.985 --> 00:21:24.425
what it could do or what it will do.

534
00:21:25.165 --> 00:21:26.425
And then start looking at what kind

535
00:21:26.425 --> 00:21:27.825
of controls are available and let them know

536
00:21:27.825 --> 00:21:31.585
what you plan on doing this is with range safety, of course

537
00:21:33.175 --> 00:21:36.545
I'll offer that when an autonomous system goes lost link.

538
00:21:37.045 --> 00:21:38.625
It may not be the worst thing.

539
00:21:38.625 --> 00:21:41.025
It may be, uh, better than it semi autonomous

540
00:21:41.105 --> 00:21:44.025

'cause it may figure out how to get back or maybe it's not.

541
00:21:44.095 --> 00:21:45.265
It's, it's food for thought.

542
00:21:46.255 --> 00:21:49.505
Alright, so THA process obviously, um,

543
00:21:49.505 --> 00:21:50.825
someone mentioned system safety.

544
00:21:51.445 --> 00:21:52.665
Uh, we definitely try to use that

545
00:21:52.665 --> 00:21:54.585
to inform our test hazard analysis process.

546
00:21:55.685 --> 00:21:56.835
There are some pitfalls.

547
00:21:57.255 --> 00:21:58.635
Be aware what went into the safety

548
00:21:59.635 --> 00:22:00.755
analysis in the first place.

549
00:22:02.465 --> 00:22:04.075
Test teams should very much

550
00:22:04.075 --> 00:22:05.315
be involved in the design process.

551
00:22:05.785 --> 00:22:06.995
Your big programs, you know,

552
00:22:06.995 --> 00:22:09.875
your people mentioned your standard PD or CDR, et cetera.

553
00:22:09.875 --> 00:22:11.955
But the smallest. Get out to the manufacturer,

554
00:22:12.015 --> 00:22:15.315
get in the lab with these guys, see how they work, try

555
00:22:15.315 --> 00:22:16.635
and participate in their software in the loop.

556
00:22:16.635 --> 00:22:19.955
Hit functional qualification test events as much as you can.

557
00:22:20.795 --> 00:22:21.715
A lot of program managers

558
00:22:21.715 --> 00:22:22.835
say, oh, I don't have money for that.

559
00:22:23.335 --> 00:22:24.675
You know, keep pushing 'em if you can.

560
00:22:24.875 --> 00:22:25.915
'cause it pays off in space.

561
00:22:26.165 --> 00:22:28.635
Every time we send one of our best operators

562
00:22:28.635 --> 00:22:29.955
to a contractor facility

563
00:22:29.955 --> 00:22:31.475
and they sit with the guys developing,

564
00:22:31.775 --> 00:22:33.995
we always learn stuff that we're glad we knew.

565
00:22:33.995 --> 00:22:35.515
When that system actually gets where the new software

566
00:22:35.515 --> 00:22:36.635
load drops or whatever it is.

567
00:22:38.655 --> 00:22:40.275

We talk about buildup and complexity,

568
00:22:40.775 --> 00:22:41.875
that's always important.

569
00:22:42.455 --> 00:22:46.515
And rain safety expertise range's, geography I mentioned.

570
00:22:47.355 --> 00:22:49.315
I don't think I need to mention a whole bunch more other

571
00:22:49.315 --> 00:22:51.595
than use the features

572
00:22:51.595 --> 00:22:53.435
and the expertise there to manage your risks.

573
00:22:53.835 --> 00:22:55.955
'cause the, you have to take some risk to make sure

574
00:22:55.955 --> 00:23:00.035
that tolerance is there for, for the risk if it does occur.

575
00:23:01.085 --> 00:23:04.035
Again, design and residual risk in my mind are intertwined.

576
00:23:07.275 --> 00:23:09.725
Okay? Some of the safety systems.

577
00:23:11.875 --> 00:23:15.655
So modeling the air vehicle, very important.

578
00:23:15.655 --> 00:23:17.615
Physics based, even more important

579
00:23:17.775 --> 00:23:20.015
or just as important, the environment in which it's

580
00:23:20.685 --> 00:23:22.215
operating in when it's live,

581
00:23:22.215 --> 00:23:23.855
or excuse me, virtual or constructive.

582
00:23:24.285 --> 00:23:26.095
They need to be very well validated

583
00:23:26.195 --> 00:23:27.495
for them to really be meaningful.

584
00:23:27.495 --> 00:23:30.775
If you're gonna have some sort of safety case to go

585
00:23:30.955 --> 00:23:32.735
and say, Hey, this is why I think I can do this program

586
00:23:33.475 --> 00:23:34.695
within this risk level.

587
00:23:35.305 --> 00:23:36.335
Those models need

588
00:23:36.335 --> 00:23:39.455
to adequately very well predict the performance

589
00:23:39.635 --> 00:23:41.535
and allow you some understanding of the,

590
00:23:41.535 --> 00:23:42.815
of the limitations of the system.

591
00:23:43.855 --> 00:23:45.015
A lot of work going on in this area.

592
00:23:45.475 --> 00:23:48.445
Some of it's for just position monitoring, which is kind

593
00:23:48.445 --> 00:23:51.445
of the traditional way, but more importantly is the work

594
00:23:51.445 --> 00:23:53.965

going on in monitoring and then control to grab something.

595
00:23:54.555 --> 00:23:56.445
Some of the concepts under development you may have heard

596
00:23:56.445 --> 00:23:58.085
of tastes, that's a joint.

597
00:23:58.285 --> 00:24:00.605
DOD um, system testing of autonomy

598
00:24:00.665 --> 00:24:03.485
and complex environments is what the acronym stands for.

599
00:24:04.075 --> 00:24:05.525
There's other ones called, uh,

600
00:24:05.525 --> 00:24:07.805
wrapped mission termination system.

601
00:24:08.305 --> 00:24:09.925
And the Navy's TRMC

602
00:24:09.925 --> 00:24:12.485
and others are putting a lot of money into research

603
00:24:12.505 --> 00:24:15.125
and making some of these things effective,

604
00:24:15.125 --> 00:24:16.645
miniaturized and, and usable.

605
00:24:17.025 --> 00:24:19.805
It all sounds great, but no program wants to stop

606
00:24:19.945 --> 00:24:22.085
and shove some of this stuff into their

607
00:24:22.085 --> 00:24:24.125
system to keep going for test.

608
00:24:24.155 --> 00:24:25.965
They, uh, the range is problem. Don't worry about that.

609
00:24:27.135 --> 00:24:29.275
Um, software testing is another huge area

610
00:24:29.745 --> 00:24:31.235
that a lot of research is being done.

611
00:24:32.015 --> 00:24:33.995
The challenge with software testing, first of all,

612
00:24:33.995 --> 00:24:37.395
you got code testing code, but we have to do something

613
00:24:37.515 --> 00:24:38.555
'cause the humans aren't gonna do it.

614
00:24:38.555 --> 00:24:40.835
There's too many lines of code that the software

615
00:24:40.835 --> 00:24:43.235
that runs our systems is just too, too large,

616
00:24:43.305 --> 00:24:44.715
even if you put it in modules.

617
00:24:45.175 --> 00:24:48.115
So the challenge is to prioritize which pieces

618
00:24:48.115 --> 00:24:49.155
of the code to get into.

619
00:24:49.735 --> 00:24:51.835
So try and look at your flight critical regimes

620
00:24:51.835 --> 00:24:55.635
of if you can isolate those, but they're still intertwined.

621
00:24:55.635 --> 00:24:57.475

So I don't have an answer. I'm just let you know

622
00:24:57.475 --> 00:24:58.715
that if someone comes up to you

623
00:24:58.915 --> 00:25:00.395
and says, Hey, we have this code.

624
00:25:00.455 --> 00:25:01.835
We we ran it through our software

625
00:25:01.835 --> 00:25:02.875
checker and we're good to go.

626
00:25:03.585 --> 00:25:05.555
I've seen plenty of examples where we miss things.

627
00:25:06.055 --> 00:25:07.675
So be ever vigilant.

628
00:25:09.625 --> 00:25:13.065
Uh, Okay,

629
00:25:14.695 --> 00:25:15.705
Technical Leadership,

630
00:25:16.745 --> 00:25:18.425
I think Glen mentioned this this morning.

631
00:25:18.545 --> 00:25:20.585
I was glad to see that and some others did too.

632
00:25:20.645 --> 00:25:23.145
But you know, throughout an organization we have

633
00:25:23.725 --> 00:25:25.545
the seasoned flight test, we have the, you know,

634
00:25:25.545 --> 00:25:28.105
the junior engineers, the guys actually out there doing it.

635
00:25:28.105 --> 00:25:30.385
Senior engineer engineers are helping and monitor.

636
00:25:30.445 --> 00:25:33.265
And then you got your leadership extremely important

637
00:25:34.285 --> 00:25:35.305
during all phases.

638
00:25:35.545 --> 00:25:38.425
Planning, test, conduct and reporting. Why reporting?

639
00:25:38.815 --> 00:25:41.625
Well reporting is gonna feed the next phase, the next test,

640
00:25:41.815 --> 00:25:43.105
next test program.

641
00:25:43.725 --> 00:25:46.265
If it's not done well, you can't leverage it very well

642
00:25:46.285 --> 00:25:49.025
to plan your test and manage your risk for the next phase

643
00:25:49.025 --> 00:25:50.505
or the next program at all.

644
00:25:51.165 --> 00:25:55.645
So make sure that the opportunities exist

645
00:25:55.985 --> 00:25:58.125
for the interactions between team and leadership

646
00:25:58.345 --> 00:26:00.605
and that leadership continues to get involved.

647
00:26:00.985 --> 00:26:02.685
You know, we have some scheduled things.

648
00:26:02.685 --> 00:26:03.805

We have test plan reviews

649
00:26:03.905 --> 00:26:06.925
and executive review boards, report reviews,

650
00:26:07.225 --> 00:26:08.805
but there's other opportunities, stats,

651
00:26:08.805 --> 00:26:10.325
reports, that sort of thing.

652
00:26:10.345 --> 00:26:13.285
So important point is

653
00:26:13.285 --> 00:26:15.525
that technical leadership involvement is a thread

654
00:26:15.525 --> 00:26:17.565
that you'll see woven and should be woven throughout an

655
00:26:17.565 --> 00:26:20.125
organization that's really managing their test risk well.

656
00:26:21.265 --> 00:26:22.525
And that's for the DT risk.

657
00:26:23.145 --> 00:26:25.605
And then moving into the operational risk as far

658
00:26:25.605 --> 00:26:27.765
as the actual flight moment that day.

659
00:26:29.265 --> 00:26:31.405
In the end, of course we all want safe, effective and,

660
00:26:32.065 --> 00:26:33.285
and efficient flight tests

661
00:26:33.665 --> 00:26:35.085
and technical leadership is there

662
00:26:35.545 --> 00:26:36.605
to help make sure that happens.

663
00:26:39.745 --> 00:26:42.885
Future, keep working on these range safety systems

664
00:26:43.080 --> 00:26:45.405
that I had mentioned, especially for autonomous.

665
00:26:45.985 --> 00:26:48.005
You're gonna see a lot of work

666
00:26:48.005 --> 00:26:49.605
and money continue to be spent on those.

667
00:26:49.665 --> 00:26:51.005
And I advocate that for sure.

668
00:26:51.745 --> 00:26:53.405
The, um, live virtual constructive methods

669
00:26:53.545 --> 00:26:55.245
for both the air vehicle and the environment

670
00:26:55.795 --> 00:26:56.805
need continued work.

671
00:26:58.365 --> 00:27:00.275
Again, be vigilant and look for good validation

672
00:27:00.275 --> 00:27:01.275
of verification reports

673
00:27:02.415 --> 00:27:03.955
and then the software testing as well.

674
00:27:07.585 --> 00:27:09.785
I think that's all I have. Any questions,

675
00:27:19.405 --> 00:27:20.405

Sir? How much, uh, testing

676
00:27:20.405 --> 00:27:21.945
have you done outside

677
00:27:21.945 --> 00:27:25.105
of a restricted airspace in a conus with an in interfacing

678
00:27:25.175 --> 00:27:27.425
with the FAA as we start

679
00:27:27.425 --> 00:27:29.265
to get these more autonomous systems

680
00:27:29.365 --> 00:27:33.225
and trying to use them in large scale exercises

681
00:27:33.225 --> 00:27:35.385
or stuff where you've got a lost link

682
00:27:35.725 --> 00:27:38.025
and this thing's traveling halfway across the country in,

683
00:27:38.045 --> 00:27:40.465
in a global Hawk type scenario, right?

684
00:27:40.605 --> 00:27:44.785
Um, the FAA, the, the office that you have to work with,

685
00:27:45.405 --> 00:27:48.625
um, how, how much interaction have you guys done with that?

686
00:27:49.125 --> 00:27:51.345
So I'll speak from some li somewhat

687
00:27:51.345 --> 00:27:52.425
limited experience on that.

688
00:27:52.805 --> 00:27:55.665
Um, the unit I work with, we have not done a lot.

689
00:27:55.665 --> 00:27:57.985
We have some COAs to move from one restricted area.

690
00:27:58.205 --> 00:28:00.705
For instance, the, um, Atlantic test range

691
00:28:00.975 --> 00:28:03.345
through national airspace to the warning areas off

692
00:28:03.345 --> 00:28:05.145
of walls offshore in the Atlantic.

693
00:28:05.685 --> 00:28:06.945
That's fairly straightforward.

694
00:28:07.125 --> 00:28:09.945
Um, we have a Navy rep at the FAA that we work with

695
00:28:10.205 --> 00:28:11.905
to help plan those things to get that work.

696
00:28:12.265 --> 00:28:15.265
I know, um, like our sister squadron VX 20 flying the

697
00:28:15.265 --> 00:28:18.865
Triton, um, they do a lot more national airspace work

698
00:28:18.865 --> 00:28:20.145
and they have flown across country,

699
00:28:20.405 --> 00:28:22.465
but again, I believe they work with the Navy rep

700
00:28:23.085 --> 00:28:24.345
to work out the bugs on that.

701
00:28:24.365 --> 00:28:26.185
And that process continues to evolve.

702
00:28:26.225 --> 00:28:30.185

I know for the smalls, um, the process is much more, um,

703
00:28:30.545 --> 00:28:32.545
efficient, accelerated, you can get through, you know,

704
00:28:32.545 --> 00:28:35.225
they have a, an online tool to get you involved initially

705
00:28:35.765 --> 00:28:37.185
and then you're starting to dialogue about

706
00:28:37.185 --> 00:28:38.265
what you're, um, trying to do.

707
00:28:39.725 --> 00:28:41.345
So I don't have a great answer for you on that,

708
00:28:41.345 --> 00:28:43.985
but that's my limited experience with it right now.

709
00:28:46.185 --> 00:28:48.955
Anyone else? Hey Doug.

710
00:28:49.095 --> 00:28:51.595
Hey Dave, do you have any opinion on the distributed, uh,

711
00:28:51.785 --> 00:28:53.075
test team structure

712
00:28:54.285 --> 00:28:57.715
where your flight test engineering might be West coast,

713
00:28:57.865 --> 00:29:00.835
your test team is on the, your operational end

714
00:29:00.835 --> 00:29:02.075
of your test team is on the east coast.

715
00:29:02.495 --> 00:29:03.515
You got any opinions on that?

716
00:29:04.755 --> 00:29:07.315
I haven't actually executed a program that way,

717
00:29:07.375 --> 00:29:08.795
but I think there's nothing wrong with it.

718
00:29:08.795 --> 00:29:09.995
I mean, modern technology, it's

719
00:29:09.995 --> 00:29:11.355
limited by the speed of light.

720
00:29:11.355 --> 00:29:12.955
So there is some lag.

721
00:29:13.175 --> 00:29:16.315
We mentioned lag or latency that may be important

722
00:29:17.215 --> 00:29:19.955
to consider if it's a, something you need to monitor.

723
00:29:20.135 --> 00:29:22.555
For instance, on telemetry, I wouldn't want it

724
00:29:22.555 --> 00:29:24.075
to take two seconds depending on

725
00:29:24.075 --> 00:29:25.275
what you're doing, if it's air vehicle work.

726
00:29:25.275 --> 00:29:27.435
But for mission systems work, it shouldn't be a big deal.

727
00:29:28.015 --> 00:29:30.595
Um, so, you know, it's co some

728
00:29:30.595 --> 00:29:32.795
of the team co-located in some remote is fine.

729
00:29:32.955 --> 00:29:34.275

I know that Triton has done some of

730
00:29:34.275 --> 00:29:35.555
that Fire scout, we talked about it.

731
00:29:35.555 --> 00:29:39.515
We never got the data pipe quite in place for engineers at,

732
00:29:39.695 --> 00:29:43.245
um, the contractor location to monitor real time.

733
00:29:43.345 --> 00:29:45.085
So I have no problem with it.

734
00:29:45.085 --> 00:29:48.925
I think you just need to do it smartly. Yeah. Hey,

735
00:29:49.475 --> 00:29:51.085
Over the years I've done a lot of, um,

736
00:29:51.435 --> 00:29:56.165
technical assurance on, uh, safety engineers, uh,

737
00:29:56.235 --> 00:29:58.205
effectively safety arguments.

738
00:29:58.785 --> 00:30:03.245
And when they get to uh, software, um, you quite often have

739
00:30:03.245 --> 00:30:06.885
to throw in a one if it's not the appropriate, uh,

740
00:30:06.905 --> 00:30:10.245
for likelihood, sorry, if it's not the appropriate, um,

741
00:30:10.495 --> 00:30:12.645
class, whichever system you use,

742
00:30:12.645 --> 00:30:14.085
seal one or whatever it happens to be.

743
00:30:14.275 --> 00:30:17.285
Okay. How do you deal with that problem when a lot

744
00:30:17.285 --> 00:30:19.965
of your testing as software as you explained,

745
00:30:20.385 --> 00:30:23.165
how do you break it down so you don't end up with likelihood

746
00:30:23.165 --> 00:30:26.925
of one because software failure, if it can happen, you have

747
00:30:26.925 --> 00:30:27.925
to assume it will happen.

748
00:30:28.745 --> 00:30:33.485
That's, that's really tough, a lot of work to help you

749
00:30:34.135 --> 00:30:36.965
understand that hey, we, we think it's gonna do this

750
00:30:38.105 --> 00:30:39.205
and it's not gonna do that.

751
00:30:39.745 --> 00:30:42.405
But in the end I think there's a lot of just, you hate

752
00:30:42.405 --> 00:30:44.125
to say it, but there's a lot of faith that

753
00:30:44.125 --> 00:30:47.085
what they're telling you is correct and you try

754
00:30:47.085 --> 00:30:48.725
and with UAVs, there's no one in there

755
00:30:48.725 --> 00:30:49.765
to grab it if it goes wrong.

756
00:30:49.905 --> 00:30:53.605

So we do more work with range space and containment

757
00:30:53.625 --> 00:30:54.725
and termination systems.

758
00:30:54.875 --> 00:30:56.685
It's, it's just kind of the reality of it right now.

759
00:30:56.725 --> 00:30:59.715
I mean, I won't say we're doing it now,

760
00:30:59.715 --> 00:31:01.115
but I think in the past sometimes to get

761
00:31:24.765 --> 00:31:26.415
back to your question, the software stuff,

762
00:31:26.695 --> 00:31:27.935
I don't have a lot of faith in it yet.

763
00:31:28.035 --> 00:31:29.735
Um, I've been burned too many times.

764
00:31:30.065 --> 00:31:31.095
Trust but verify

765
00:31:31.315 --> 00:31:35.815
and the verified stuff is tough if you guys catch

766
00:31:35.815 --> 00:31:37.935
that mostly used to make,

767
00:31:40.275 --> 00:31:42.735
so the software question, I don't have a lot

768
00:31:42.735 --> 00:31:45.055
of faith in the, the software testing

769
00:31:45.635 --> 00:31:49.175
and the results help you manage the risk completely.

770
00:31:49.175 --> 00:31:52.775
They help some for UAVs, there's no one in the system.

771
00:31:52.805 --> 00:31:54.055
They take it if it doesn't do

772
00:31:54.055 --> 00:31:55.295
what they thought it was gonna do.

773
00:31:55.875 --> 00:31:57.255
So don't worry. You guys still have jobs.

774
00:31:58.515 --> 00:32:00.375
So you don't have any requirement

775
00:32:00.375 --> 00:32:02.055
for a design insurance level then at all?

776
00:32:02.395 --> 00:32:04.655
Or is there some minimum standard that you have

777
00:32:04.655 --> 00:32:08.255
to go achieve based on the size of the air vehicle or,

778
00:32:08.765 --> 00:32:10.655
Okay, so like from an airworthiness perspective, right?

779
00:32:10.655 --> 00:32:15.255
Like do 1 78 kind of right type of thing.

780
00:32:15.615 --> 00:32:17.175
Software pedigree essentially, right? Right.

781
00:32:17.175 --> 00:32:20.975
So that uas, so in nav air

782
00:32:22.075 --> 00:32:23.095
it depends on group.

783
00:32:23.435 --> 00:32:24.455

So like group threes

784
00:32:24.455 --> 00:32:27.575
and below, which was the 400 pound roughly and below.

785
00:32:27.575 --> 00:32:30.415
So type of vehicle we have what's called a safety

786
00:32:30.415 --> 00:32:31.495
of flight flight clearance.

787
00:32:31.575 --> 00:32:34.255
And basically you, you acknowledge from the beginning

788
00:32:34.255 --> 00:32:35.815
that it may crash anywhere from launch

789
00:32:35.835 --> 00:32:37.215
to recovery and anywhere up in the way.

790
00:32:37.955 --> 00:32:39.485
So there's, there is work that goes into it.

791
00:32:39.505 --> 00:32:41.125
Now you get bigger than those then yes,

792
00:32:41.125 --> 00:32:42.285
there's more work being done on

793
00:32:42.305 --> 00:32:43.805
by the software folks at Nair

794
00:32:43.865 --> 00:32:45.125
as part of our worthiness process.

795
00:32:45.985 --> 00:32:48.485
But I think it's pretty recognized fact that is not the same

796
00:32:48.485 --> 00:32:50.565
as what we're doing for certainly commercial

797
00:32:51.005 --> 00:32:52.405
transport or man aviation.

798
00:32:52.955 --> 00:32:55.485
It's just not, and a lot of it's

799
00:32:55.485 --> 00:32:56.485
because things are moving

800
00:32:56.485 --> 00:32:57.725
so fast they don't wanna take the time

801
00:32:57.725 --> 00:32:59.405
and say it's manage the risk and we're gonna go throw a

802
00:32:59.405 --> 00:33:01.525
bunch of these out to the troops to use 'em, you know,

803
00:33:01.655 --> 00:33:02.845
especially in the smalls.

804
00:33:03.555 --> 00:33:05.605
Yeah, it's a great question. It's, we're not there.

805
00:33:07.585 --> 00:33:10.245
Anyone else else? If I can jump in on the question

806
00:33:10.245 --> 00:33:12.045
before about how to handle the, the software,

807
00:33:12.265 --> 00:33:14.525
if I can make a suggestion there, it is true

808
00:33:14.755 --> 00:33:18.205
that if you are applying the, the standard THA approach

809
00:33:18.205 --> 00:33:22.445
that we are discussing here this morning, software

810
00:33:23.505 --> 00:33:25.645

always behaves in the way it was programmed.

811
00:33:25.705 --> 00:33:28.925
The probability is one, if you come up against that problem,

812
00:33:28.945 --> 00:33:30.565
can I suggest you move your event?

813
00:33:31.105 --> 00:33:32.365
So go upstream

814
00:33:32.425 --> 00:33:36.885
and find the probability of reaching the conditions

815
00:33:36.885 --> 00:33:40.245
that put the software into the place

816
00:33:40.245 --> 00:33:41.925
where it will respond with a one.

817
00:33:42.465 --> 00:33:44.325
So for example, if it, if you know

818
00:33:44.325 --> 00:33:48.845
that the software will turn right, if it's day,

819
00:33:49.035 --> 00:33:51.885
it's Tuesday and the crosswind is 10 knots,

820
00:33:53.285 --> 00:33:55.615
move upstream to what is the probability

821
00:33:55.615 --> 00:33:58.375
of your test occurring during the day on Tuesday

822
00:33:58.525 --> 00:33:59.775
with a 10 not crosswind.

823
00:34:00.115 --> 00:34:03.575
So get your probability upstream of the event

824
00:34:03.575 --> 00:34:05.615
because it's true software will give you

825
00:34:05.695 --> 00:34:06.735
a probability of one.

826
00:34:09.065 --> 00:34:10.805
That's, that's a great, great comment

827
00:34:10.805 --> 00:34:14.645
because you can plan around if you have some inclination

828
00:34:14.645 --> 00:34:16.525
that it may have certain issues with certain types

829
00:34:16.525 --> 00:34:19.245
of environmental conditions or even days as relevant.

830
00:34:19.445 --> 00:34:21.645
Remember the days of, um, GPS constellation

831
00:34:21.665 --> 00:34:22.925
and Y 2K and all that.

832
00:34:22.925 --> 00:34:24.645
I mean, we managed around that stuff.

833
00:34:27.265 --> 00:34:32.065
Anyone else's coming,

834
00:34:32.655 --> 00:34:33.655
He's coming with a mic.

835
00:34:36.545 --> 00:34:40.865
Hmm. Uh, so when you do the data

836
00:34:41.665 --> 00:34:45.705
accuracy check or instrumentation need, do you use,

837
00:34:46.085 --> 00:34:49.705

do you do that through uh, uh, simulate some kind

838
00:34:49.705 --> 00:34:52.705
of simulation or you do, uh, you perform that with a

839
00:34:53.335 --> 00:34:54.345
live flight test?

840
00:34:55.285 --> 00:34:58.465
So is the question, do we roll flight test results

841
00:34:58.465 --> 00:34:59.505
back into the simulation?

842
00:34:59.895 --> 00:35:02.985
When you do data check data accuracy check

843
00:35:03.725 --> 00:35:07.345
and the instrumentation need, do you use, uh, some kind

844
00:35:07.345 --> 00:35:08.665
of simulation or you

845
00:35:09.645 --> 00:35:10.645
Yes. For, for

846
00:35:10.645 --> 00:35:13.705
the bigger systems that are more, um, more complex,

847
00:35:13.705 --> 00:35:16.265
more expensive for, definitely for the smaller systems,

848
00:35:16.465 --> 00:35:19.145
a lot of times it's more effective to just go fly it.

849
00:35:20.445 --> 00:35:22.185
But yes, we are using more and more simulation

850
00:35:22.405 --> 00:35:23.945
and we're getting pushed to use, you know,

851
00:35:23.975 --> 00:35:25.865
good modern environ model the environment.

852
00:35:26.175 --> 00:35:28.465
It's like, Hey guys, this is a $20,000 system.

853
00:35:28.485 --> 00:35:29.945
Do you really wanna spend that much time

854
00:35:29.945 --> 00:35:33.625
and money to go fly virtually when I could go throw it out

855
00:35:33.695 --> 00:35:35.785
over the river for an hour and get you your answer?

856
00:35:35.965 --> 00:35:36.965
So,

857
00:35:41.405 --> 00:35:42.405
All right, thank you Dave.

858
00:35:42.615 --> 00:35:45.985
Hold on. Hey Dave.