WEBVTT

1
00:00:00.025 --> 00:00:01.685
Return to their seats, please.

2
00:00:22.665 --> 00:00:26.655
Alright, so Wednesday afternoon, we're,

3
00:00:26.655 --> 00:00:27.855
we're post coffee break.

4
00:00:28.105 --> 00:00:30.495
We've got two more fantastic presentations,

5
00:00:30.695 --> 00:00:32.455
a panel discussion, some closing

6
00:00:32.455 --> 00:00:33.695
thoughts, and then happy hour.

7
00:00:33.955 --> 00:00:36.935
So let's get, let's get into it. Yes.

8
00:00:37.855 --> 00:00:40.955
Our next speaker is gonna be Raymond RJ Shriner.

9
00:00:41.535 --> 00:00:42.915
Uh, he will be presenting

10
00:00:42.915 --> 00:00:45.475
to us today about some state-based flight control design.

11
00:00:45.655 --> 00:00:48.065
I'm very excited to hear about this, uh,

12
00:00:48.065 --> 00:00:50.385
retired lieutenant colonel, uh,

13
00:00:50.485 --> 00:00:52.385
US Naval Test Pilot school class 1 24

14
00:00:53.015 --> 00:00:56.945
lead testing on multiple rotary wing, rotary wing platforms.

15
00:00:57.335 --> 00:00:59.185
It's all, you can tell, I don't say rotary ringing

16
00:00:59.185 --> 00:01:00.625
very often.

17
00:01:00.725 --> 00:01:03.745
Uh, 2016 you worked for an eval company Z Arrow,

18
00:01:03.955 --> 00:01:06.825
where they conducted envelope expansion for manned eval.

19
00:01:07.165 --> 00:01:09.105
Uh, something really cool that I learned this morning,

20
00:01:09.135 --> 00:01:12.145
culminating in the first manned vertical takeoff, uh,

21
00:01:12.195 --> 00:01:14.515
transition to wing born flight, return

22
00:01:14.515 --> 00:01:15.755
to precision hover and landing.

23
00:01:17.375 --> 00:01:19.395
And he was also the chief test pilot for Whisk

24
00:01:19.395 --> 00:01:20.845
and Soreno. Let's give up for

25
00:01:20.905 --> 00:01:21.905
Rj.

26
00:01:31.275 --> 00:01:34.295
So I'd just like to say first, uh, thank you to the, uh,

27
00:01:34.295 --> 00:01:35.935

flight test safety, uh, council

28
00:01:35.935 --> 00:01:37.215
and the flight test safety workshop

29
00:01:37.235 --> 00:01:38.975
for the opportunity to present today.

30
00:01:39.355 --> 00:01:44.055
Uh, this is a compilation of, uh, some work that, uh, Marty

31
00:01:44.075 --> 00:01:46.855
and I have done over some, uh, flight control design studies

32
00:01:47.285 --> 00:01:49.535
with, uh, primarily with NASA aims.

33
00:01:49.915 --> 00:01:52.615
Uh, but it includes a, a number of different studies with,

34
00:01:52.635 --> 00:01:54.175
uh, universities and, uh,

35
00:01:54.195 --> 00:01:56.095
and some of the stuff we've, uh, worked on

36
00:01:56.095 --> 00:01:57.655
with some of the companies as well.

37
00:01:58.555 --> 00:02:02.855
Uh, so, uh, RJ is, is not my call sign.

38
00:02:02.965 --> 00:02:05.135
That is, so it does not mean regional jet.

39
00:02:05.255 --> 00:02:07.655
I, I heard that earlier and I, I was like, my, my,

40
00:02:08.155 --> 00:02:10.175
my head was, uh, perking up there.

41
00:02:10.555 --> 00:02:12.375
Um, so, uh, call sign's plug.

42
00:02:12.435 --> 00:02:14.255
I'm just a, a good crayon eating Marine.

43
00:02:14.755 --> 00:02:17.055
Uh, I was a COBRA pilot in, in the Marines.

44
00:02:17.055 --> 00:02:21.455
Uh, Marty was a V 22 pilot Army, uh, V 22 pilot.

45
00:02:26.925 --> 00:02:28.305
So this is the new frontier.

46
00:02:28.925 --> 00:02:32.545
Uh, there's a whole series of, uh, new aircraft, uh,

47
00:02:32.655 --> 00:02:34.145
that are in development right now.

48
00:02:34.725 --> 00:02:37.265
Uh, they've got wings, multi rotors.

49
00:02:37.405 --> 00:02:41.225
Uh, they hover, they fly on the wing, uh, distributed,

50
00:02:41.335 --> 00:02:45.985
distributed electric propulsion, uh, battery electrics,

51
00:02:46.365 --> 00:02:49.265
uh, over actuated designs, uh,

52
00:02:49.435 --> 00:02:51.105
which is really just a fancy way

53
00:02:51.105 --> 00:02:53.225
of saying they've got multiple different ways to,

54
00:02:53.565 --> 00:02:56.185

to make the forces and moments to control the aircraft.

55
00:02:57.385 --> 00:03:00.165
And this is, this is kind of the, the target for,

56
00:03:00.225 --> 00:03:01.445
for this presentation here.

57
00:03:02.085 --> 00:03:05.745
Uh, one of the goals of a lot of these, uh, efforts is to

58
00:03:06.405 --> 00:03:08.625
reduce the pilot training burden.

59
00:03:09.125 --> 00:03:12.425
So there's, they're in search of a, uh, flight control, uh,

60
00:03:12.775 --> 00:03:16.105
kind of concept that reduces the burden, uh,

61
00:03:16.165 --> 00:03:19.625
for pilot training, pilot proficiency, improve safety,

62
00:03:20.125 --> 00:03:23.505
and then ultimately they've got their eye on, uh, sort

63
00:03:23.505 --> 00:03:26.105
of advanced autonomy, which would lead to, uh,

64
00:03:26.105 --> 00:03:29.465
either remotely or uh, uh, fully autonomous flight.

65
00:03:34.065 --> 00:03:36.445
So, uh, getting to some of the NASA aims studies

66
00:03:36.445 --> 00:03:37.645
that we participated in.

67
00:03:38.305 --> 00:03:41.405
Um, here you can see that you've got this, uh,

68
00:03:41.405 --> 00:03:43.125
distributed electric propulsion, kind

69
00:03:43.125 --> 00:03:44.845
of a generic aircraft in vtal.

70
00:03:45.305 --> 00:03:48.125
Uh, and then this, this diagram just shows, uh, some

71
00:03:48.125 --> 00:03:51.205
of the ways that you can, uh, change the effectors,

72
00:03:51.265 --> 00:03:53.085
if you will, uh, to get the forces

73
00:03:53.225 --> 00:03:57.445
and moments to, to create ya heve pitch and roll.

74
00:04:01.385 --> 00:04:04.925
And then as you, uh, start getting, uh, from a hover,

75
00:04:04.985 --> 00:04:07.045
and then you want to transition onto the wing,

76
00:04:07.385 --> 00:04:11.005
you've got this, uh, sort of hybrid, uh, lift, uh, concept

77
00:04:11.535 --> 00:04:16.525
where, uh, the, uh, lift is gonna transition from the rotors

78
00:04:17.075 --> 00:04:19.725
onto the, uh, onto the wing.

79
00:04:20.445 --> 00:04:22.665
And one of the important things that, uh, I meant

80
00:04:22.665 --> 00:04:26.785
to say upfront, but, uh, is that, uh, state-based controls,

81
00:04:26.785 --> 00:04:29.065

what is state, what do I mean by state-based controls?

82
00:04:29.405 --> 00:04:32.985
Uh, and the best example that I can give you is, uh,

83
00:04:32.985 --> 00:04:35.865
the F 35 B fly controls where, uh,

84
00:04:37.365 --> 00:04:41.055
the right stick trees get bigger, trees get smaller,

85
00:04:41.115 --> 00:04:42.775
it doesn't matter what air speeds you're at.

86
00:04:43.035 --> 00:04:45.895
And then on the, on the left end scepter, I want

87
00:04:45.895 --> 00:04:47.455
to go faster, I want to go slower.

88
00:04:47.675 --> 00:04:49.655
So that's, that's kind of the concept here.

89
00:04:49.905 --> 00:04:51.495
There are a couple of different ways

90
00:04:51.715 --> 00:04:53.535
to do state-based controls.

91
00:04:53.915 --> 00:04:55.895
Uh, the F 35 happens to, uh,

92
00:04:55.985 --> 00:04:58.535
focus on the front side, uh, controls.

93
00:04:58.925 --> 00:05:00.495
There's other concepts out there

94
00:05:00.495 --> 00:05:03.775
that would potentially focus on the backside controls.

95
00:05:03.775 --> 00:05:05.295
And so it would be like a helo esque,

96
00:05:05.885 --> 00:05:09.225
and I'm gonna talk to some of those examples here in a bit.

97
00:05:10.645 --> 00:05:13.825
But in this, in this diagram, you can see that you've got,

98
00:05:13.825 --> 00:05:15.865
that you're going from thrust borne to wing borne,

99
00:05:15.965 --> 00:05:18.945
and then some of the changes as, uh, as the, as the, uh,

100
00:05:19.085 --> 00:05:21.905
hybrid lift changes throughout the transition.

101
00:05:23.045 --> 00:05:25.425
And then a lot of times you, you end up finding that, uh,

102
00:05:25.445 --> 00:05:26.705
in order to do this well

103
00:05:26.805 --> 00:05:29.065
and to achieve those goals that I talked about, which is,

104
00:05:29.165 --> 00:05:30.865
uh, I want to have a state-based control,

105
00:05:30.865 --> 00:05:33.425
where this is always, trees get bigger, trees get smaller,

106
00:05:34.005 --> 00:05:36.305
uh, then you end up having some, some novel

107
00:05:36.325 --> 00:05:37.745
and cept configurations.

108
00:05:38.165 --> 00:05:41.825

Uh, the the one, uh, presented here, uh, happens to be from,

109
00:05:41.885 --> 00:05:44.505
uh, the, the cited reference, which is really just a,

110
00:05:44.825 --> 00:05:46.745
a unified esque, uh, control.

111
00:05:49.745 --> 00:05:52.685
Uh, and then transition turns out to be where a lot

112
00:05:52.685 --> 00:05:55.085
of the really interesting stuff occurs with these aircraft.

113
00:05:55.345 --> 00:05:57.540
Uh, you, you run into a lot of of problems.

114
00:05:57.785 --> 00:05:59.925
And so one of the things that we did was we wanted

115
00:05:59.925 --> 00:06:04.205
to take a look at some of the, uh, lessons learned from, uh,

116
00:06:04.435 --> 00:06:08.445
tilt rotor aircraft, uh, of the past, uh, namely XB 15,

117
00:06:08.765 --> 00:06:11.925
V 22, and the a w 6 0 9, to see what we could glean out of

118
00:06:11.925 --> 00:06:13.565
that, uh, and,

119
00:06:13.705 --> 00:06:15.405
and talk about how, how that applies

120
00:06:15.425 --> 00:06:16.805
to state-based controls.

121
00:06:19.545 --> 00:06:23.405
So there was a study, uh, an FAA study on, uh,

122
00:06:23.795 --> 00:06:26.085
digital fly by wire accidents.

123
00:06:26.345 --> 00:06:28.725
Uh, and, uh, Marty participated in that.

124
00:06:29.185 --> 00:06:32.365
And he, uh, contributed, uh, the, this slide and,

125
00:06:32.365 --> 00:06:34.405
and studied all of these accidents, uh,

126
00:06:35.305 --> 00:06:39.965
and that were tilt rotor, uh, based, um, sort of accidents.

127
00:06:40.155 --> 00:06:43.005
This is not a completely comprehensive list of, uh,

128
00:06:43.365 --> 00:06:47.165
accidents, uh, for the V 22 obviously, which has a number

129
00:06:47.165 --> 00:06:49.285
of, uh, combat related stuff.

130
00:06:49.285 --> 00:06:51.325
But they were, they were not relevant to this study here.

131
00:06:51.945 --> 00:06:53.965
Uh, I'm not gonna get into the details

132
00:06:53.985 --> 00:06:55.405
of this particular slide,

133
00:06:55.405 --> 00:06:57.965
but these are the ones that were, uh, considered relevant

134
00:06:58.425 --> 00:07:00.805
for, uh, the purposes of, uh, digital fly

135
00:07:00.805 --> 00:07:02.085

by wire, uh, studies.

136
00:07:04.015 --> 00:07:06.115
And then just to sort of, uh, explain

137
00:07:06.115 --> 00:07:07.835
what you're looking at here, if you're not familiar.

138
00:07:07.975 --> 00:07:10.035
So this is, uh, sort of on the, on the left of

139
00:07:10.035 --> 00:07:14.035
that diagram is the nielle angle, uh, for the tilt rotor.

140
00:07:14.175 --> 00:07:17.355
And then on the bottom of that diagram is, uh, sort

141
00:07:17.355 --> 00:07:19.435
of airspeed or dynamic pressure.

142
00:07:19.775 --> 00:07:22.435
And then we've got overlaid there, the,

143
00:07:22.465 --> 00:07:23.955
what we call the transition corridor.

144
00:07:24.215 --> 00:07:26.595
So those are sort of the limits of what you're allowed

145
00:07:26.595 --> 00:07:30.555
to have, uh, in terms of the tilt angle versus airspeed.

146
00:07:30.735 --> 00:07:34.435
And that's gonna be defined by a number of different things,

147
00:07:34.575 --> 00:07:35.955
uh, wing stall and,

148
00:07:36.095 --> 00:07:38.515
and generally some structural or aerodynamics.

149
00:07:41.065 --> 00:07:45.905
And so the takeaway from that study that FAA study was,

150
00:07:46.795 --> 00:07:48.095
uh, some causal factors.

151
00:07:48.395 --> 00:07:50.335
And, uh, I'll, I'll sort of review those here.

152
00:07:50.595 --> 00:07:55.115
Uh, so, uh, first, first of all, uh, one of, one

153
00:07:55.155 --> 00:07:57.475
of the issues was balancing of flight controls in,

154
00:07:57.475 --> 00:07:58.595
in the powered lift design.

155
00:07:58.935 --> 00:08:02.615
So, uh, you've, you've got rotors, you've got wings,

156
00:08:02.615 --> 00:08:03.775
and you, you have to balance that

157
00:08:03.775 --> 00:08:05.075
throughout the entire regime.

158
00:08:08.575 --> 00:08:11.535
Aerodynamics you, uh, unique to powered lift designs.

159
00:08:11.835 --> 00:08:14.295
Uh, so in some cases you've got VRS

160
00:08:14.355 --> 00:08:17.735
or vortex ring state that you have to worry about factor in,

161
00:08:19.405 --> 00:08:23.855
uh, pilot air and material failure.

162
00:08:28.375 --> 00:08:31.835

So, uh, part of that FAA study, uh, that, uh,

163
00:08:32.235 --> 00:08:35.555
included other, uh, other types of aircraft in contrast, uh,

164
00:08:35.735 --> 00:08:37.475
you know, different than the tilt rotor stuff,

165
00:08:37.775 --> 00:08:39.475
was the transport category aircraft.

166
00:08:39.935 --> 00:08:43.635
Uh, a lot of their accidents were basically focused on FMS

167
00:08:43.975 --> 00:08:47.115
and auto auto automation or autopilot failures.

168
00:08:49.825 --> 00:08:52.445
So I'm gonna, uh, sort of talk a little bit, uh,

169
00:08:52.545 --> 00:08:55.485
in detail here about that first factor, uh,

170
00:08:55.795 --> 00:08:57.045
from that previous slide here.

171
00:08:57.045 --> 00:09:00.405
So there was, uh, sort of five, um, subcategories,

172
00:09:00.405 --> 00:09:02.685
if you will, of causal factors there.

173
00:09:03.105 --> 00:09:05.685
One was, uh, balancing of multiple tasks

174
00:09:06.065 --> 00:09:08.805
or functions, uh, on the same, uh, effector.

175
00:09:09.265 --> 00:09:11.245
Uh, so one of example of

176
00:09:11.245 --> 00:09:13.765
that is when you're in forward flight, you're asking

177
00:09:13.765 --> 00:09:15.925
that effector, maybe one of your prop rotors

178
00:09:15.945 --> 00:09:19.245
to not only do thrust, but maybe some, uh, yaw

179
00:09:19.245 --> 00:09:20.285
or yaw dampening.

180
00:09:20.825 --> 00:09:23.965
Um, so you're asking a little much out of a, a, an effector,

181
00:09:24.385 --> 00:09:27.245
uh, blending of control effectors, uh,

182
00:09:27.305 --> 00:09:29.045
to achieve the appropriate control throughout the,

183
00:09:29.225 --> 00:09:30.325
the entire transition.

184
00:09:30.625 --> 00:09:34.005
So in some cases, what you might find, uh, at certain parts

185
00:09:34.005 --> 00:09:36.725
of the transition is you don't have the control power

186
00:09:36.725 --> 00:09:38.605
that you think you need or you that you should have.

187
00:09:39.195 --> 00:09:42.095
Um, and that's gonna change with the cell angle, with the,

188
00:09:42.115 --> 00:09:46.415
the wing, uh, with flaps, with, uh, uh, all the, all the,

189
00:09:46.415 --> 00:09:48.135

uh, surfaces associated with the wing.

190
00:09:49.785 --> 00:09:53.465
And then balancing sources of lift in the transition, uh,

191
00:09:53.595 --> 00:09:55.465
which is just talking about the wing and the,

192
00:09:55.465 --> 00:09:57.825
and the rotors, and then balancing cockpit

193
00:09:57.825 --> 00:09:59.585
controls of the same axis.

194
00:09:59.585 --> 00:10:02.585
So in some cases, a, a great example of that is a V 22,

195
00:10:02.955 --> 00:10:06.675
where you've got the tilt, uh, control

196
00:10:07.435 --> 00:10:10.495
on the blot, and you, so you can do pitch

197
00:10:10.605 --> 00:10:12.885
with multiple different axes, right?

198
00:10:13.465 --> 00:10:14.565
Uh, so,

199
00:10:14.785 --> 00:10:18.205
and in, in certain cases, misapplication of those at,

200
00:10:18.225 --> 00:10:20.485
at certain parts of the transition can be dangerous.

201
00:10:20.945 --> 00:10:23.885
Uh, and, and then of course, the, uh, the idea

202
00:10:23.885 --> 00:10:26.205
that the pilot needs to adapt, uh,

203
00:10:26.435 --> 00:10:28.855
to the flight care characteristics, uh,

204
00:10:29.135 --> 00:10:30.255
wherever you are in the envelope.

205
00:10:30.515 --> 00:10:33.975
So the, the idea behind state-based design is a pilot

206
00:10:33.975 --> 00:10:35.295
doesn't have to worry about that.

207
00:10:35.835 --> 00:10:37.745
Um, you're just, trees get bigger,

208
00:10:37.745 --> 00:10:39.105
trees get smaller all the time.

209
00:10:39.445 --> 00:10:43.915
And, uh, so it's, it's, uh, F 35 s uh, control.

210
00:10:44.215 --> 00:10:47.795
So these, uh,

211
00:10:48.045 --> 00:10:51.235
these last three here, uh, on these causal factors

212
00:10:51.295 --> 00:10:54.515
of the tilt rotors, this is really where, uh, the potential

213
00:10:54.515 --> 00:10:57.915
for state-based controls to avoid, uh, the, the,

214
00:10:58.095 --> 00:11:00.955
the old access based, uh, sort of problems are.

215
00:11:01.215 --> 00:11:04.395
So, and if, if I didn't, uh, say it up front, uh,

216
00:11:04.395 --> 00:11:06.995

what I meant to say was, uh, you've got state-based,

217
00:11:06.995 --> 00:11:09.535
which is kind of like vector control.

218
00:11:09.715 --> 00:11:12.375
If you think about it. I'm gonna tell the aircraft, uh,

219
00:11:12.475 --> 00:11:15.415
in three dimensions which direction I want it to, uh, head.

220
00:11:15.835 --> 00:11:18.935
And then, uh, the legacy aircraft that we're all used to,

221
00:11:19.145 --> 00:11:23.575
those are more, uh, maybe access control, uh, type aircraft,

222
00:11:23.595 --> 00:11:24.735
if you can think about it like that.

223
00:11:27.745 --> 00:11:30.165
So why do we want state-based controls?

224
00:11:30.425 --> 00:11:33.365
Um, and, uh, one, one of the reasons is, is

225
00:11:33.365 --> 00:11:35.685
that we wanna simplify the manual flight control, uh,

226
00:11:35.685 --> 00:11:37.365
of the vehicles through the transition.

227
00:11:37.825 --> 00:11:39.205
Um, so you wanna make sure that the,

228
00:11:39.305 --> 00:11:41.605
the pilot's always flying either front side

229
00:11:41.605 --> 00:11:43.285
or backside, should be simple.

230
00:11:43.745 --> 00:11:44.765
Uh, and then the idea is

231
00:11:44.765 --> 00:11:47.725
that we're gonna simplify the training, uh, for the pilot,

232
00:11:48.265 --> 00:11:51.685
and then also ideally simplify any failure modes.

233
00:11:51.865 --> 00:11:55.685
Um, one of the nice things about, uh, state bates design is

234
00:11:55.685 --> 00:11:58.045
that it maps really nicely, uh, towards, uh,

235
00:11:58.045 --> 00:11:59.285
degraded visual environments.

236
00:11:59.625 --> 00:12:02.085
And so, if you could think of it like, uh, TRC,

237
00:12:02.185 --> 00:12:04.245
you're in a helicopter and you got translation rate

238
00:12:04.245 --> 00:12:05.925
control, uh, it's very common.

239
00:12:06.185 --> 00:12:08.925
And then it's a, a big workload reducer for a pilot

240
00:12:09.145 --> 00:12:12.205
to use TRC in, uh, you know, really dark night.

241
00:12:12.545 --> 00:12:15.605
Um, and, uh, compared to a a, an attitude based system.

242
00:12:16.635 --> 00:12:19.015
So, and then the, the big money maker

243
00:12:19.035 --> 00:12:21.135

for the companies is they're all looking for a bridge

244
00:12:21.155 --> 00:12:22.295
to remotely pilot it.

245
00:12:22.295 --> 00:12:24.415
And eventually, that category of aircraft

246
00:12:24.415 --> 00:12:26.575
that we're talking about, they've got their eye on

247
00:12:26.665 --> 00:12:27.895
fully autonomous flight.

248
00:12:28.355 --> 00:12:33.075
So, talk about, uh, some lessons learned here,

249
00:12:33.415 --> 00:12:35.875
uh, that we can take away from state-based controls.

250
00:12:36.405 --> 00:12:40.785
Uh, so we get the, uh, control effect blending, uh, for, uh,

251
00:12:40.785 --> 00:12:44.505
hybrid designs that does not necessarily, uh, drive state,

252
00:12:44.845 --> 00:12:46.225
uh, or vector controls.

253
00:12:46.285 --> 00:12:48.905
So what, what I don't want you to take away is that, uh,

254
00:12:49.005 --> 00:12:52.745
if you're do that, that I'm saying, uh, anything like, uh,

255
00:12:52.745 --> 00:12:54.425
you have to do state based controls, you,

256
00:12:54.525 --> 00:12:57.505
you could potentially just make a, an aircraft, uh,

257
00:12:57.505 --> 00:12:59.185
of these types that are attitude

258
00:12:59.185 --> 00:13:00.305
based, and they work just fine.

259
00:13:01.395 --> 00:13:04.885
And in, in many cases, if it fits with your mission, uh,

260
00:13:05.025 --> 00:13:06.165
it, it'll, it'll be okay.

261
00:13:06.385 --> 00:13:10.085
If your goal is to get to, uh, fully autonomous,

262
00:13:10.155 --> 00:13:12.965
then you can start with state-based, uh, concepts,

263
00:13:12.965 --> 00:13:14.365
and then that'll, that'll set up the

264
00:13:14.365 --> 00:13:15.765
architecture so that you're ready for that.

265
00:13:16.435 --> 00:13:18.565
Also, if your goal is to reduce that, uh,

266
00:13:18.615 --> 00:13:20.565
pilot training burden, uh,

267
00:13:20.585 --> 00:13:22.925
and you wanna make sure that your pilot is always working

268
00:13:23.305 --> 00:13:25.365
the same controls, uh, uh,

269
00:13:25.385 --> 00:13:27.605
or at least the same control strategy, uh,

270
00:13:27.635 --> 00:13:29.205

this is a mechanism to do that.

271
00:13:30.675 --> 00:13:32.375
So, uh, state va, uh, state

272
00:13:32.375 --> 00:13:34.855
or vector control can eliminate the control sta uh,

273
00:13:35.255 --> 00:13:36.975
strategy change in longitudinal

274
00:13:37.075 --> 00:13:38.975
and, uh, vertical axis for transition.

275
00:13:38.975 --> 00:13:40.695
And so that's just talking about in a,

276
00:13:40.695 --> 00:13:43.895
in a traditional helicopter, uh, you go from, uh, sort

277
00:13:43.895 --> 00:13:45.575
of backside control scheme,

278
00:13:45.755 --> 00:13:47.575
and then the pilot mentally just kind

279
00:13:47.575 --> 00:13:49.255
of adjust throughout the transition.

280
00:13:49.475 --> 00:13:51.015
And then e eventually you end up

281
00:13:51.015 --> 00:13:52.335
with a front side control scheme.

282
00:13:54.625 --> 00:13:57.245
And then automation of the transition can be made easier

283
00:13:57.905 --> 00:14:00.475
when, uh, when you've got state based controls.

284
00:14:00.475 --> 00:14:04.805
And an example of that here is, uh, the auto, the cell.

285
00:14:05.065 --> 00:14:08.805
So, uh, with state based controls, you don't even need, uh,

286
00:14:09.275 --> 00:14:13.045
like in the V 22, they've got the, the cell controller,

287
00:14:13.225 --> 00:14:14.245
but you can't automate

288
00:14:14.245 --> 00:14:15.925
that if you've got a state-based controller.

289
00:14:20.385 --> 00:14:23.685
So another one of the big lessons learned,

290
00:14:24.225 --> 00:14:26.405
and I'll spend a little bit of time on this one,

291
00:14:26.465 --> 00:14:31.245
but for good aggression and precision, the la lateral

292
00:14:31.425 --> 00:14:35.445
and the longitudinal controls are best on the Sabin scepter.

293
00:14:35.705 --> 00:14:37.925
And I'll go into a little bit of detail here about

294
00:14:37.925 --> 00:14:39.245
what I mean by that.

295
00:14:39.705 --> 00:14:43.285
But, uh, this actually is a challenge area for, uh,

296
00:14:43.285 --> 00:14:44.485
state-based controls.

297
00:14:45.075 --> 00:14:48.025

Uh, and I'll kind of, I'll, I'll try to step through this.

298
00:14:48.565 --> 00:14:52.615
So on on top, you've got, uh,

299
00:14:53.145 --> 00:14:54.615
fixed wing centric controls,

300
00:14:54.615 --> 00:14:57.415
or think of it as, uh, unified controls, if you will.

301
00:14:57.755 --> 00:15:02.575
So, uh, your forward naft is on your left, uh, your,

302
00:15:02.645 --> 00:15:05.655
your left hand, and you can speed up, slow down.

303
00:15:05.915 --> 00:15:08.935
And then if you want to go, uh, trees get bigger, smaller,

304
00:15:08.935 --> 00:15:10.175
that's on your right hand.

305
00:15:10.175 --> 00:15:12.675
And then your position, uh,

306
00:15:12.935 --> 00:15:14.875
and this is whether you're in a hover

307
00:15:15.055 --> 00:15:16.315
or whether you're in forward flight,

308
00:15:16.345 --> 00:15:20.155
this particular example is in, in a hover, compare that

309
00:15:20.455 --> 00:15:21.795
to a helo centric

310
00:15:21.795 --> 00:15:25.995
or a reverse, uh, unified scheme where, uh,

311
00:15:26.215 --> 00:15:28.995
on the right hand, you're basically a helicopter.

312
00:15:29.135 --> 00:15:31.755
So you, you, you can tell the aircraft which,

313
00:15:31.755 --> 00:15:32.835
which way you want to go.

314
00:15:33.375 --> 00:15:35.595
Um, and then on the left hand,

315
00:15:35.735 --> 00:15:38.595
you basically got your altitude or your H dot.

316
00:15:39.545 --> 00:15:44.245
So, uh, concept here is you've got a, uh,

317
00:15:44.245 --> 00:15:45.685
some tasks that you need to do.

318
00:15:46.025 --> 00:15:47.405
Uh, and this is, this is a,

319
00:15:47.405 --> 00:15:50.405
an a DS 33 task called Precision hover,

320
00:15:50.575 --> 00:15:52.925
where you start on a, uh, from a hover,

321
00:15:53.265 --> 00:15:56.805
you transition along a a 45 degree relative bearing

322
00:15:57.445 --> 00:16:00.085
constant altitude, and then you capture a precision hover,

323
00:16:00.425 --> 00:16:02.245
and then you take those two control schemes

324
00:16:02.245 --> 00:16:05.325

and you say, which one can I be more precise

325
00:16:05.345 --> 00:16:06.485
and more aggressive with?

326
00:16:07.025 --> 00:16:09.125
And you will find that one

327
00:16:09.125 --> 00:16:11.365
of those control schemes is gonna shine

328
00:16:11.835 --> 00:16:13.765
with this type of maneuver.

329
00:16:14.375 --> 00:16:15.515
Uh, and, uh,

330
00:16:15.615 --> 00:16:18.075
and then one of, one of the control schemes is probably

331
00:16:18.075 --> 00:16:21.035
gonna be adequate, but it's not gonna be as nearly

332
00:16:21.095 --> 00:16:22.795
as precise or as aggressive.

333
00:16:26.815 --> 00:16:30.195
So, and then I want to contrast that with, uh,

334
00:16:30.535 --> 00:16:32.195
the same set of controls.

335
00:16:32.195 --> 00:16:33.915
So you've got unified and fixed wing,

336
00:16:33.935 --> 00:16:36.515
but now we're talking about the far end

337
00:16:36.655 --> 00:16:38.195
of the transition envelope,

338
00:16:38.455 --> 00:16:41.395
and we're talking about, uh, wing, worn, uh, flight.

339
00:16:42.025 --> 00:16:46.525
So, uh, slightly different on, uh, on the left end cept here

340
00:16:46.525 --> 00:16:50.485
for the helicopter, or the reverse, uh, reverse unified.

341
00:16:50.905 --> 00:16:53.325
But you've now got flight path angle on your,

342
00:16:53.505 --> 00:16:57.375
on your left hand, and you've got acceleration, uh,

343
00:16:57.595 --> 00:16:58.895
on your, on your right hand.

344
00:16:59.155 --> 00:17:02.855
Uh, going forward. Uh, the unified control is the same.

345
00:17:02.915 --> 00:17:04.975
So you're, you're still just flying the same, uh,

346
00:17:05.105 --> 00:17:07.295
trees get bigger, trees get smaller on your right hand,

347
00:17:07.635 --> 00:17:08.695
and you can accelerate.

348
00:17:08.695 --> 00:17:09.895
So you're basically an airplane.

349
00:17:10.315 --> 00:17:14.035
Uh, and this is where, uh, once you're on the wing, this is

350
00:17:14.035 --> 00:17:15.835
where unified is gonna shine.

351
00:17:17.495 --> 00:17:20.155

One of the, uh, one of the maneuvers that we use

352
00:17:20.215 --> 00:17:22.395
to stress this, uh, evaluation

353
00:17:22.735 --> 00:17:26.195
and compare these two, uh, control schemes was a, uh,

354
00:17:26.385 --> 00:17:28.395
what we call a climbing parallel offset.

355
00:17:28.735 --> 00:17:32.035
So you can think of a climbing turn with a roll reversal

356
00:17:32.095 --> 00:17:33.275
and then an acceleration.

357
00:17:33.575 --> 00:17:36.195
Uh, and then the simulations that we did, we just had boxes

358
00:17:36.225 --> 00:17:38.715
that we were flying through, and we set 'em up to

359
00:17:38.715 --> 00:17:40.835
where it was challenging to get through the boxes.

360
00:17:41.595 --> 00:17:45.255
Uh, and then once you get that, uh, that, uh, course,

361
00:17:45.955 --> 00:17:50.405
if you will set up properly, you can tease out the benefits

362
00:17:50.585 --> 00:17:52.925
of, uh, one control scheme versus the other,

363
00:17:52.925 --> 00:17:54.965
and you'll find that one control scheme, uh,

364
00:17:55.025 --> 00:17:56.885
the aggressiveness and the precision is much

365
00:17:56.885 --> 00:17:58.325
better with this maneuver.

366
00:18:02.505 --> 00:18:05.415
And then, uh, sort of talking about automation

367
00:18:05.755 --> 00:18:07.255
and, uh, augmentation.

368
00:18:07.475 --> 00:18:10.175
So, uh, definitely once you get to the higher levels of, uh,

369
00:18:10.185 --> 00:18:12.255
automation and augmentation, there's a number

370
00:18:12.255 --> 00:18:15.135
of trades there that once you understand, uh, you can,

371
00:18:15.235 --> 00:18:18.755
you can sort of, uh, pull out some assessment metrics.

372
00:18:19.295 --> 00:18:21.635
Uh, it's not as easy as just saying, Hey, just go out

373
00:18:21.635 --> 00:18:24.115
and do an A DS 33, uh, stick.

374
00:18:24.215 --> 00:18:26.155
You know, gimme the frequency and bandwidth.

375
00:18:26.155 --> 00:18:27.435
It's, it's, it's more difficult than that.

376
00:18:28.015 --> 00:18:32.315
So, uh, talking about some trends in, in automation,

377
00:18:32.315 --> 00:18:34.835
and just trying to look at it from this lens here, uh,

378
00:18:35.055 --> 00:18:38.475

you've got, this represents what, what is essentially a, uh,

379
00:18:38.545 --> 00:18:41.235
traditional access based aircraft, um,

380
00:18:41.485 --> 00:18:43.395
where the progression is, uh,

381
00:18:43.395 --> 00:18:45.555
you don't have any augmentation, uh,

382
00:18:45.575 --> 00:18:48.115
and then maybe you've got some native, uh, a FCS,

383
00:18:48.115 --> 00:18:49.755
some stabilization functions.

384
00:18:50.455 --> 00:18:53.875
Uh, and then you've got your selectable A FCS modes,

385
00:18:53.875 --> 00:18:57.875
which might be, uh, TRC or attitude command or, uh,

386
00:18:58.355 --> 00:19:01.055
and then you get into the core automation stuff, which is

387
00:19:01.735 --> 00:19:02.745
your hold modes.

388
00:19:03.085 --> 00:19:05.385
Uh, so you've got altitude hold, heading, hold, speed, hold,

389
00:19:05.805 --> 00:19:07.785
uh, and then you've got the advanced automation stuff,

390
00:19:07.785 --> 00:19:11.855
which would be, uh, TCGC, that kind of stuff,

391
00:19:11.855 --> 00:19:14.255
where the aircraft is basically making the decision for you.

392
00:19:14.815 --> 00:19:18.395
Uh, and then integrated throughout that is, uh, sort

393
00:19:18.395 --> 00:19:19.875
of the idea that you want to, uh,

394
00:19:19.875 --> 00:19:21.555
alleviate the pilot workload.

395
00:19:22.095 --> 00:19:25.595
Uh, there's this, uh, requirement as you move to the right

396
00:19:25.595 --> 00:19:28.115
that the system's gonna interpret the pilot intent

397
00:19:28.135 --> 00:19:31.475
and sort of, uh, maybe give you some, uh, restrictions to,

398
00:19:31.575 --> 00:19:33.555
uh, uh, certain flexibility measures.

399
00:19:33.895 --> 00:19:36.395
Uh, and then it's gonna, uh, there, there is a requirement

400
00:19:36.395 --> 00:19:38.635
for queuing, uh, that sort of tapers off

401
00:19:38.655 --> 00:19:41.555
as you get towards the, uh, advanced automation

402
00:19:41.855 --> 00:19:44.795
and then susceptibility for, uh, failure, uh,

403
00:19:44.985 --> 00:19:46.955
depending on your sensors and your inputs.

404
00:19:48.665 --> 00:19:50.325
So when you look at it through this lens

405
00:19:51.295 --> 00:19:55.525

where state-based control has, uh, uh, potential is

406
00:19:55.525 --> 00:19:58.125
to take those three center pillars, if you will,

407
00:19:58.145 --> 00:19:59.605
and kind of mash 'em into one.

408
00:20:00.025 --> 00:20:01.765
And so the idea is, is you, you're gonna,

409
00:20:01.765 --> 00:20:03.445
you're gonna go from state-based control,

410
00:20:04.265 --> 00:20:07.525
and then eventually you're gonna mature the system in into

411
00:20:07.525 --> 00:20:08.885
that advanced automation.

412
00:20:09.975 --> 00:20:12.835
Um, and then one of the things that, uh, that Marty

413
00:20:12.855 --> 00:20:16.115
and I, uh, sort of wanted to highlight is you want to kind

414
00:20:16.115 --> 00:20:18.235
of get rid of that augmentation off, right?

415
00:20:18.295 --> 00:20:21.035
If, if, if your goal is to really get to that point where

416
00:20:21.575 --> 00:20:24.635
you're providing an aircraft to, uh, a certified aircraft

417
00:20:24.635 --> 00:20:27.875
or a final product to a, a pilot, they should not have

418
00:20:27.875 --> 00:20:30.395
to worry about flying that aircraft that is, uh,

419
00:20:30.515 --> 00:20:31.635
augmentation off.

420
00:20:31.735 --> 00:20:33.995
So that that should be, uh, something that

421
00:20:33.995 --> 00:20:36.755
that pilot doesn't necessarily have to worry about anymore.

422
00:20:40.875 --> 00:20:42.255
And the reason, uh,

423
00:20:42.315 --> 00:20:45.575
or one of the reasons for that is, uh, sort of the evolution

424
00:20:45.575 --> 00:20:46.655
of the pilot skillset.

425
00:20:47.125 --> 00:20:49.185
If you, if you look at, uh, historically,

426
00:20:49.185 --> 00:20:51.145
what have we asked for these pilots?

427
00:20:51.655 --> 00:20:54.475
And, uh, and you can see from the diagram here that,

428
00:20:54.655 --> 00:20:56.275
you know, you're going from the 1960s

429
00:20:56.275 --> 00:20:57.635
where you basically got some,

430
00:20:57.905 --> 00:21:00.355
some typical aircraft basic capabilities,

431
00:21:00.495 --> 00:21:03.355
and then we're adding, uh, more systems and more systems.

432
00:21:03.975 --> 00:21:06.475

And then, uh, essentially the requirements

433
00:21:06.495 --> 00:21:07.595
for the pilot knowledge

434
00:21:07.815 --> 00:21:10.435
and skills has not diminished as a revolt, as a result

435
00:21:10.435 --> 00:21:11.435
of the automation systems

436
00:21:11.455 --> 00:21:13.155
of the modern flight flight deck

437
00:21:13.155 --> 00:21:14.515
designs, it's actually increased.

438
00:21:14.895 --> 00:21:16.915
Uh, and now the pilots we're asking them

439
00:21:16.915 --> 00:21:18.555
to be managers systems, as well as

440
00:21:19.075 --> 00:21:21.755
maintaining all their basic, uh, knowledge and skill sets.

441
00:21:22.135 --> 00:21:25.815
So this is, this is one of the reasons why we actually want

442
00:21:25.815 --> 00:21:28.615
to take off those basic reversionary modes

443
00:21:28.615 --> 00:21:29.895
and simplify it for the pilot.

444
00:21:29.995 --> 00:21:32.895
And that's where, uh, there is potential for, uh,

445
00:21:32.895 --> 00:21:34.375
state-based designs to help.

446
00:21:37.935 --> 00:21:40.135
A couple other lessons learned, uh, from the studies

447
00:21:40.165 --> 00:21:42.415
that we did, uh, was that anticipation

448
00:21:42.415 --> 00:21:45.215
of the automated mode change is a form of workload.

449
00:21:45.395 --> 00:21:47.855
So, uh, just happened to worry about whether

450
00:21:47.855 --> 00:21:49.895
or not it's doing or tracking that it did it right.

451
00:21:50.315 --> 00:21:52.735
Uh, and sometimes manual selection is just easier.

452
00:21:53.155 --> 00:21:54.935
So example of that is TRC.

453
00:21:54.935 --> 00:21:56.375
Do you really want the aircraft going in

454
00:21:56.375 --> 00:21:57.695
and outta TRC automatically,

455
00:21:58.035 --> 00:22:00.655
or do you want to just command it and know where it's at?

456
00:22:01.195 --> 00:22:04.535
Uh, relocating, uh, directional controls from the pedals

457
00:22:04.915 --> 00:22:08.495
to the stick inceptors, uh, can impact the workload.

458
00:22:08.795 --> 00:22:10.655
Uh, a lot of the designs are doing it.

459
00:22:11.075 --> 00:22:14.575

Uh, and the question is, what's the purpose of integrating,

460
00:22:14.795 --> 00:22:17.455
uh, the directional control on, on a stick cept?

461
00:22:17.855 --> 00:22:19.455
A lot of times it's not for performance.

462
00:22:19.555 --> 00:22:22.655
Uh, what you'll find is that, uh, performance actually, uh,

463
00:22:22.675 --> 00:22:24.975
can go down in certain sit, uh, situations,

464
00:22:25.275 --> 00:22:26.455
but there is a logistics

465
00:22:26.455 --> 00:22:28.575
and a maintenance, uh, sort of reason behind it.

466
00:22:29.495 --> 00:22:31.555
Uh, air ground flight control logic, uh,

467
00:22:31.555 --> 00:22:32.955
changes are critical.

468
00:22:33.215 --> 00:22:35.075
Uh, so one of the things we worried about is,

469
00:22:35.075 --> 00:22:36.755
as you're coming in on some of these approaches

470
00:22:36.755 --> 00:22:39.435
and you're doing crosswind and you touch down one wheel

471
00:22:39.435 --> 00:22:42.355
and you hit a, a proximity sensor, uh, you really have

472
00:22:42.355 --> 00:22:45.475
to think about how the aircraft, uh, touches down

473
00:22:45.475 --> 00:22:47.715
and makes that transition from flying to,

474
00:22:47.935 --> 00:22:49.075
to not flying anymore.

475
00:22:49.535 --> 00:22:51.595
Uh, particularly important with your stole landings

476
00:22:51.595 --> 00:22:53.635
and your conventional landings, if you have that capability.

477
00:22:54.655 --> 00:22:57.635
And then automated reversion, uh, from a state-based control

478
00:22:58.015 --> 00:23:00.435
to that access based control in, uh,

479
00:23:00.435 --> 00:23:02.795
failure scenarios represents a significant risk.

480
00:23:02.895 --> 00:23:04.715
So if you're in the middle of a transition,

481
00:23:04.715 --> 00:23:05.835
and then suddenly you have a failure

482
00:23:05.835 --> 00:23:08.155
that automatically throws you into a, a,

483
00:23:08.175 --> 00:23:10.595
an attitude control aircraft, that can be,

484
00:23:10.615 --> 00:23:11.755
uh, that can be very risky.

485
00:23:14.105 --> 00:23:17.245
So what we did was we put together some guidelines, uh,

486
00:23:17.315 --> 00:23:19.445

that we thought was applicable probably to just,

487
00:23:19.555 --> 00:23:21.325
just about everybody in this, uh,

488
00:23:22.185 --> 00:23:23.605
in this category of aircraft.

489
00:23:24.065 --> 00:23:25.805
Um, I won't go through all of these,

490
00:23:25.985 --> 00:23:27.925
but I do want to highlight, uh, two of them

491
00:23:27.925 --> 00:23:29.645
that I thought are particularly important.

492
00:23:30.025 --> 00:23:32.685
Uh, one is that you want to apply the stressors in order

493
00:23:32.685 --> 00:23:34.045
to properly vet the performance

494
00:23:34.045 --> 00:23:36.445
of the flight control system, uh, and the automation,

495
00:23:36.445 --> 00:23:38.685
and you want to identify the benefits, uh,

496
00:23:38.755 --> 00:23:39.755
and the shortfalls.

497
00:23:40.345 --> 00:23:42.205
Uh, and then the other thing that, uh,

498
00:23:42.345 --> 00:23:44.685
is particularly important in, in my opinion, is

499
00:23:44.685 --> 00:23:46.125
that you include the failure modes.

500
00:23:46.425 --> 00:23:49.765
So, uh, you know, these aircraft, uh, typically have

501
00:23:50.565 --> 00:23:54.485
multiple motors, multiple batteries, multiple, you know, uh,

502
00:23:55.045 --> 00:23:56.365
multiple conventional surfaces

503
00:23:56.365 --> 00:23:58.405
that can fail in various ways.

504
00:23:58.585 --> 00:23:59.965
And so you need to make, make sure

505
00:23:59.965 --> 00:24:03.405
that you include the failure modes degraded, uh, operation.

506
00:24:03.405 --> 00:24:05.845
And, and if you have reversionary modes, um,

507
00:24:05.865 --> 00:24:07.605
you wanna make sure that you evaluate those,

508
00:24:07.745 --> 00:24:08.845
uh, throughout the envelope.

509
00:24:09.145 --> 00:24:10.885
Uh, one thing I would like to point out is

510
00:24:10.885 --> 00:24:13.605
that the reversionary modes there, there probably is some,

511
00:24:13.835 --> 00:24:15.645
some good, uh, utility for those

512
00:24:15.705 --> 00:24:17.005
during the flight test program.

513
00:24:17.585 --> 00:24:19.365

Uh, so you, you may, you may find

514
00:24:19.365 --> 00:24:20.765
that you want a reversionary mode

515
00:24:20.765 --> 00:24:21.925
during your flight test program,

516
00:24:22.305 --> 00:24:24.645
but ultimately your goal, if you're gonna achieve, uh,

517
00:24:24.645 --> 00:24:27.325
the stuff that we talked about up front, uh, should be to,

518
00:24:27.325 --> 00:24:30.125
uh, eliminate those from the, uh, from the final product.

519
00:24:35.795 --> 00:24:37.935
And then just talking about the stress maneuvers here.

520
00:24:38.195 --> 00:24:40.375
Uh, so these are, these are some of the, uh,

521
00:24:40.375 --> 00:24:42.135
stress maneuvers that are, that are typical

522
00:24:42.235 --> 00:24:43.335
and that have worked out well.

523
00:24:43.715 --> 00:24:45.975
Uh, my three favorites are sort

524
00:24:45.975 --> 00:24:49.575
of highlighted there in green, uh, the precision hover, uh,

525
00:24:49.595 --> 00:24:53.295
the pirouette, if, so, if I was to jump into an eval, uh,

526
00:24:53.515 --> 00:24:56.135
or an eval simulator, the first three things

527
00:24:56.135 --> 00:24:58.335
that I would do are these, these guys right here in the

528
00:24:58.335 --> 00:25:00.455
green, I'd want to do a precision hover, I'd want

529
00:25:00.455 --> 00:25:02.615
to do a pirouette, and then I would, uh, get on the wing

530
00:25:02.615 --> 00:25:04.415
and I would do that, uh, sort

531
00:25:04.575 --> 00:25:06.615
of three axis wing borne tracking stuff.

532
00:25:07.435 --> 00:25:10.055
So the other, the other maneuvers are all, uh, good.

533
00:25:10.055 --> 00:25:12.815
And they have their place in evaluating the, the pros

534
00:25:12.815 --> 00:25:14.175
and cons in the transition region.

535
00:25:14.635 --> 00:25:17.255
Uh, the reference there, by the way, is, uh,

536
00:25:17.535 --> 00:25:20.575
recently released, uh, FAA document, uh, that, uh,

537
00:25:20.805 --> 00:25:22.335
that we contributed to.

538
00:25:22.915 --> 00:25:25.055
Uh, and, uh, and that's out there.

539
00:25:25.155 --> 00:25:27.095
It has the mission task elements, uh,

540
00:25:27.115 --> 00:25:29.695

and it's, it's a useful reference for any of the, any

541
00:25:29.695 --> 00:25:31.895
of the e VTA companies that are, that are coming up.

542
00:25:35.885 --> 00:25:38.385
So, uh, I'll open it up to questions here.

543
00:25:38.605 --> 00:25:39.665
Um, and, uh,

544
00:25:39.665 --> 00:25:41.985
before I do that, I just wanna sort of, uh, point out, uh,

545
00:25:42.005 --> 00:25:45.425
so, uh, Marty, he's the, he's the V 22 expert, uh,

546
00:25:45.605 --> 00:25:46.825
on the team for us.

547
00:25:46.965 --> 00:25:49.305
And then, uh, I'm, I'm the EV tall guy.

548
00:25:49.305 --> 00:25:51.225
I've been working evals for about eight years now.

549
00:25:51.445 --> 00:25:54.305
Uh, that aircraft on the right was a manned EV tall that we,

550
00:25:54.405 --> 00:25:57.065
we actually flew, I think, I believe it's that, that first

551
00:25:57.815 --> 00:25:59.705
eval that's gone from, uh, from a hover

552
00:25:59.705 --> 00:26:02.825
to transitioning back, uh, that was in 2017.

553
00:26:03.135 --> 00:26:05.625
That was not a, a state-based design.

554
00:26:05.625 --> 00:26:08.625
That was an attitude based design, Dave VFR,

555
00:26:08.685 --> 00:26:09.705
and it worked just fine.

556
00:26:09.965 --> 00:26:12.505
Uh, it, it would not be a good IFR platform,

557
00:26:12.505 --> 00:26:15.625
but it did, it did the job at the time for, for the company

558
00:26:15.735 --> 00:26:17.495
that, uh, that I was working for.

559
00:26:19.175 --> 00:26:21.435
And, uh, the other thing I wanna say, I'll open it up

560
00:26:21.435 --> 00:26:23.115
to question, so anybody's got a question, go ahead

561
00:26:23.115 --> 00:26:24.195
and, uh, head to a mic.

562
00:26:24.215 --> 00:26:26.395
And then, uh, I wanna say thanks to Taylor

563
00:26:26.895 --> 00:26:29.395
for the fruit salad, uh, concept.

564
00:26:29.775 --> 00:26:31.875
I'm, I'm definitely gonna be handing out some,

565
00:26:31.905 --> 00:26:34.035
some pineapples and, uh, I thought

566
00:26:34.035 --> 00:26:35.355
that was brilliant, so thank you.

567
00:26:48.775 --> 00:26:51.675

Hey, uh, bill fell from Sikorsky great presentation.

568
00:26:52.745 --> 00:26:54.805
I'm just curious on the pirouette, as one

569
00:26:54.805 --> 00:26:57.445
of the maneuvers you listed to shake out the machine,

570
00:26:57.545 --> 00:27:00.565
it seems like most of these machines are designed

571
00:27:00.745 --> 00:27:02.845
to go from point A to point B

572
00:27:02.905 --> 00:27:04.925
as an air taxi sort of service.

573
00:27:06.005 --> 00:27:08.295
What do you, what are you getting out of the pirouette?

574
00:27:08.605 --> 00:27:10.495
Yeah, uh, thanks Bill for that question.

575
00:27:10.595 --> 00:27:14.455
So, uh, I think at from, as a pilot, um, I'm, I'm trying

576
00:27:14.455 --> 00:27:16.975
to understand, at least in a, in a hover, I want

577
00:27:16.975 --> 00:27:19.735
to understand my low speed sort of maneuverability

578
00:27:19.795 --> 00:27:22.575
or where the limits are, you know, so, so a lot of it is,

579
00:27:22.575 --> 00:27:25.735
it may, it may not be a mission representative, uh, task

580
00:27:25.915 --> 00:27:27.495
for your particular operation.

581
00:27:27.675 --> 00:27:28.775
So that's a great question.

582
00:27:29.075 --> 00:27:30.855
Uh, it may not be mission representative.

583
00:27:30.915 --> 00:27:33.335
In fact, if your mission is hey, hover

584
00:27:33.475 --> 00:27:35.855
and then land, um, at the boat,

585
00:27:36.885 --> 00:27:38.145
you, you never have to do that.

586
00:27:38.165 --> 00:27:40.825
You, you, if you know you're gonna do a straight in, um,

587
00:27:41.405 --> 00:27:43.745
but let's, let's kind of back into reality

588
00:27:43.745 --> 00:27:45.825
and we know what are we gonna ask these aircraft to do?

589
00:27:46.075 --> 00:27:47.785
We're gonna ask 'em to do all the things,

590
00:27:47.785 --> 00:27:50.105
and we're gonna, we're gonna ask them to go, uh,

591
00:27:50.215 --> 00:27:51.305
into places, and we're,

592
00:27:51.305 --> 00:27:54.065
and likely they're gonna, they're gonna sort

593
00:27:54.065 --> 00:27:56.635
of eventually just be treated like helicopters.

594
00:27:56.775 --> 00:28:01.475

So I, I, I, I agree, uh, the pirouette is not necessarily,

595
00:28:01.695 --> 00:28:03.755
uh, something that the FAA should say, Hey,

596
00:28:03.755 --> 00:28:05.715
if you can't do this, you, you're not gonna get certified.

597
00:28:05.935 --> 00:28:07.915
The, so it's really all about the mission.

598
00:28:08.375 --> 00:28:11.515
And, uh, if that's not the mission, um, that's okay.

599
00:28:11.785 --> 00:28:13.915
That just the pirouette just tells you something.

600
00:28:13.915 --> 00:28:16.115
So it's an in, in informative maneuver.

601
00:28:16.735 --> 00:28:18.755
In fact, all three of those maneuvers that I talked about,

602
00:28:18.755 --> 00:28:21.435
those are just, that's gonna give you the best information

603
00:28:21.435 --> 00:28:22.595
in the shortest amount of time.

604
00:28:23.085 --> 00:28:24.515
Great. Thank you. Thank you.

605
00:28:30.105 --> 00:28:32.125
Hey, rj, uh, just a question for you.

606
00:28:32.125 --> 00:28:35.085
Do you have any comments on, uh, on directional control?

607
00:28:35.125 --> 00:28:36.725
Particularly on handheld

608
00:28:37.065 --> 00:28:38.065
And stuff? Yeah.

609
00:28:38.065 --> 00:28:39.245
Um, yeah, I,

610
00:28:39.365 --> 00:28:40.925
I guess I could give you a couple of thoughts.

611
00:28:40.985 --> 00:28:42.405
Um, one is, uh,

612
00:28:44.385 --> 00:28:48.175
early on in the test programs, uh, test pilots

613
00:28:49.445 --> 00:28:52.345
really kind of need to understand the risk of

614
00:28:53.165 --> 00:28:55.785
if you're gonna move that directional control to the in

615
00:28:55.845 --> 00:28:57.815
to the stick cept, uh,

616
00:29:00.505 --> 00:29:02.805
you need to understand the risk of, of doing that, right?

617
00:29:03.185 --> 00:29:07.005
Um, there's, in some cases, uh, you might say, Hey, let's,

618
00:29:07.005 --> 00:29:09.525
let's, let's just keep, let's just have pedals for the,

619
00:29:09.625 --> 00:29:11.205
you know, the, for the prototype,

620
00:29:11.545 --> 00:29:13.445
and let's convince ourselves that we're ready

621
00:29:13.445 --> 00:29:16.755

to put it on the stick, um, if there's a failure mode.

622
00:29:16.815 --> 00:29:19.115
So really, it kind of gets back to failure modes.

623
00:29:19.115 --> 00:29:20.195
If you've got a failure mode

624
00:29:21.055 --> 00:29:25.085
where you need a large magnitude rapid input

625
00:29:25.725 --> 00:29:29.895
in directional control, uh, my suggestion would be,

626
00:29:30.645 --> 00:29:32.105
you, you, you probably ought

627
00:29:32.105 --> 00:29:33.545
to think about keeping pedals, right?

628
00:29:34.565 --> 00:29:36.185
If you can convince yourself

629
00:29:36.375 --> 00:29:39.625
that the design does not have a failure mode

630
00:29:39.625 --> 00:29:41.605
where the aircraft, aircraft is gonna,

631
00:29:41.865 --> 00:29:44.045
the nose is gonna start swinging one way, and,

632
00:29:44.145 --> 00:29:47.745
and it's important to get the correct input,

633
00:29:47.875 --> 00:29:51.105
large magnitude rapid, uh, then you could move,

634
00:29:51.345 --> 00:29:52.665
I think you could successfully move it

635
00:29:52.665 --> 00:29:53.825
to the stick inceptors, and it

636
00:29:53.825 --> 00:29:55.025
doesn't matter which side, right?

637
00:29:55.645 --> 00:29:57.945
Uh, but the, the thing I worry about is you're in the middle

638
00:29:57.945 --> 00:30:00.065
of the transition and then you get a heart over,

639
00:30:00.125 --> 00:30:02.105
for whatever reason, the aircraft goes sideways.

640
00:30:02.995 --> 00:30:05.375
Are you gonna remember what, you know, it,

641
00:30:05.405 --> 00:30:07.975
it's not instinctual for, at least for a test pilot

642
00:30:08.005 --> 00:30:10.025
that grew up with pedals, right?

643
00:30:10.365 --> 00:30:13.065
So, uh, there, now I'll make a counterpoint to that.

644
00:30:13.195 --> 00:30:17.185
There is a category of pilots that, that is instinctual,

645
00:30:17.325 --> 00:30:19.515
and that's the RC guys, right?

646
00:30:19.775 --> 00:30:22.315
And that there's a, a, a group of pilots

647
00:30:22.315 --> 00:30:24.395
that's coming up in the RC community and the,

648
00:30:24.395 --> 00:30:27.715

and the UAS community where that could totally make sense.

649
00:30:28.715 --> 00:30:30.135
So, but for me and,

650
00:30:30.195 --> 00:30:34.215
and for my lizard brain mapping, um, I, my, I'm,

651
00:30:34.235 --> 00:30:36.215
I'm pushing on this, I'm pushing on the floor even,

652
00:30:36.215 --> 00:30:38.015
even when it, it doesn't have pedals.

653
00:30:38.665 --> 00:30:39.725
So, and that,

654
00:30:39.725 --> 00:30:42.165
and that was, that was a very common thing in the NASA

655
00:30:42.165 --> 00:30:44.205
studies was the pilots are pushing on,

656
00:30:44.225 --> 00:30:46.085
on the floor even when there wasn't any pedals.

657
00:30:47.635 --> 00:30:51.395
Thanks. I think you, Dave, yeah.

658
00:30:57.845 --> 00:31:01.645
All right. Cheers. Thanks.