WEBVTT

1
00:00:04.970 --> 00:00:07.340
Thanks a lot, rod. All right.

2
00:00:07.340 --> 00:00:11.180
Our next two speakers are also no strangers to this workshop, or, or again,

3
00:00:11.190 --> 00:00:14.260
other symposia that we have. Uh, we've got, uh,

4
00:00:14.260 --> 00:00:18.500
Marty Schubert and Rick Simons that'll be presenting challenge, uh,

5
00:00:18.500 --> 00:00:22.620
challenges in flight testing. New Evie Tall Designs,

6
00:00:22.740 --> 00:00:27.190
a very popular subject these days. Uh, Martin Schubert, uh,

7
00:00:27.510 --> 00:00:29.230
a West Point grad. So, uh,

8
00:00:29.460 --> 00:00:32.510
back in the day when they weren't as good as good at hockey as they are today.

9
00:00:33.090 --> 00:00:36.190
Uh, also has a master, uh, from Georgia Tech, uh,

10
00:00:36.190 --> 00:00:40.750
and also doing some consulting and support of NASA and the FAA

11
00:00:41.050 --> 00:00:45.590
on Urban Air Mobility Concepts, which is one of the prime uses for EV to,

12
00:00:46.420 --> 00:00:49.280
uh, retired from Bell, uh, helicopter. Uh,

13
00:00:49.550 --> 00:00:54.040

lots of experience on the Osprey as well as the Chinook and,

14
00:00:54.540 --> 00:00:58.840
uh, board member of the flight test, uh, safety committee and graduate of,

15
00:00:59.340 --> 00:01:02.080
uh, Navy test pilot school in 92,

16
00:01:02.080 --> 00:01:05.760
which I believe would put you around Class 1 0 1. Close.

17
00:01:07.900 --> 00:01:12.400
All right, uh, Rick Simons, uh, aircraft certification flight test. Uh,

18
00:01:12.400 --> 00:01:17.360
graduated from Arkansas Tech and Ry Riddle with a master's. Uh,

19
00:01:17.360 --> 00:01:22.200
another navy, uh, fellow classmate, uh, class 86 a little bit before me.

20
00:01:23.610 --> 00:01:28.350
Uh, flew on the XV 15 tilt rotor,

21
00:01:28.770 --> 00:01:33.480
uh, at the FA conducted cert flight testing until retirement in, uh,

22
00:01:33.480 --> 00:01:37.280
2013 as a designated engineering representative,

23
00:01:37.820 --> 00:01:41.920
and was also the chief test pilot for the Y 400, uh,

24
00:01:42.070 --> 00:01:46.260
tilt wing aircraft. Please welcome me, uh, please, uh,

25
00:01:46.260 --> 00:01:48.740
help me welcome to the stage Marty and Rick.

26
00:02:07.760 --> 00:02:11.490
Okay. Um, I put this together, uh,

27
00:02:12.540 --> 00:02:17.000
ju just recently because in 2020 I retired as a test pilot,

28
00:02:17.340 --> 00:02:20.410
and about six months after that retirement,

29
00:02:20.450 --> 00:02:24.600
I got bored and I started looking for work. And, uh,

30
00:02:24.880 --> 00:02:29.010
I got cajoled into EV toll. And, uh,

31
00:02:29.750 --> 00:02:33.490
and now after two years, I've kind of formed some opinions on the challenges.

32
00:02:33.710 --> 00:02:38.320
Uh, one of those challenges I'm gonna talk to re involve certification,

33
00:02:38.540 --> 00:02:42.880
and that's why I, uh, bothered Rick here and ask him to help me out,

34
00:02:43.820 --> 00:02:48.080
cuz I did, uh, almost 40 years of flying military aircraft and,

35
00:02:48.220 --> 00:02:52.760
and developing and testing military aircraft. So I was, uh,

36
00:02:52.920 --> 00:02:54.720
a little bit lacking in the civil side.

37
00:02:55.580 --> 00:02:58.640
So it's been drinking from a fire hose for me. That's

38
00:02:59.740 --> 00:03:03.920
The challenges I'm gonna talk about, kind of call 'em risks that I see.

39
00:03:04.730 --> 00:03:06.430
And I broke 'em into four areas.

40
00:03:09.940 --> 00:03:12.490
First of all, the new frontier that we're talking about,

41
00:03:13.150 --> 00:03:16.560
there's a lot of different designs. These are just a handful of 'em.

42
00:03:17.230 --> 00:03:22.130
I'm gonna talk to general considerations that I've seen as general trends

43
00:03:22.270 --> 00:03:27.210
I'm seeing in the industry and what kind of impacts are gonna mean for a flight

44
00:03:27.240 --> 00:03:31.520
test. It's, it's a big task. There's a lot of moving parts.

45
00:03:33.860 --> 00:03:37.980
Let me back up. Four areas of, I've identified,

46
00:03:38.310 --> 00:03:42.860
first of all, a lot of innovation, a lot of new design coming out.

47
00:03:42.860 --> 00:03:44.580
There's some baseline design risks,

48
00:03:44.580 --> 00:03:47.500
and then there are piling on other certification risks in,

49
00:03:47.600 --> 00:03:51.210
in developing these vehicles. And then we've got to,

50
00:03:51.640 --> 00:03:55.370
there's a bunch of airworthiness criteria and means of compliance that are in

51
00:03:55.370 --> 00:03:59.730
flux right now trying to react to this tidal wave of vehicles that are coming.

52
00:04:01.050 --> 00:04:05.470

And then there's new test teams. Many of these organizations don't have tests,

53
00:04:05.500 --> 00:04:07.390
have never tested an aircraft before,

54
00:04:07.770 --> 00:04:11.310
and are trying to build test teams from scratch. They've,

55
00:04:11.310 --> 00:04:15.910
they're bringing in some people from different areas. They're, uh, co uh,

56
00:04:15.950 --> 00:04:18.910
cobbling together teams. And at the same time,

57
00:04:19.150 --> 00:04:23.630
they're having to cope with this concept of remotely piloted versus

58
00:04:24.130 --> 00:04:26.950
manned operations. These vehicles,

59
00:04:27.060 --> 00:04:31.750
when they get put into like air taxi or urban air mobility

60
00:04:32.250 --> 00:04:34.870
are gonna be manned. So they've got to get through that.

61
00:04:35.050 --> 00:04:39.190
And they're wrestling with how best to balance those two things.

62
00:04:43.450 --> 00:04:46.710
The first one, uh, the baseline design risks.

63
00:04:47.220 --> 00:04:50.430
Many of these vehicles use distributed electrical propulsion.

64
00:04:51.060 --> 00:04:52.240
So they're battery powered,

65
00:04:52.590 --> 00:04:56.400
they're using electric motors and they're using a lot of 'em.

66
00:04:56.830 --> 00:05:01.770
And so they're over actuated. They have to prioritize those, balance them,

67
00:05:02.540 --> 00:05:07.040
uh, in failures. They have to have adaptive controls. So this is a,

68
00:05:07.280 --> 00:05:12.000
a new revolution with respect to flight control design. And we are, uh,

69
00:05:12.470 --> 00:05:16.810
it's gonna be an incredible challenge for, uh, flight testers. Here.

70
00:05:16.910 --> 00:05:21.010
I'm showing the lift plus cruise model where we have a pusher prop for high

71
00:05:21.010 --> 00:05:23.690
speed, and then we have low speed. You have, uh,

72
00:05:24.200 --> 00:05:26.610
when you're in thrust borne flight, you have these, uh,

73
00:05:28.050 --> 00:05:30.530
electric propulsions that come on and, uh,

74
00:05:30.760 --> 00:05:35.640
they have to sequence in a particular way for, for your maneuvering.

75
00:05:36.220 --> 00:05:40.790
So at the same time, you're going from,

76
00:05:41.100 --> 00:05:45.390
many of these concepts are going from wing borne to thrust borne flights.

77
00:05:45.390 --> 00:05:48.970
So they have to have all sorts of control mixing. You're not,

78
00:05:48.970 --> 00:05:51.170
you're over actuated. So you're prioritizing,

79
00:05:51.190 --> 00:05:54.050
you're blending your controls based on your speed regime.

80
00:05:55.360 --> 00:05:57.020
And then a lot of,

81
00:05:57.040 --> 00:06:01.400
lot of the manufacturers are looking at very unique,

82
00:06:02.420 --> 00:06:05.360
um, CEP mappings where they're and,

83
00:06:05.500 --> 00:06:10.040
and response types to handle this very issu issue of transition.

84
00:06:10.420 --> 00:06:12.600
How do you make it fly like a fixed wing,

85
00:06:12.600 --> 00:06:16.400
then fly like a helicopter and make that very intuitive?

86
00:06:20.400 --> 00:06:23.180
The baseline design risk here is batteries.

87
00:06:23.990 --> 00:06:28.480
Everybody knows, uh, you've all been asked that question at the airport.

88
00:06:28.500 --> 00:06:32.920
Do you have any lithium ion batteries in your luggage? Well,

89
00:06:32.920 --> 00:06:35.840
you can imagine a thousand or or so those things in the,

90
00:06:35.840 --> 00:06:39.600
in this aircraft that is, represents a significant hazard.

91
00:06:41.460 --> 00:06:44.970
So from the headlines, this is just in January,

92

00:06:45.130 --> 00:06:47.650
I pulled out two headlines In January alone, there were,

93
00:06:47.780 --> 00:06:52.530
there were two incidents that took thousands of gallons of water to put out

94
00:06:52.730 --> 00:06:55.130
a, a lithium ion battery fire.

95
00:06:56.110 --> 00:07:00.130
So the idea here is that you can't afford a battery fire in these,

96
00:07:01.170 --> 00:07:06.000
while statistically less likely to occur a battery fire in,

97
00:07:06.020 --> 00:07:10.710
in an airplane. They are, they are, uh, much harder to put out.

98
00:07:11.920 --> 00:07:13.500
So what's our focus now?

99
00:07:13.930 --> 00:07:18.580
Battery management has gotta be just absolutely critical. You're,

100
00:07:18.580 --> 00:07:19.980
you're talking in these vehicles,

101
00:07:19.980 --> 00:07:23.340
we're gonna be rapidly charging them then discharging them rapidly,

102
00:07:23.780 --> 00:07:27.140
charging them, discharging them. So there's a lot of, uh,

103
00:07:27.370 --> 00:07:32.300
potential for thermal runaway. So we, you've gotta innovate for that and,

104
00:07:32.300 --> 00:07:34.860
uh, you've gotta focus on containment and,

105
00:07:34.920 --> 00:07:37.300

and avoiding damage to the battery packs.

106
00:07:38.130 --> 00:07:39.950
So in flight test,

107
00:07:40.370 --> 00:07:44.430
we we're gonna have to do that building block to show that all this battery

108
00:07:44.430 --> 00:07:45.750
management stuff works.

109
00:07:47.530 --> 00:07:51.940
Battery power diminishes, uh,

110
00:07:52.170 --> 00:07:55.340
with power required. So this is, uh,

111
00:07:55.370 --> 00:07:58.740
from a paper that was given at S E T P a couple years ago.

112
00:07:58.740 --> 00:08:01.100
It's a really good paper, I'd recommend everybody read it.

113
00:08:01.810 --> 00:08:04.750
But it shows that there is, uh,

114
00:08:05.030 --> 00:08:06.990
a diminishment of your power available,

115
00:08:07.130 --> 00:08:11.270
unlike a fossil fuel where it is putting out the same power available right up

116
00:08:11.270 --> 00:08:14.370
to the point where you run outta gas here,

117
00:08:14.990 --> 00:08:19.010
it diminishes your, your capability to put out power available diminishes.

118

00:08:19.010 --> 00:08:23.050
And you've gotta establish some sort of, uh,

119
00:08:23.370 --> 00:08:28.130
threshold where you can't op you, you should not operate here, for instance,

120
00:08:28.190 --> 00:08:32.650
the normal range that green represents that area where you're capable of putting

121
00:08:32.670 --> 00:08:35.250
out max capability on your electric motors.

122
00:08:35.910 --> 00:08:40.690
But then as you start coming down on that curve and your, your,

123
00:08:41.120 --> 00:08:45.200
your state of charge starts to dwindle, you're gonna have to, you're,

124
00:08:45.200 --> 00:08:47.640
you're gonna see impacts to not only performance,

125
00:08:47.660 --> 00:08:51.080
but maybe even handle it qualities. So where do you draw that line?

126
00:08:51.500 --> 00:08:52.640
How do you test that?

127
00:08:55.140 --> 00:09:00.040
So available power is dependent on state of function, which, uh, uh,

128
00:09:00.100 --> 00:09:03.120
the largest contributor is state of charge of the battery.

129
00:09:04.290 --> 00:09:05.630
And that battery is state of charge,

130
00:09:05.630 --> 00:09:09.650
is dependent on power demand through the flight. So you've gotta be predictive,

131
00:09:09.870 --> 00:09:13.810
you have to have bingo calculations that are even more involved with than, uh,

132
00:09:13.880 --> 00:09:17.330
ones that we're using for the regular fossil fuels.

133
00:09:18.220 --> 00:09:20.400
And the real bad news is gross weight doesn't change.

134
00:09:20.420 --> 00:09:21.920
You don't get that fuel burn benefit.

135
00:09:22.750 --> 00:09:26.120
That thing is as heavy on landing as it is on takeoff.

136
00:09:26.970 --> 00:09:30.390
So your critical case is not takeoff at all in these aircraft.

137
00:09:30.540 --> 00:09:34.390
It's the landing and the predictive capability in the landing.

138
00:09:35.270 --> 00:09:35.930
And lastly,

139
00:09:35.930 --> 00:09:39.530
that state of function of the battery has a whole lot of other things that feed

140
00:09:39.600 --> 00:09:42.370
into it. State of health, the age of the batteries,

141
00:09:42.370 --> 00:09:45.570
how well they're gonna hold their charge, temperature of the battery.

142
00:09:46.360 --> 00:09:49.300
And then last, and, and in addition to that,

143
00:09:49.800 --> 00:09:53.260
you have to worry about thermal management of your motors,

144
00:09:53.260 --> 00:09:54.900
your electric motors and inverters.

145
00:09:55.700 --> 00:10:00.180
A kind of analogous to gearbox limits that we have in a rotor craft.

146
00:10:00.200 --> 00:10:04.700
You'll have your engine power, which would be analogous to the engine, your,

147
00:10:04.810 --> 00:10:06.340
your, um, battery performance.

148
00:10:06.360 --> 00:10:08.860
But then you're gonna be also limited by thermal limits.

149
00:10:12.120 --> 00:10:15.700
One other, uh, baseline design risk is the,

150
00:10:15.910 --> 00:10:20.300
we're using variable RPM on a lot of these vehicles and, uh,

151
00:10:20.310 --> 00:10:21.460
we're still learning a lot.

152
00:10:21.700 --> 00:10:26.060
I come from an area where we're all collective controlled rotors with constant

153
00:10:26.360 --> 00:10:31.020
rpm. Variable RPM has, uh, a lot of things that we've got to understand.

154
00:10:31.640 --> 00:10:35.500
One of the things I've anecdotally I've seen in NASA Ames Sim that uh,

155
00:10:35.530 --> 00:10:39.580
Rick and I have participated in is ride quality with some of these electric

156
00:10:39.600 --> 00:10:40.580
motors start to suffer.

157
00:10:40.680 --> 00:10:45.500
So ride quality is starting to factor into our

158
00:10:45.500 --> 00:10:48.660
handling qualities ratings much more than previously.

159
00:10:48.720 --> 00:10:52.300
We need to consider that for, especially for passenger comfort.

160
00:10:53.120 --> 00:10:57.540
And then vortex ring state, I don't think be as, as predictable,

161
00:10:58.160 --> 00:10:59.620
uh, at when,

162
00:10:59.620 --> 00:11:03.500
when you're descending in your own wake with these things as it is with a

163
00:11:03.500 --> 00:11:06.500
collective controlled rotor. So a lot of, uh,

164
00:11:06.800 --> 00:11:09.380
lot of innovation and flight test challenges there.

165
00:11:11.760 --> 00:11:15.340
In addition to the baseline risk, I'm seeing some other stuff. First of all,

166
00:11:15.940 --> 00:11:19.700
a helicopter can carry about 50% of its gross weight in payload.

167
00:11:20.590 --> 00:11:24.540
These vehicles because of batteries are in the 15% range.

168
00:11:25.240 --> 00:11:27.940
So there's an incredible push to reduce weight.

169
00:11:28.440 --> 00:11:32.020
And then we're seeing that across the board in, in many of these concepts,

170
00:11:32.490 --> 00:11:35.340
they're going to lighter ceps, they're going to side sticks.

171
00:11:35.570 --> 00:11:39.380
They don't want active sticks cuz active sticks way more. They're,

172
00:11:39.380 --> 00:11:41.900
they're getting rid of pedals, putting them on the sticks,

173
00:11:44.780 --> 00:11:49.610
rethinking manual braking brakes, wheels even are, are heavy.

174
00:11:49.750 --> 00:11:54.720
So breaking, let's, let's integrate it through the flight controls maybe. Um,

175
00:11:55.260 --> 00:11:58.840
and that, you know, they're again, trying to get rid of those pedals.

176
00:11:58.840 --> 00:12:01.040
They're trying to get rid of some of that weight.

177
00:12:02.400 --> 00:12:05.290
There's a pressure to reduce the control infrastructure.

178
00:12:05.430 --> 00:12:08.890
Now the redundancy is built into the distributed electrical propulsion.

179
00:12:09.230 --> 00:12:10.450
So they're taking credit for that.

180
00:12:10.990 --> 00:12:15.490
And winnowing down that triple redundant old fly by wire.

181
00:12:15.630 --> 00:12:18.730
Fly wire is now old in comparison to what, uh,

182
00:12:18.830 --> 00:12:22.770
the traditional way we do it is, is, uh, going away.

183
00:12:22.820 --> 00:12:27.400
We're going to something entirely different here. And then there's a,

184
00:12:28.040 --> 00:12:31.690
obviously a pressure to reduce structural weight. Um,

185
00:12:32.430 --> 00:12:36.270
transparency. Transparencies tend to be heavier than the skin of the aircraft.

186
00:12:36.410 --> 00:12:39.870
So let's reduce those transparencies. Let's reduce the field of view.

187
00:12:39.920 --> 00:12:42.990
Let's use cameras, let's do stuff like that.

188
00:12:43.650 --> 00:12:46.230
And then by reducing structural weight,

189
00:12:46.250 --> 00:12:49.910
and you have all of these forcing functions out there, these, these thrust uh,

190
00:12:50.090 --> 00:12:50.950
uh, effectors,

191
00:12:52.050 --> 00:12:56.550
now you have AEL issues that you've gotta address. And finally,

192
00:12:56.860 --> 00:13:01.110
because there's a, uh, a limited structural envelope on many of these aircraft,

193
00:13:01.120 --> 00:13:04.590
there is an expectation there's gonna be a lot of envelope protection.

194
00:13:05.250 --> 00:13:10.150
And that's a flight test challenge to verify that all that works. I,

195
00:13:10.290 --> 00:13:15.270
we got a lot of our work in the V 22 was based on the structural

196
00:13:15.270 --> 00:13:19.330
load limiting proof. And then, uh,

197
00:13:20.290 --> 00:13:22.480
going toward glass cockpits, think Tesla,

198
00:13:23.110 --> 00:13:26.960
pushing everything onto the glass with all the inherent risks that come with

199
00:13:26.960 --> 00:13:31.240
that. There's a tendency to do that by many of the manufacturers. So,

200
00:13:32.140 --> 00:13:32.920
and then lastly,

201
00:13:32.920 --> 00:13:36.240
I just put one in there that some of them are going to skid type aircraft,

202
00:13:36.290 --> 00:13:40.360
where if you were in a low power situation, a wheeled aircraft might be better.

203
00:13:41.150 --> 00:13:44.970
You could take off with a wheeled aircraft. In a conventional type takeoff,

204
00:13:45.110 --> 00:13:48.370
you could land in a conventional and use a lot less electrical power,

205
00:13:49.310 --> 00:13:52.090
but wheels and brakes are weight.

206
00:13:52.190 --> 00:13:57.100
So we're gonna go with skids just to keep it simple. And then la uh,

207
00:13:57.400 --> 00:14:02.300
the next area where they're accepting a lot of certification risk is, uh,

208

00:14:02.300 --> 00:14:07.230
pursuing simplified vehicle operations. To make these vehicles business viable,

209
00:14:07.290 --> 00:14:09.510
you have to have thousands of them in the air.

210
00:14:09.970 --> 00:14:12.750
You have to have thousands of pilots. You don't want to train,

211
00:14:12.760 --> 00:14:15.830
spend a lot of money training them. You want to make it dead simple.

212
00:14:16.090 --> 00:14:20.230
So here I'm showing a gamma document where they just deconstructed all the

213
00:14:20.230 --> 00:14:22.430
various things a pilot does. And,

214
00:14:22.610 --> 00:14:27.230
and they talked in that document how simplified vehicle operations can make all

215
00:14:27.510 --> 00:14:31.470
of those things easier. Basically, it's the, uh,

216
00:14:32.010 --> 00:14:35.430
the communicate aviate navigate kind of thing.

217
00:14:35.930 --> 00:14:39.590
I'm gonna talk to the aviate a little bit. Here's what we're seeing.

218
00:14:40.120 --> 00:14:44.630
We're seeing this move toward almost video type, uh,

219
00:14:44.640 --> 00:14:48.750
drone controls on some of these concepts and making it work all the way through

220
00:14:48.750 --> 00:14:50.560
the entire envelope here.

221
00:14:50.600 --> 00:14:55.070
I just show the controls you might see on a DJO DJ I controller,

222
00:14:55.630 --> 00:14:57.070
I own one of those little suckers.

223
00:14:58.180 --> 00:15:02.100
I bought it so I could make myself smart on all this stuff. Um,

224
00:15:02.440 --> 00:15:05.980
you're gonna see novel receptor mappings, really crazy stuff, uh,

225
00:15:06.090 --> 00:15:09.180
with a lot of different hybrid, uh, response types.

226
00:15:10.110 --> 00:15:14.140
We're gonna see state and trajectory control, vice attitude control,

227
00:15:15.010 --> 00:15:19.390
um, that kind of solves some of this transition from wing borne to,

228
00:15:20.130 --> 00:15:23.190
uh, um, thrust bo thrust borne,

229
00:15:23.450 --> 00:15:28.110
but it complicates the heck out of like the lateral directional axis handling

230
00:15:28.280 --> 00:15:32.860
crosswinds. And, um, and one other is,

231
00:15:33.080 --> 00:15:33.550
uh,

232
00:15:33.550 --> 00:15:38.200
going to a reversionary mode if you're using state and trajectory

233
00:15:38.270 --> 00:15:41.960
control. How do you handle movement to a reversionary mode?

234
00:15:42.180 --> 00:15:45.720
Do you have a reversionary mode? And then lastly, I'll show there,

235
00:15:45.720 --> 00:15:48.880
there's envelope protections there too. Uh,

236
00:15:49.180 --> 00:15:51.360
not only are they gonna do it for structural low limiting,

237
00:15:51.360 --> 00:15:55.280
they may do it for handling qualities and various other things just to simplify

238
00:15:55.380 --> 00:15:58.400
the, the pilot task a lot going on.

239
00:16:00.290 --> 00:16:04.110
So I'm gonna transition over to Rick and he's gonna talk about the next big area

240
00:16:04.130 --> 00:16:04.963
of risk.

241
00:16:11.970 --> 00:16:15.630
The, um, once, once they get it designed, then the,

242
00:16:15.630 --> 00:16:18.030
the next thing that has to be, uh, uh,

243
00:16:18.030 --> 00:16:21.950
addressed is going to the authorities and coming up with a way to certify it.

244
00:16:22.730 --> 00:16:26.550
And that is an another area that's in great, uh, flux. And,

245
00:16:26.610 --> 00:16:29.750
and Dave Weber spoke earlier. This slide is from what presentation.

246
00:16:29.770 --> 00:16:31.830
And if you haven't seen that presentation,

247
00:16:32.370 --> 00:16:34.030
you probably ought to get it because it,

248
00:16:34.090 --> 00:16:38.110
it addresses the fundamentals that most people in this room are familiar with.

249
00:16:38.650 --> 00:16:40.790
But then the challenges that are coming in the future,

250
00:16:41.530 --> 00:16:43.830
and if you're in this room and you've done civil cert,

251
00:16:43.830 --> 00:16:46.510
you're probably going down the left side of this, this chart.

252
00:16:46.890 --> 00:16:51.190
You've either certified a small aircraft or transport or you know, engines,

253
00:16:51.280 --> 00:16:55.040
props, and that's the traditional route. Uh,

254
00:16:55.220 --> 00:16:58.920
unless you've done gliders and airships and now the tilt rotor, uh,

255
00:16:59.190 --> 00:17:03.600
very few people go to the, uh, to the right side of this chart and that,

256
00:17:03.600 --> 00:17:06.240
and the right side of the chart's unique and that it's a special class.

257
00:17:06.240 --> 00:17:07.280
And that's right in the rules,

258
00:17:08.240 --> 00:17:11.060
but it means there's no air where this criteria been developed for those

259
00:17:11.340 --> 00:17:14.940
aircraft, which is exactly where these aircraft are right now. Okay?

260
00:17:15.720 --> 00:17:17.900
And for a few years, the FAA said, well,

261
00:17:17.900 --> 00:17:20.340
we're just gonna certify 'em as a part 23 airplane.

262
00:17:20.480 --> 00:17:21.700
And especially under the new rules,

263
00:17:21.800 --> 00:17:26.540
it made it easier because a lot of the rules were written almost like

264
00:17:26.820 --> 00:17:27.040
you,

265
00:17:27.040 --> 00:17:31.660
you tell the FAA how your aircraft operates instead of them telling you how it

266
00:17:31.660 --> 00:17:36.040
had to operate. But that decision was reversed here, just, uh,

267
00:17:36.260 --> 00:17:41.040
not that long ago. And now it's gonna be treated as a special class. Okay?

268
00:17:41.580 --> 00:17:46.440
And the most current, uh, uh, example, probably the ex the,

269
00:17:46.460 --> 00:17:51.180
the, uh, the 6 0 9 and 6 0 9 s now been in, in,

270
00:17:51.240 --> 00:17:54.300
in efforts to certify for right at 25 years.

271
00:17:56.660 --> 00:17:59.750
That, let that sink in a second. Okay?

272
00:17:59.850 --> 00:18:02.830
So the right side of the chart really takes advantage of everything.

273
00:18:02.830 --> 00:18:04.950
On the left side of the chart, if you see at the bottom,

274
00:18:05.330 --> 00:18:09.470
you take any rule that it's in the already published for these other class of

275
00:18:09.670 --> 00:18:13.670
aircraft that if it applies to this design, then that's the rule you pick.

276
00:18:13.860 --> 00:18:17.790
Sometimes you have to pick between the, the small airplane and the,

277
00:18:17.890 --> 00:18:21.110
and the helicopter rule. Sometimes you have to pick parts of both of,

278
00:18:21.210 --> 00:18:25.190
of the same rule because of the transition between the different modes,

279
00:18:25.920 --> 00:18:28.790
right? When you get all the,

280
00:18:29.010 --> 00:18:32.590
the rules that you can find that apply to the design and then you find there's

281
00:18:32.590 --> 00:18:36.710
something in the design that's unique, like electric motors for propulsion,

282
00:18:37.140 --> 00:18:41.740
like batteries, for, for fuel, then you have to come up with a,

283
00:18:41.980 --> 00:18:46.180
a a a unique criteria that didn't exist before.

284
00:18:46.520 --> 00:18:47.220
And that's,

285

00:18:47.220 --> 00:18:50.620
that's one thing that ran into the 6 0 9 taking it so long because it's got a

286
00:18:50.620 --> 00:18:54.900
lot of rules that had to be written for that design because there was nothing in

287
00:18:54.900 --> 00:18:58.860
the rules to cover it. And all these aircraft are gonna have that challenge.

288
00:18:59.920 --> 00:19:02.500
And not only are the manufacturers gonna have a challenge,

289
00:19:02.560 --> 00:19:06.580
the FAA is gonna have the challenge because now they have to go through and sort

290
00:19:07.440 --> 00:19:11.940
how they're going to cover the air worthiness criteria and not have a gap

291
00:19:13.160 --> 00:19:17.620
or conflicting rules where they've got something from 23 and then something from

292
00:19:17.620 --> 00:19:21.580
27 and two or don't read the same. And,

293
00:19:21.640 --> 00:19:23.980
and maybe you have to have both of them. Uh,

294
00:19:24.280 --> 00:19:27.540
and then there's those unique parts that have never been covered before.

295
00:19:28.280 --> 00:19:33.140
And so that's gonna be a challenge for the authorities as well as it is for

296
00:19:33.240 --> 00:19:35.900
the, uh, for the designers. And,

297

00:19:36.040 --> 00:19:40.460
and that's a high risk that you get way into the flight test program and find

298
00:19:40.460 --> 00:19:43.500
out you missed a very important error airworthiness criteria.

299
00:19:49.270 --> 00:19:53.080
Looks like there's something missing there. Okay? Um,

300
00:19:53.380 --> 00:19:58.160
the safety continuum is, uh, is something the FAA has always dealt with.

301
00:19:58.160 --> 00:20:02.560
Basically, if you got less people, you got less weight, you got less power,

302
00:20:03.220 --> 00:20:05.720
uh, then, then maybe the aircraft can,

303
00:20:05.900 --> 00:20:08.240
can go to a less reliable.

304
00:20:08.540 --> 00:20:12.640
So most people that deal with transport are used to this 10 and minus nine

305
00:20:12.640 --> 00:20:17.140
number. But if you go to the smaller aircraft, they allow a lower reliability.

306
00:20:18.040 --> 00:20:22.260
And just a few years ago, the FAA wrote a policy statement and,

307
00:20:22.260 --> 00:20:25.540
and brought the rotor craft into this cuz they'd always resisted.

308
00:20:26.200 --> 00:20:29.220
And now they have broken it down with the same one.

309
00:20:29.280 --> 00:20:33.620

So it's a matter of exposure. If the exposure's lower, then there's there,

310
00:20:33.640 --> 00:20:38.420
you don't have to go to the higher standard. Okay? That may be an issue. Now.

311
00:20:38.480 --> 00:20:42.180
And the yasa who's developing their program has, uh,

312
00:20:42.700 --> 00:20:46.380
identified that if you're flying over populated area with these aircraft,

313
00:20:47.010 --> 00:20:49.440
maybe we have to reay at the higher level.

314
00:20:49.620 --> 00:20:52.140
So they have this enhanced condition,

315
00:20:52.830 --> 00:20:57.490
which says that you still have to maintain that higher reliability level. Okay?

316
00:20:58.110 --> 00:21:02.050
And so there's gonna be a challenge here. But again, with the designs,

317
00:21:02.400 --> 00:21:06.650
with the manufacturers and with the authorities, how are we gonna blend that?

318
00:21:06.990 --> 00:21:10.370
Is the FAA going to come up with a way to deal with the operation?

319
00:21:11.080 --> 00:21:11.913
And then if you,

320
00:21:12.000 --> 00:21:16.220
if you design to the operation of the aircraft and then that aircraft then gets

321
00:21:16.220 --> 00:21:20.380

used in a different way later, have you got the appropriate level of, of safety?

322
00:21:20.790 --> 00:21:24.940
Especially if you go say to the basic and you don't plan on that, uh,

323
00:21:25.040 --> 00:21:29.660
air taxi mode, but then somebody finds a use that has a higher risk,

324
00:21:30.120 --> 00:21:31.860
is that appropriate certification?

325
00:21:37.530 --> 00:21:38.980
Once you come up with the cert basis,

326
00:21:39.850 --> 00:21:43.180
then you gotta determine how you're gonna find compliance to that cert basis.

327
00:21:44.000 --> 00:21:48.980
For most of the standard certification the FAA has published, uh,

328
00:21:49.620 --> 00:21:51.700
advisory circulars and say, this is one way to do it.

329
00:21:51.700 --> 00:21:53.900
If you've got a better way, fine, uh,

330
00:21:53.920 --> 00:21:57.820
you have special conditions that came outta the cert basis for areas that didn't

331
00:21:57.820 --> 00:21:59.180
have ways to comply it.

332
00:21:59.180 --> 00:22:02.500
And then you have to determine in an issue paper how you're gonna find

333
00:22:02.500 --> 00:22:07.260
compliance to those rules in this aircraft. It may be, um,

334

00:22:07.840 --> 00:22:10.340
in all these aircraft that may be a, a real challenge.

335
00:22:11.080 --> 00:22:15.660
And so you've got electric propulsion. Now a lot of the rules will say, okay,

336
00:22:16.120 --> 00:22:20.340
one engine in operative, what's that mean when you got 16 motors up there?

337
00:22:20.990 --> 00:22:25.280
Okay, so how many combination of failures do you have to show?

338
00:22:25.280 --> 00:22:28.720
That's the equivalent level of safety and that's gonna be the bottom line.

339
00:22:28.720 --> 00:22:32.280
What's the equivalent level of safety? Indirect con flight controls,

340
00:22:32.280 --> 00:22:35.680
which is a new terminology for fly by wire. Uh,

341
00:22:36.410 --> 00:22:40.200
these aircraft are gonna have vertical takeoff and landing to this date,

342
00:22:40.200 --> 00:22:44.040
there's no civil helicopter certified with a fly by wire.

343
00:22:44.510 --> 00:22:45.720
There's a few military,

344
00:22:45.980 --> 00:22:50.160
but there's no civil aircraft of ro craft certified with fly by wire.

345
00:22:50.460 --> 00:22:54.350
So all these aircraft, to my knowledge, all of 'em are fly by wire.

346
00:22:55.210 --> 00:22:59.910
So this is a new challenge. Uh, got novel receptor designs, which, uh,

347
00:23:00.280 --> 00:23:02.670
Marty talked about, uh, a lot of the,

348
00:23:03.030 --> 00:23:07.230
a lot of 'em are making their own ceps cuz they're, they're vertically,

349
00:23:07.230 --> 00:23:10.390
they're trying to do the company where they make everything for the aircraft

350
00:23:10.510 --> 00:23:11.343
in-house.

351
00:23:13.370 --> 00:23:17.090
Standardization is gonna become another issue when you come to pilot

352
00:23:17.090 --> 00:23:21.010
qualifications and, and other issues. Uh,

353
00:23:21.670 --> 00:23:25.490
and then the novel mapping. Think about getting out of this aircraft.

354
00:23:25.910 --> 00:23:29.210
One of these aircraft has got these unique, uh, you know,

355
00:23:29.650 --> 00:23:34.210
controls and then you get out in a standard part 23 airplane

356
00:23:34.870 --> 00:23:38.770
is a negative habit transfer gonna create an unsafe condition that didn't exist

357
00:23:38.770 --> 00:23:43.410
before because you never had this unique blend of controls.

358
00:23:43.700 --> 00:23:47.840
Maybe you're ING height now with the left hand and then another aircraft.

359
00:23:47.840 --> 00:23:51.920
You hand it with the right hand. All these things are, are gonna be a,

360
00:23:51.940 --> 00:23:54.360
an issue that have to be addressed somewhere.

361
00:23:55.040 --> 00:23:59.280
Envelope protection is really good to make it easier for the pilot not to exceed

362
00:23:59.280 --> 00:24:00.120
the limits of the aircraft.

363
00:24:00.860 --> 00:24:05.120
But when you hit those envelope protection limits is perceived as a handl

364
00:24:05.120 --> 00:24:09.360
qualities issue cuz the pilot may feel he just lost control. Cuz in fact he did.

365
00:24:09.540 --> 00:24:13.640
The aircraft took, took the controls. Another issue that we,

366
00:24:14.240 --> 00:24:17.240
envelope protection may become a healing qualities part that we have to deal

367
00:24:17.240 --> 00:24:19.360
with in simulation,

368
00:24:19.830 --> 00:24:22.820
when you got an aircraft that may only have 20 minutes of flight time,

369
00:24:24.370 --> 00:24:27.430
it takes forever to do the flight test, to do the air weathers.

370
00:24:27.970 --> 00:24:31.270
So you're gonna want as much, uh, simulator credit as you can get,

371
00:24:31.850 --> 00:24:35.050
but how you validate the simulators, right?

372
00:24:35.670 --> 00:24:39.930
And the FAA is looking very strongly at using the, uh, maneuvers,

373
00:24:39.930 --> 00:24:43.370
which were used by the army in a S 33,

374
00:24:44.300 --> 00:24:48.770
adapt those for civil appropriateness and then maybe have a,

375
00:24:48.850 --> 00:24:52.630
I think Dave Czu calls it a catalog of maneuvers.

376
00:24:53.270 --> 00:24:57.290
You come up with the ops, the conops for the aircraft, you pick the maneuvers,

377
00:24:57.290 --> 00:25:02.160
which are appropriate to expose anything we missed during cert. Uh,

378
00:25:02.300 --> 00:25:04.320
you expose it to these maneuvers and,

379
00:25:04.420 --> 00:25:07.600
and then come up with a standard for that using, uh,

380
00:25:07.600 --> 00:25:10.040
Cooper Harper scale or something modified from that.

381
00:25:14.140 --> 00:25:19.060
I think Marty used the term moving parts for the first time. Now we've got a,

382
00:25:19.400 --> 00:25:23.060
an aircraft where you don't have a set of rules,

383
00:25:23.600 --> 00:25:27.710
you don't have a set of means of compliance. You're developing the aircraft.

384
00:25:27.730 --> 00:25:30.870
And in fact, two of the applicants already have, uh,

385
00:25:31.010 --> 00:25:33.830

put in for their search cases and those have been published in the Federal

386
00:25:34.150 --> 00:25:38.520
Register. Yet a lot of the ways you're gonna show compliance,

387
00:25:38.640 --> 00:25:42.000
a lot of the, the things that you normally use to,

388
00:25:42.220 --> 00:25:46.280
to certify aircraft are still being developed for this new area.

389
00:25:46.790 --> 00:25:51.600
This is just a small list of the liaisons we have with other

390
00:25:51.600 --> 00:25:56.400
groups that's in this, uh, vertical Flight Society's, uh, flight test council,

391
00:25:57.080 --> 00:26:00.750
right? There's other groups out here, and especially UK and some of the others,

392
00:26:01.020 --> 00:26:04.310
they're doing a lot more work that we're don't even liaisoning with.

393
00:26:04.930 --> 00:26:06.190
So we don't know what, uh,

394
00:26:06.190 --> 00:26:09.190
some of those standards are gonna be that they're developing.

395
00:26:12.480 --> 00:26:17.100
And then if, uh, when you use the fly by wire, the,

396
00:26:17.100 --> 00:26:21.260
the IDs 33 is a great tool for, uh,

397
00:26:21.470 --> 00:26:25.820
these designs. And then the NASA designed, or, or Dr. Tisler,

398

00:26:26.280 --> 00:26:29.500
um, who finalized the, uh, conduit and cipher.

399
00:26:30.300 --> 00:26:32.940
A lot of the companies are using this to analyze their control systems,

400
00:26:33.800 --> 00:26:37.420
but the FAA is not gonna require it and probably not gonna give credit for it.

401
00:26:37.650 --> 00:26:41.140
Another thing you have to address, but within those programs,

402
00:26:41.140 --> 00:26:45.920
it addresses the limits. You like phase delay, time delay, uh, your bandwidth,

403
00:26:45.980 --> 00:26:49.720
all these kind of requirements to get good handling qualities. Uh,

404
00:26:49.980 --> 00:26:54.000
so there's another thing. It's excellent tools, but there's no standard for 'em.

405
00:26:54.000 --> 00:26:57.560
And these limits were set for military mission, not civil mission.

406
00:26:59.240 --> 00:27:00.250
Turn it back over to Marty.

407
00:27:02.360 --> 00:27:06.130
Okay, we're running outta time. So I'm gonna just keep this real short. Uh,

408
00:27:06.130 --> 00:27:09.130
there's the two others and these are, uh,

409
00:27:09.330 --> 00:27:12.250
I don't really have to lecture you guys, uh, on a lot of this.

410
00:27:12.310 --> 00:27:15.810

If you're developing a new test team, there's a lot, uh, that you have to,

411
00:27:16.430 --> 00:27:20.490
to to work on. Many of these teams are gonna be using the,

412
00:27:20.790 --> 00:27:25.290
the same guys that design the aircraft are gonna be evaluating the aircraft.

413
00:27:25.750 --> 00:27:27.970
And so you've gotta avoid those biases.

414
00:27:27.970 --> 00:27:32.050
You've gotta train that out of them through, through good telemetry operations.

415
00:27:32.910 --> 00:27:36.290
Um, I just put some ideas here in the, uh,

416
00:27:36.390 --> 00:27:41.090
orange on how we as a safety committee can help in that

417
00:27:41.110 --> 00:27:44.730
regard. You can look at this later on and you'll see what,

418
00:27:45.000 --> 00:27:46.130
what I'm talking about.

419
00:27:47.540 --> 00:27:51.850
And then the other issue is re how we're gonna properly

420
00:27:52.360 --> 00:27:56.490
integrate remote piloting and autonomous flight tests with these vehicles.

421
00:27:57.190 --> 00:27:57.410
Uh,

422
00:27:57.410 --> 00:28:02.250
the s TPA stuff that we did yesterday I thought might be a tool where you

423
00:28:02.250 --> 00:28:05.250
could examine the risks and the losses,

424
00:28:05.310 --> 00:28:08.490
the loss in productivity versus the loss of the aircraft.

425
00:28:08.940 --> 00:28:13.650
Maybe balance that and help figure out how to better blend these

426
00:28:13.750 --> 00:28:17.820
two. And I think that test team maturity is gonna be a big factor here.

427
00:28:17.920 --> 00:28:20.140
So as you train these teams,

428
00:28:20.480 --> 00:28:23.740
you're gonna want to transition to that man flight test a little bit earlier.

429
00:28:25.130 --> 00:28:27.630
And again, I put some more ideas down on,

430
00:28:27.850 --> 00:28:30.830
on what I noodling on this, what I,

431
00:28:30.880 --> 00:28:35.590
where I think piloted manned flight test can help. And, uh,

432
00:28:35.590 --> 00:28:37.270
give you an idea of, uh,

433
00:28:38.170 --> 00:28:41.200
maybe how we can address some of these challenges.

434
00:28:43.370 --> 00:28:48.110
So summarizing there's the four issues that we've talked about and big ones

435
00:28:48.750 --> 00:28:52.320
a lot of moving parts. Again, um, it's,

436
00:28:52.390 --> 00:28:55.520
it's almost a little bit negative the way we've portrayed it.

437
00:28:55.640 --> 00:28:56.880
I don't want to be that way.

438
00:28:57.030 --> 00:29:00.720
What I am seeing is a very dynamic industry,

439
00:29:01.600 --> 00:29:05.570
tons of innovation, tons of smart people doing really great things.

440
00:29:06.160 --> 00:29:08.050
This is an innovation machine.

441
00:29:09.050 --> 00:29:13.180
Many of these aircraft are probably not gonna make it in their current form,

442
00:29:13.720 --> 00:29:18.260
but we are gonna learn some things and get a much better in the aviation

443
00:29:18.540 --> 00:29:22.340
industry. So we, I'm embracing it. I hope everybody else does too.

444
00:29:23.010 --> 00:29:26.980
It's just we got a lot of work to do to make sure that that occurs,

445
00:29:26.980 --> 00:29:30.740
that that innovation occurs safely. Thanks a bunch.

446
00:29:40.500 --> 00:29:40.800
All right,

447
00:29:40.800 --> 00:29:43.910
We've got some, we got a question in the back.

448
00:29:51.990 --> 00:29:52.823
Check, check.

449

00:29:54.710 --> 00:29:56.850
Hey, nice presentation guys. Uh, thanks

450
00:29:56.850 --> 00:29:57.850
Frank. Just

451
00:29:57.870 --> 00:29:58.930
Wor wondering, you know,

452
00:29:58.930 --> 00:30:03.010
when part of the JMR program was to come up with a DS 33 F

453
00:30:04.100 --> 00:30:07.100
maneuvers and what we really tried to do is come up with, uh,

454
00:30:08.020 --> 00:30:10.420
configuration agnostic standards, right? How do you,

455
00:30:10.920 --> 00:30:15.420
how do you come up with maneuvers that say a tiltrotor could fly, ducted fan,

456
00:30:15.420 --> 00:30:19.340
helicopter could fly and really suss out some of those differences.

457
00:30:19.810 --> 00:30:24.310
And I'm wondering if you guys have seen from the authorities them trying to move

458
00:30:24.540 --> 00:30:25.830
away from the configuration,

459
00:30:25.830 --> 00:30:30.400
which I think is what's driving a lot of the certification problems. You know,

460
00:30:30.400 --> 00:30:31.560
like you said, how do you,

461
00:30:32.100 --> 00:30:36.940
how do you certify a 16 engine machine versus

462
00:30:37.120 --> 00:30:40.900
one that only has two? And we really struggled on,

463
00:30:41.710 --> 00:30:44.370
and it was a consortium that that worked, that project,

464
00:30:45.030 --> 00:30:49.610
we really struggled with how do you come up with these maneuvers that really are

465
00:30:49.810 --> 00:30:50.643
configuration agnostic?

466
00:30:50.870 --> 00:30:54.840
And I'm wondering if you guys have seen from the authorities that attempt to,

467
00:30:55.610 --> 00:30:59.640
hey, let's not set up a survey basis per airframe and type,

468
00:31:00.260 --> 00:31:04.660
but let's come up with these broader standards. And then you,

469
00:31:04.900 --> 00:31:06.500
like you said, you kind of pick and choose.

470
00:31:07.270 --> 00:31:08.000
Yeah, funny you should

471
00:31:08.000 --> 00:31:08.920
Mention. Great, great brief.

472
00:31:09.230 --> 00:31:11.160
Yeah, funny you should mention that the,

473
00:31:11.340 --> 00:31:16.240
the very maneuvers that we came up with in the JMR work, we're looking at those,

474
00:31:16.270 --> 00:31:21.040
examining those, uh, for the transition, uh, phase for,

475
00:31:21.060 --> 00:31:25.680
for these aircraft. Uh, Rick talked about those MTEs,

476
00:31:26.140 --> 00:31:29.280
the FAS version of that is called handling qualities, task elements.

477
00:31:29.280 --> 00:31:33.080
That's kind of why I got pulled into this because of my eighties 33 experience.

478
00:31:33.700 --> 00:31:37.240
And we're adapting those toward that very goal agnostic.

479
00:31:37.980 --> 00:31:42.160
Now there may be categories, uh, say a lift plus cruise or,

480
00:31:42.780 --> 00:31:46.200
or uh, uh, another vehicle, a hybrid lift, maybe a,

481
00:31:46.320 --> 00:31:50.680
a tilt rotor where you may pick and choose the hqt that apply.

482
00:31:50.980 --> 00:31:52.400
But those hqt,

483
00:31:52.740 --> 00:31:57.040
we are trying to make it as agnostic as possible. And part of that work,

484
00:31:57.590 --> 00:32:00.840
I've been enlisted with, uh, systems Technology Inc.

485
00:32:00.980 --> 00:32:05.720
To to draft up a flight test guide that talks to that very

486
00:32:05.720 --> 00:32:08.480
thing and a catalog of maneuvers for that.

487
00:32:11.410 --> 00:32:14.730
Any other questions? Couple in the back

488
00:32:16.950 --> 00:32:21.120
Test. Morning Dave Roberts, uh, unmanned flight test at Pax River. Um,

489
00:32:21.120 --> 00:32:23.680
couple comments. So certification,

490
00:32:24.600 --> 00:32:27.810
a lot of these objectives, both military and civilian platforms,

491
00:32:27.810 --> 00:32:32.010
they wanna go to totally unmanned or not even a safety pilot or maybe a safety

492
00:32:32.010 --> 00:32:34.330
pilot on the ground. So certification,

493
00:32:34.510 --> 00:32:37.530
all the stuff you're talking about in your test design is importantly I think

494
00:32:37.530 --> 00:32:39.780
about how can the system system be certified.

495
00:32:39.780 --> 00:32:42.400
So there's no aviation type personnel in the loop at all.

496
00:32:42.820 --> 00:32:43.960
That's one of the challenges.

497
00:32:44.260 --> 00:32:47.080
And then you talked about moving to the unmanned sooner.

498
00:32:47.680 --> 00:32:50.560
A lot of companies wanna start unmanned right away cuz that's their end goal.

499
00:32:51.790 --> 00:32:54.610
But to get the program going to get a lot of the data needed and the artifacts

500
00:32:54.610 --> 00:32:56.610

for certification, you've gotta be manned for a while.

501
00:32:56.710 --> 00:33:01.210
So all your challenges with, um, novel ceps and that sort of thing,

502
00:33:02.560 --> 00:33:04.940
you got this are important and you get to get through that,

503
00:33:04.940 --> 00:33:07.940
but eventually they become a non-issue once you get outta the test phase.

504
00:33:08.000 --> 00:33:09.620
So just things to think about when,

505
00:33:09.850 --> 00:33:13.580
when folks are designing their tests and doing buildup from a risk perspective.

506
00:33:16.200 --> 00:33:19.410
Amen. Yeah. Yes.

507
00:33:19.850 --> 00:33:22.330
I don't know this thing is on. Alright,

508
00:33:22.430 --> 00:33:25.850
so I don't want to first start off negative, um,

509
00:33:26.200 --> 00:33:30.170
because obviously this country is going into a big EV push. Um,

510
00:33:30.670 --> 00:33:32.650
you see it in the news every day. Um,

511
00:33:32.870 --> 00:33:37.210
and many people may or may not know a standard Tesla is significantly

512
00:33:37.720 --> 00:33:41.050
heavier than their counterparts, their, their, uh,

513
00:33:41.180 --> 00:33:42.810
combustion engine counterparts.

514
00:33:43.430 --> 00:33:47.650
And that's what's what I see driving the issues here in aviation

515
00:33:48.710 --> 00:33:52.950
is shaving off all of this weight, shaving off, you know,

516
00:33:52.950 --> 00:33:57.190
cutting or manipulating flight controls, structures,

517
00:33:57.190 --> 00:33:59.510
everything else just to get these machines in the air.

518
00:34:00.360 --> 00:34:02.500
And then we gotta consider it the life cycles.

519
00:34:02.880 --> 00:34:06.380
How long will these machines last, uh,

520
00:34:06.520 --> 00:34:10.140
in the environments? And it depends on what environments,

521
00:34:10.240 --> 00:34:14.610
the heat cold, all of it. So, uh, it's,

522
00:34:15.510 --> 00:34:20.140
and then going even further, if, if one of these machines go down,

523
00:34:21.550 --> 00:34:21.920
uh,

524
00:34:21.920 --> 00:34:26.770
it's interesting how the FA and TSB are gonna handle these investigations

525
00:34:27.140 --> 00:34:28.320
moving forward too.

526
00:34:29.120 --> 00:34:32.980
So o obviously the EV push is, uh,

527

00:34:33.120 --> 00:34:38.100
big in this country right now, but we're, we're kind of at a standstill.

528
00:34:38.140 --> 00:34:42.040
I don't know if folks have been reading the news lately. Uh,

529
00:34:42.460 --> 00:34:45.320
EVs are getting tougher to sell at this point.

530
00:34:45.800 --> 00:34:49.670
I think it's five or 15% of the country right now. Uh,

531
00:34:49.670 --> 00:34:52.750
because the STR structure infrastructure's not there.

532
00:34:53.290 --> 00:34:55.990
And then I'm looking at the aviation side.

533
00:34:56.490 --> 00:34:59.910
The infrastructure is going to be a problem in the future.

534
00:35:01.050 --> 00:35:02.750
Oh, agree. Um,

535
00:35:03.710 --> 00:35:06.120
it's interesting in that the ev the,

536
00:35:07.080 --> 00:35:10.380
the aircraft EVs are gonna be in competition with the ground,

537
00:35:11.000 --> 00:35:15.180
the ground EVs for battery and, and, and for infrastructure.

538
00:35:15.440 --> 00:35:20.260
So that really is not fully understood, I don't think.

539
00:35:20.880 --> 00:35:25.020
But what I, what I do think is important is the innovation that's occurring,

540
00:35:25.290 --> 00:35:29.500

chasing weight reduction, chasing simplified vehicle operations.

541
00:35:30.210 --> 00:35:35.200
Maybe it doesn't in the end make these vehicles happen quickly,

542
00:35:35.900 --> 00:35:37.360
but it can be translated,

543
00:35:37.730 --> 00:35:42.720
moved into the traditional platforms where we always have re wrestled with

544
00:35:42.720 --> 00:35:43.553
weight reduction.

545
00:35:44.180 --> 00:35:48.920
So maybe we're gonna gain some innovation here that can help all of us.

546
00:35:49.220 --> 00:35:52.080
And uh, that's what's really kind of exciting about this field.

547
00:35:57.460 --> 00:35:59.570
That's good. All right, thanks. Thank you.