1
00:00:00.000 --> 00:00:02.365
Alright, get everybody filtered back in here.

2
00:00:03.245 --> 00:00:07.325
Uh, I think this next topic is super exciting

3
00:00:08.415 --> 00:00:12.785
because, uh, it's one of those rare opportunities

4
00:00:13.695 --> 00:00:15.465
that the technical community

5
00:00:16.585 --> 00:00:18.805
can finally catch up to management.

6
00:00:19.695 --> 00:00:22.505
They've always lived in an augmented reality environment.

7
00:00:23.005 --> 00:00:26.785
So, uh,

8
00:00:27.785 --> 00:00:29.245
so we've got three presenters here,

9
00:00:29.745 --> 00:00:30.845
all three that I know well.

10
00:00:31.805 --> 00:00:36.245
Uh, Zach Rodder, uh, has, uh,

11
00:00:37.755 --> 00:00:40.925
he's got three degrees.

12
00:00:41.435 --> 00:00:42.965
He's been with us for five years.

13
00:00:43.465 --> 00:00:46.885
He, uh, started out in instrumentation

14

00:00:46.905 --> 00:00:48.245
and now he's the last three.

15
00:00:48.435 --> 00:00:51.765
He's been, uh, working stability and control testing.

16
00:00:52.585 --> 00:00:55.145
And, uh, he's been great.

17
00:00:55.175 --> 00:00:59.065
It's another one of those examples of, uh, when people have

18
00:00:59.845 --> 00:01:02.635
multi skill set, they, they become more valuable to us.

19
00:01:03.095 --> 00:01:06.435
Uh, interesting thing I found out.

20
00:01:06.475 --> 00:01:08.805
He once, uh, took center stage

21
00:01:08.805 --> 00:01:12.715
during the halftime at a Rose Bowl to, uh, do a magic trick.

22
00:01:12.855 --> 00:01:15.135
So if you wanna see some slide of hand later,

23
00:01:15.205 --> 00:01:17.125
just ask him for it.

24
00:01:18.035 --> 00:01:20.915
Uh, Tyler Wilhelm is

25
00:01:21.525 --> 00:01:23.175
technically one of our customers.

26
00:01:23.175 --> 00:01:24.935
He's in the design engineering side of the house,

27
00:01:25.515 --> 00:01:27.655
and, uh, he specializes in flight

28
00:01:27.655 --> 00:01:29.015
dynamics and ground handling.

29
00:01:30.085 --> 00:01:32.215
He's, uh, been with the company for 20 years

30
00:01:32.675 --> 00:01:37.305
and has worked, uh, four seven dash eight, a couple

31
00:01:37.305 --> 00:01:38.585
of variations, the eight, seven,

32
00:01:38.605 --> 00:01:40.225
and now working on the 7, 7, 7 9.

33
00:01:41.075 --> 00:01:44.525
Uh, he once stepped into the ring with a sumo wrestler.

34
00:01:44.985 --> 00:01:46.635
He didn't step out.

35
00:01:51.085 --> 00:01:53.425
And then our, our third presenter is Garrett Hoppy.

36
00:01:54.295 --> 00:01:57.185
And, uh, he's been with the Boeing Company

37
00:01:57.205 --> 00:01:59.185
as a flight test engineer now for 12 years.

38
00:01:59.725 --> 00:02:04.415
And, uh, specializes in both EOPS and stability and control.

39
00:02:05.105 --> 00:02:07.635
He's a private pilot and also an engineering unit member.

40
00:02:08.335 --> 00:02:11.915
And, uh, his, he's got

41

00:02:12.755 --> 00:02:15.225
maybe a concerning weekend hobby.

42
00:02:16.045 --> 00:02:17.425
He builds homemade bombs

43
00:02:19.605 --> 00:02:22.425
and then puts him in his backpack and goes skiing with him.

44
00:02:23.165 --> 00:02:25.425
And if you want to have an interesting conversation about a

45
00:02:25.585 --> 00:02:30.275
THA, that one I think is the high water mark for me.

46
00:02:30.295 --> 00:02:31.295
So come on up.

47
00:02:44.415 --> 00:02:46.195
Uh, thank you for that introduction, Darren.

48
00:02:46.735 --> 00:02:48.995
Uh, today, yeah, we're gonna talk a little bit about using

49
00:02:49.025 --> 00:02:50.755
augmented reality for PIO testing.

50
00:02:51.455 --> 00:02:53.515
Um, in this case it really was

51
00:02:54.285 --> 00:02:57.915
ended up being a right place at the right time kind

52
00:02:57.915 --> 00:03:01.445
of project that, uh, really has a cool opportunity to, uh,

53
00:03:01.445 --> 00:03:02.605
enhance flight test safety.

54
00:03:03.945 --> 00:03:06.005
Oh, press the red button here.

55
00:03:07.985 --> 00:03:09.245
Uh, a little bit of outline here.

56
00:03:09.265 --> 00:03:11.485
So, Garrett's gonna come up and talk about the background

57
00:03:11.485 --> 00:03:13.725
and some of what we currently do for PIO testing.

58
00:03:14.465 --> 00:03:15.885
Uh, and then I'll come back up

59
00:03:15.885 --> 00:03:17.565
and talk about, uh,

60
00:03:17.565 --> 00:03:19.285
including augmented reality and what we do.

61
00:03:19.905 --> 00:03:23.855
Uh, and then Zach will cover the results at the end there.

62
00:03:23.875 --> 00:03:24.875
And since learned,

63
00:03:30.045 --> 00:03:31.045
Hello.

64
00:03:31.535 --> 00:03:33.595
So prior to discussing the feasibility

65
00:03:33.895 --> 00:03:36.555
and flight test safety benefits of using augmented reality

66
00:03:36.555 --> 00:03:39.935
for PO testing, I'm gonna first define what PIO is

67
00:03:40.555 --> 00:03:42.215
or we traditionally do for PO testing

68

00:03:42.595 --> 00:03:43.895
and the risks involved in that.

69
00:03:44.905 --> 00:03:47.525
So before we get started, how many people, by a show

70
00:03:47.525 --> 00:03:49.205
of hands in this room, have been part

71
00:03:49.205 --> 00:03:50.805
of a PIO flight test campaign?

72
00:03:52.395 --> 00:03:54.075
Okay, maybe about half.

73
00:03:54.815 --> 00:03:55.995
So for some of you, some

74
00:03:55.995 --> 00:03:57.795
of what's in these first slides will be a little bit

75
00:03:57.795 --> 00:03:59.635
of review, but there's some pretty cool videos.

76
00:03:59.975 --> 00:04:03.185
So hopefully that's, um, so

77
00:04:03.185 --> 00:04:06.775
what is P-I-O-A-P-I-O event, uh, is a sustained

78
00:04:06.775 --> 00:04:09.655
or uncontrollable oscillation resulting from the efforts

79
00:04:09.675 --> 00:04:12.175
of the pilot to precisely control the aircraft

80
00:04:13.195 --> 00:04:16.495
and the way we define PIO, um, is that for an event

81
00:04:16.495 --> 00:04:19.075
to be considered a PIO event, uh,

82
00:04:19.075 --> 00:04:20.315
these four things must be true.

83
00:04:20.985 --> 00:04:24.725
Um, the pilot must be actively attempting precise control,

84
00:04:24.885 --> 00:04:26.615
the aircraft, um,

85
00:04:26.715 --> 00:04:29.615
the pilot's inputs must be substantially out of phase

86
00:04:29.845 --> 00:04:31.215
with the airplane's response.

87
00:04:32.305 --> 00:04:34.485
Uh, it needs to be sustained for more than just one cycle

88
00:04:35.025 --> 00:04:36.765
and being an amplitude to matter.

89
00:04:37.845 --> 00:04:40.065
So, uh, the first video example I have is

90
00:04:40.065 --> 00:04:42.185
of an F 22 crash in 1992.

91
00:04:43.405 --> 00:04:45.305
Um, this, the Edwards Air Force base

92
00:04:45.425 --> 00:04:48.005
during developmental testing, uh, during a go

93
00:04:48.005 --> 00:04:49.365
around the pilot commands, uh,

94
00:04:49.435 --> 00:04:51.455
full nose down on the stick while

95

00:04:51.455 --> 00:04:53.335
simultaneously retracting the landing gear.

96
00:04:53.975 --> 00:04:55.915
And what the pilot didn't know at the time was the

97
00:04:56.035 --> 00:04:58.195
retraction of landing gear caused a control law change,

98
00:04:58.725 --> 00:05:00.755
which significantly increased the

99
00:05:00.755 --> 00:05:02.155
commanded pitch rate the aircraft.

100
00:05:03.425 --> 00:05:06.855
And that change in pitch gradient was unexpected.

101
00:05:07.315 --> 00:05:09.015
And as the pilot attempted to regain control

102
00:05:09.015 --> 00:05:10.735
of the aircraft, the stabilizer

103
00:05:10.735 --> 00:05:12.735
and thrust vectoring became rate saturated

104
00:05:13.035 --> 00:05:15.815
and lagged behind his inputs by about 180 degrees.

105
00:05:19.005 --> 00:05:21.885
I'd like to fast forward to about a minute

106
00:05:21.945 --> 00:05:25.425
and close enough it

107
00:05:32.365 --> 00:05:33.165
happens to hear

108
00:05:37.925 --> 00:05:41.375
the landing gear come up and the pilot's off to the races

109
00:05:41.375 --> 00:05:45.895
and pitch, eventually

110
00:05:50.455 --> 00:05:51.325
pilot survives.

111
00:05:54.925 --> 00:05:59.585
So this is a kind of classic example of PIO in that, um,

112
00:06:00.705 --> 00:06:03.085
you're trying to pull up as the airplane's going down

113
00:06:05.075 --> 00:06:07.075
'cause you're out of phase with the airplane, you're just

114
00:06:08.245 --> 00:06:11.285
opposites and, um, increasing amplitude.

115
00:06:17.825 --> 00:06:19.225
I might need help going to the next slide.

116
00:06:24.675 --> 00:06:26.645
Okay. Uh, I've got two more examples

117
00:06:27.105 --> 00:06:28.165
and they're related to each other.

118
00:06:29.585 --> 00:06:33.405
Uh, so, uh, the first is of the space shuttle enterprise.

119
00:06:33.825 --> 00:06:35.205
Uh, in 1977,

120
00:06:35.675 --> 00:06:38.285
they were also at Edwards Air Force Base doing developmental

121
00:06:38.285 --> 00:06:40.665
testing and, um,

122

00:06:41.585 --> 00:06:43.355
experienced a PIO on landing

123
00:06:44.055 --> 00:06:47.875
and later discovered the reason for this PIO, uh, was analog

124
00:06:47.935 --> 00:06:50.735
to digital to analog conversion

125
00:06:50.815 --> 00:06:53.335
and the control laws that resulted in a 200

126
00:06:53.435 --> 00:06:55.715
to 300 millisecond delay

127
00:06:57.605 --> 00:06:59.825
and, uh, related video.

128
00:07:00.925 --> 00:07:05.805
Um, NASA FHC digital fly by wire program, uh,

129
00:07:05.805 --> 00:07:08.965
experimented with delays of 20 to 200 milliseconds

130
00:07:09.105 --> 00:07:13.515
and their effect on handling qualities, PIO.

131
00:07:13.615 --> 00:07:17.235
And, uh, this data was used to create a PIO filter to

132
00:07:17.865 --> 00:07:19.755
prove the spatial qualities.

133
00:07:28.575 --> 00:07:31.615
Spatials coming in is, isn't as spectacular as the last one,

134
00:07:33.145 --> 00:07:35.485
but they do still bounce and kind of pour this a bit

135
00:07:35.505 --> 00:07:39.855
and tell they're struggling to precisely t pitch

136
00:07:48.185 --> 00:07:48.475
next.

137
00:07:49.015 --> 00:07:52.075
Uh, the exciting part of this also happens on the go

138
00:07:52.075 --> 00:07:55.365
where they're experimenting with a 200 millisecond delay.

139
00:07:56.385 --> 00:07:57.295
It'll come in a moment,

140
00:08:04.825 --> 00:08:06.605
so as the pilot tries to climb out

141
00:08:10.195 --> 00:08:12.435
undesirable handling qualities at least.

142
00:08:16.055 --> 00:08:20.875
Um, so this effect of lag on handling qualities

143
00:08:20.975 --> 00:08:23.755
and PIO in particular is relevant

144
00:08:23.755 --> 00:08:25.835
to our augmented reality system that we tested.

145
00:08:25.975 --> 00:08:28.195
And so, um, save that thought

146
00:08:28.195 --> 00:08:29.475
and we'll come back to it in a little bit.

147
00:08:32.385 --> 00:08:34.445
So how do we test for PIO

148
00:08:34.445 --> 00:08:35.885
and what are the risks involved in that?

149

00:08:36.705 --> 00:08:40.125
Um, from the previous videos, PO is obviously a bad thing.

150
00:08:40.995 --> 00:08:43.935
Um, and the intent of our PIO testing is

151
00:08:43.955 --> 00:08:45.215
to reduce the likelihood

152
00:08:45.475 --> 00:08:47.575
of exposing our customers to that hazard.

153
00:08:49.035 --> 00:08:51.935
And so, one acceptable way of, um,

154
00:08:52.405 --> 00:08:57.365
executing a PIO test program is described in AC 25 7 D.

155
00:08:58.095 --> 00:09:01.015
Um, uh, among other things

156
00:09:01.595 --> 00:09:05.015
the AC calls out offset landings as well as capture tasks

157
00:09:05.195 --> 00:09:06.905
and potentially formation flying tasks.

158
00:09:08.025 --> 00:09:11.245
And, uh, that's in support of 25 1 43,

159
00:09:11.695 --> 00:09:13.925
which says the airplane must be safely controllable

160
00:09:13.925 --> 00:09:16.325
and maneuverable, uh, during all phases of flight.

161
00:09:19.595 --> 00:09:21.605
Okay, so pause real quick here.

162
00:09:21.605 --> 00:09:23.925
These are the videos that, uh, I can only share in this room

163
00:09:23.985 --> 00:09:25.005
and they can't be recorded.

164
00:09:26.005 --> 00:09:27.845
So cool. Okay.

165
00:09:31.115 --> 00:09:35.495
So in order to test for PIO, um, we start,

166
00:09:36.145 --> 00:09:39.765
you know, up at altitude doing captures, uh,

167
00:09:39.765 --> 00:09:42.905
and pitch roll, that sort of thing.

168
00:09:43.525 --> 00:09:46.905
And then we progressively get closer to the runway to get

169
00:09:46.905 --> 00:09:48.265
to our offset landing task.

170
00:09:49.345 --> 00:09:54.105
And that's a risk mitigation, uh, for us to, to execute some

171
00:09:54.105 --> 00:09:56.265
of these near ground highly dynamic maneuvers.

172
00:09:56.565 --> 00:09:58.115
So this first one, uh,

173
00:09:58.115 --> 00:09:59.835
I don't have videos of the up and away testing.

174
00:09:59.855 --> 00:10:00.915
So we didn't have a chase plane,

175
00:10:00.935 --> 00:10:02.995
so we're gonna start out near the ground.

176

00:10:03.325 --> 00:10:05.515
We're isolating our axes.

177
00:10:05.975 --> 00:10:08.685
Um, so our lateral longitudinal axis

178
00:10:08.685 --> 00:10:10.525
before going to a full on offset landing.

179
00:10:13.615 --> 00:10:15.795
So our pilot is capturing center line

180
00:10:16.435 --> 00:10:20.715
and edge line in this, uh,

181
00:10:20.745 --> 00:10:23.565
test maneuver, low altitude precision maneuvers,

182
00:10:23.565 --> 00:10:27.825
lateral captures, and we use the, um,

183
00:10:29.175 --> 00:10:30.345
proximity to the runway

184
00:10:30.525 --> 00:10:34.565
and the, the very defined tracking task

185
00:10:34.905 --> 00:10:36.165
of the runway edge lines

186
00:10:36.165 --> 00:10:38.205
and center lines to drive up pilot gains.

187
00:10:38.575 --> 00:10:39.575
'cause if you just do a lot

188
00:10:39.575 --> 00:10:42.125
of this testing up at altitude without something

189
00:10:42.125 --> 00:10:43.565
to really precisely track,

190
00:10:44.545 --> 00:10:46.035
your pilots aren't gonna be high gain

191
00:10:46.035 --> 00:10:50.535
and it won't be a really representative PIO test.

192
00:10:54.565 --> 00:10:56.465
The next or longitudinal axis

193
00:10:59.175 --> 00:11:01.245
we're capturing altitudes between

194
00:11:01.995 --> 00:11:04.115
102 hundred feet in this video.

195
00:11:13.685 --> 00:11:16.305
And, you know, in this case, the ground rush of that,

196
00:11:16.325 --> 00:11:19.545
you know, full nose down input really drives up the pilot

197
00:11:19.735 --> 00:11:22.515
game because obviously you don't wanna hit the runway.

198
00:11:25.365 --> 00:11:27.745
And now I know a lot of the fighter pilots in the room are

199
00:11:27.745 --> 00:11:29.305
kind of saying like, ho hum.

200
00:11:30.065 --> 00:11:31.925
But for us in the commercial world,

201
00:11:31.995 --> 00:11:33.085
like that's pretty dynamic.

202
00:11:36.045 --> 00:11:37.505
And here's our offset landing task.

203

00:11:37.645 --> 00:11:41.485
So it simulates that could come out of IMC conditions

204
00:11:41.485 --> 00:11:42.925
that maybe 400 feet above the ground

205
00:11:43.465 --> 00:11:46.205
and you find your offset from the runway

206
00:11:46.585 --> 00:11:50.845
and you need to make a very rapid adjustment, um, instead

207
00:11:50.845 --> 00:11:53.975
of going around, which might be the more prudent, um,

208
00:11:53.995 --> 00:11:55.015
option in that scenario.

209
00:11:59.575 --> 00:12:02.525
So this maneuver, you know, they're offset.

210
00:12:02.525 --> 00:12:05.165
We also have a desired landing box in the bottom left here

211
00:12:05.385 --> 00:12:06.605
and an adequate landing box,

212
00:12:06.605 --> 00:12:08.575
which is the slightly larger one.

213
00:12:08.575 --> 00:12:10.735
We use that to drive, uh, rating scales.

214
00:12:16.365 --> 00:12:20.525
So due to the full control inputs, that's,

215
00:12:20.525 --> 00:12:21.845
that's a full wheel input right there.

216
00:12:22.665 --> 00:12:25.865
Um, and often full column inputs, uh,

217
00:12:25.865 --> 00:12:29.805
this testing is pretty high risk, um, with a risk

218
00:12:29.805 --> 00:12:31.925
of unintentional ground contact or

219
00:12:32.325 --> 00:12:33.935
otherwise called crashing.

220
00:12:36.025 --> 00:12:40.575
Um, and we even have, uh, uh, knock it off criteria

221
00:12:40.795 --> 00:12:44.545
to address wing tip ground contact related

222
00:12:44.565 --> 00:12:46.705
to our bank angle and altitude.

223
00:12:48.975 --> 00:12:50.195
So that's really all just to say

224
00:12:50.195 --> 00:12:54.395
that the traditional PAO testing that we do is high risk,

225
00:12:55.185 --> 00:12:57.405
um, due to its proximity to ground

226
00:12:57.465 --> 00:12:58.645
and, and how dynamic it's,

227
00:13:04.845 --> 00:13:05.845
Thank you Garrett. And then,

228
00:13:05.845 --> 00:13:08.515
so we'll talk a little bit more about this

229
00:13:08.515 --> 00:13:09.595
project specifically.

230

00:13:10.215 --> 00:13:13.925
So, um, a little bit of background of myself.

231
00:13:14.125 --> 00:13:16.885
I have, uh, fairly significant, uh, history

232
00:13:16.885 --> 00:13:18.805
of being on the airplane for our PIO testing.

233
00:13:19.565 --> 00:13:22.185
Uh, I've done it through 4, 7, 8, 7, all these things.

234
00:13:22.205 --> 00:13:24.505
But coming out of the 8, 7, 10, like Garrett mentioned,

235
00:13:24.505 --> 00:13:28.065
sometimes our PIO testing especially up in a way, isn't all

236
00:13:28.065 --> 00:13:31.105
that efficient because we have really, really good pilots

237
00:13:31.125 --> 00:13:34.025
who adapt very quickly to any deficient find.

238
00:13:34.955 --> 00:13:37.095
And that's not quite what we want when we're doing these.

239
00:13:37.635 --> 00:13:39.015
So I, I had that in mind.

240
00:13:39.135 --> 00:13:40.575
I was looking already for ways

241
00:13:40.675 --> 00:13:42.905
of doing better and more efficient testing.

242
00:13:43.725 --> 00:13:44.785
And also a little jealous

243
00:13:44.785 --> 00:13:46.105
because from the nineties,

244
00:13:46.565 --> 00:13:48.385
Boeing would take up two airplanes

245
00:13:48.385 --> 00:13:50.105
and do formation flying up

246
00:13:50.105 --> 00:13:52.705
and away as part of the PAO test suite.

247
00:13:52.965 --> 00:13:54.465
And there's some really cool pictures.

248
00:13:54.885 --> 00:13:58.145
And then we stopped doing that for safety and cost concerns

249
00:13:58.165 --> 00:14:01.235
and I missed out and I kinda always wanted that.

250
00:14:01.925 --> 00:14:04.425
Uh, so just to level set a little bit here though,

251
00:14:04.625 --> 00:14:05.825
bringing in augmented reality.

252
00:14:06.125 --> 00:14:08.825
So there's a lot of different, different definitions

253
00:14:08.885 --> 00:14:11.265
for augmented mixed virtual reality.

254
00:14:11.875 --> 00:14:13.775
The one we are relying on here, really,

255
00:14:13.795 --> 00:14:15.775
it provides virtual inputs

256
00:14:15.795 --> 00:14:19.455
to the human without removing necessarily other inputs.

257

00:14:19.975 --> 00:14:23.385
Uh, so you're mixing fake things in the real thing.

258
00:14:23.975 --> 00:14:26.115
Uh, it alters your perception in the real world environment

259
00:14:26.115 --> 00:14:27.475
and it gives you that opportunity

260
00:14:27.495 --> 00:14:30.995
to maybe do high risk things without actually being in a

261
00:14:30.995 --> 00:14:33.355
high risk situation like PIO testing.

262
00:14:34.545 --> 00:14:38.525
Uh, so this all really started, I had that mindset already

263
00:14:38.545 --> 00:14:41.645
of looking for more and better ways of doing PIO testing.

264
00:14:41.885 --> 00:14:43.845
I was talking to our tech fellows and things about that.

265
00:14:44.425 --> 00:14:47.395
And it just so happened that you probably, a lot

266
00:14:47.395 --> 00:14:49.875
of people in this room might know Dave Clyde from STI.

267
00:14:50.135 --> 00:14:51.255
Uh, Dave came up

268
00:14:51.595 --> 00:14:55.215
and gave us a presentation pitching a lot

269
00:14:55.215 --> 00:14:57.495
of the capabilities that they had, one

270
00:14:57.495 --> 00:14:59.535
of them being the system called Fused Reality.

271
00:15:00.095 --> 00:15:03.395
Uh, they started it as a helicopter air crew gun trainer.

272
00:15:03.455 --> 00:15:06.075
And that moved into a CCB 22 cabin trainer.

273
00:15:06.075 --> 00:15:09.035
And then they started taking it into inflight use.

274
00:15:09.995 --> 00:15:12.655
Uh, and what really happened, I saw this presentation,

275
00:15:12.815 --> 00:15:14.655
I went, holy cow, that's really cool.

276
00:15:14.715 --> 00:15:16.575
We could do the formation flying that I've always kind

277
00:15:16.575 --> 00:15:17.895
of wanted to do just virtually.

278
00:15:18.335 --> 00:15:20.015
I said to one of our tech Foss, I'm like, Hey,

279
00:15:20.555 --> 00:15:22.655
we should really talk to SDI and do this.

280
00:15:22.655 --> 00:15:23.655
And he goes, yes, you should.

281
00:15:24.195 --> 00:15:26.455
So that's how this project came together.

282
00:15:27.115 --> 00:15:28.175
Uh, in 2019,

283
00:15:28.315 --> 00:15:31.015
we agreed on doing this on a future eco demonstrator,

284

00:15:31.115 --> 00:15:33.735
but then the world changed and kind of delayed us.

285
00:15:33.875 --> 00:15:36.475
But you can see an example here, you know,

286
00:15:36.495 --> 00:15:37.635
the real world environment,

287
00:15:37.635 --> 00:15:39.995
what's the camera's seeing out in front of the pilot

288
00:15:40.535 --> 00:15:41.555
as the top image.

289
00:15:41.955 --> 00:15:43.895
But what the pilot's actually seeing in their headset

290
00:15:44.675 --> 00:15:45.775
is the bottom image.

291
00:15:47.755 --> 00:15:52.395
So this system came on board. Uh, it's very modular.

292
00:15:52.575 --> 00:15:54.995
Uh, we put it on the 7 7 7 eco demonstrator.

293
00:15:55.535 --> 00:15:57.795
Uh, it really only consists of a few components.

294
00:15:58.335 --> 00:16:01.515
Uh, and we put everything really in a modified galley cart.

295
00:16:01.545 --> 00:16:03.595
Made it really easy. Roll it on, put it in,

296
00:16:03.595 --> 00:16:05.355
plug everything together, and let's go.

297
00:16:07.935 --> 00:16:09.595
Uh, so quick overview.

298
00:16:09.975 --> 00:16:12.595
Uh, we were able to test fuse reality on the

299
00:16:12.595 --> 00:16:14.435
7 7 7 200 ERE code demonstrator.

300
00:16:14.775 --> 00:16:16.915
Uh, last December we had two flights.

301
00:16:16.975 --> 00:16:18.875
We got four test pilots through,

302
00:16:19.575 --> 00:16:21.955
across the three virtual scenes that you can see here.

303
00:16:21.955 --> 00:16:24.355
We had an air-to-air formation flying scene.

304
00:16:24.915 --> 00:16:28.175
Uh, we had an airfield scene that had a finite runway on it.

305
00:16:28.635 --> 00:16:31.055
Uh, and then we had an infinite runway scene

306
00:16:31.055 --> 00:16:33.215
that we could use for those kind of lateral

307
00:16:33.215 --> 00:16:34.375
and vertical capture tasks.

308
00:16:35.205 --> 00:16:36.665
Uh, we had the four maneuver types

309
00:16:36.665 --> 00:16:39.265
and we ended up getting 22 conditions done.

310
00:16:40.455 --> 00:16:42.935
Uh, we focused on a couple

311

00:16:42.955 --> 00:16:44.735
of key conditions from the suite of testing.

312
00:16:44.865 --> 00:16:46.695
First one being pitch attitude captures.

313
00:16:47.475 --> 00:16:51.655
Uh, these really evaluate for pitch PIO, uh,

314
00:16:51.835 --> 00:16:53.735
and using high gain inputs and,

315
00:16:53.735 --> 00:16:54.975
and driving the pilot to those.

316
00:16:55.435 --> 00:16:58.775
Uh, you can see an example of the, um, plot above.

317
00:16:59.495 --> 00:17:04.245
Um, and you know, so we, the test team, me in this case,

318
00:17:04.245 --> 00:17:07.045
driving from the back would call out specific pitch

319
00:17:07.325 --> 00:17:08.965
attitudes and the pilot would pitch to those.

320
00:17:09.025 --> 00:17:11.885
And capture gives you both the gross acquisition

321
00:17:11.885 --> 00:17:13.525
and the target tracking task.

322
00:17:14.225 --> 00:17:18.005
Uh, these were excellent for comparison between

323
00:17:19.025 --> 00:17:22.765
the Ryer plane, no AR system and the AR system.

324
00:17:22.935 --> 00:17:24.445
Doing back to back comparisons.

325
00:17:24.865 --> 00:17:26.325
You can see examples here,

326
00:17:26.385 --> 00:17:28.245
the pilot pitching, there's a zero target.

327
00:17:30.755 --> 00:17:33.955
I pitch back up five.

328
00:17:35.995 --> 00:17:40.735
Okay, uh, formation flying. We finally got to do this.

329
00:17:40.735 --> 00:17:44.255
This is really cool. Um, so you can evaluate

330
00:17:44.255 --> 00:17:45.615
for both pitch general PAO.

331
00:17:45.615 --> 00:17:48.135
You, you're working hard doing the the tanker task

332
00:17:48.155 --> 00:17:49.405
or formation task task.

333
00:17:50.195 --> 00:17:55.095
Uh, the task here was to visually align one of these, uh,

334
00:17:55.655 --> 00:17:57.935
trailing matrix of green balls.

335
00:17:57.935 --> 00:17:59.135
I don't know if you can quite see it there,

336
00:17:59.155 --> 00:18:02.385
but it's right around engine three on the lead airplane.

337
00:18:02.845 --> 00:18:05.225
So pilot's tracking and visually trying to align that.

338

00:18:05.285 --> 00:18:07.585
And then we turn off that ball once they've completed it,

339
00:18:07.615 --> 00:18:08.705
turn on a different one.

340
00:18:08.805 --> 00:18:12.325
Now the task is to move that green ball up to visually

341
00:18:12.465 --> 00:18:14.125
to on the tailpipe of engine two.

342
00:18:14.895 --> 00:18:17.795
Uh, the impact that augmented reality brought is it

343
00:18:17.795 --> 00:18:18.915
allows it to be completed.

344
00:18:19.085 --> 00:18:20.515
Again, I kind of went over that already,

345
00:18:20.695 --> 00:18:24.875
but, um, we haven't done these in 20 plus years, uh,

346
00:18:24.875 --> 00:18:25.875
but we can do 'em virtually

347
00:18:25.875 --> 00:18:30.385
now, jumping runway.

348
00:18:30.605 --> 00:18:32.385
So the, the video that Garrett showed,

349
00:18:32.445 --> 00:18:35.225
we have a fixed runway and then we maneuver

350
00:18:35.245 --> 00:18:37.705
and capture over the center line or edge lines.

351
00:18:38.245 --> 00:18:40.865
Uh, in this case, I can make the runway move.

352
00:18:41.365 --> 00:18:44.635
So, uh, we have that opportunity to where, all right,

353
00:18:44.635 --> 00:18:46.115
the task is captured over center line,

354
00:18:46.115 --> 00:18:47.235
but now the runway moves.

355
00:18:47.525 --> 00:18:50.185
So now maintaining your altitude slide over

356
00:18:50.185 --> 00:18:52.535
and recapture the runway as well.

357
00:18:54.015 --> 00:18:57.425
This, we're able to take away that being near the ground,

358
00:18:57.485 --> 00:18:59.365
the actual risk part.

359
00:18:59.705 --> 00:19:02.325
So we conducted these conditions up at 15,000 feet,

360
00:19:02.665 --> 00:19:05.605
but in right now, the pilot's at 50 feet,

361
00:19:05.655 --> 00:19:08.325
55 feet over the runway, the runway.

362
00:19:09.015 --> 00:19:10.795
Um, and they were really feeling it.

363
00:19:10.795 --> 00:19:13.955
We got really great, uh, feedback on the immersiveness

364
00:19:14.015 --> 00:19:16.115
of the system and it really felt like you

365

00:19:16.115 --> 00:19:17.235
were down there right over the runway.

366
00:19:18.145 --> 00:19:19.405
We also can do an infinite runway.

367
00:19:19.465 --> 00:19:21.965
It gives us the opportunity to do the testing in one pass

368
00:19:21.965 --> 00:19:24.365
instead of multiple passes, real runway.

369
00:19:24.585 --> 00:19:26.955
And then we can do our offset landing.

370
00:19:27.025 --> 00:19:29.575
Same way, um, similar purpose.

371
00:19:30.195 --> 00:19:32.455
Uh, we can begin five miles out.

372
00:19:32.975 --> 00:19:35.035
You need to send to 400 virtual feet

373
00:19:35.055 --> 00:19:38.895
and then correct gives us the opportunity to do all of

374
00:19:38.895 --> 00:19:40.295
that again up and away,

375
00:19:40.565 --> 00:19:43.455
away in our own airspace away from other airplanes.

376
00:19:43.965 --> 00:19:46.865
And it increases the efficiency to where as soon

377
00:19:46.865 --> 00:19:49.545
as we're done talking about this one hit a couple of buttons

378
00:19:49.545 --> 00:19:50.905
and there's a new runway five miles

379
00:19:50.925 --> 00:19:51.945
out, let's go do it again.

380
00:19:53.295 --> 00:19:54.725
Don't have to deal with anybody else.

381
00:19:54.785 --> 00:19:57.805
And we can even project the landing box right on the runway.

382
00:20:00.135 --> 00:20:01.715
So Zach's gonna talk a little bit about

383
00:20:02.255 --> 00:20:04.395
how we made sure we did this safely since

384
00:20:04.395 --> 00:20:05.475
it was totally new to us.

385
00:20:05.855 --> 00:20:06.855
So

386
00:20:10.375 --> 00:20:11.735
You've seen what we've tested for,

387
00:20:11.915 --> 00:20:13.095
uh, but how did we do it safely?

388
00:20:13.635 --> 00:20:15.815
Uh, prior to testing, uh, we did a lot

389
00:20:15.815 --> 00:20:16.855
of time in the simulator.

390
00:20:16.915 --> 00:20:20.255
We required that two of the pilots in any given sort, uh,

391
00:20:20.675 --> 00:20:23.375
to have practiced representative conditions in the cab prior

392

00:20:23.375 --> 00:20:24.765
to flying these conditions.

393
00:20:25.165 --> 00:20:26.865
And at least one of those pilots

394
00:20:26.885 --> 00:20:30.535
or one of those pilots that have practiced, um, act

395
00:20:30.535 --> 00:20:32.635
as a safety pilot and all that.

396
00:20:32.635 --> 00:20:36.085
The next slide, um, outta these sessions, a lot

397
00:20:36.085 --> 00:20:40.275
of positive pilot feedback was received, um, such as,

398
00:20:40.895 --> 00:20:42.895
uh, avoiding certain types of glasses,

399
00:20:44.135 --> 00:20:46.365
could have negative interactions with the augmented reality

400
00:20:46.385 --> 00:20:49.735
and the idea for a screen repeater in the flight deck so

401
00:20:49.735 --> 00:20:52.015
that that safety pilot can have situational awareness

402
00:20:52.855 --> 00:20:54.225
what the pilot under test is seeing.

403
00:20:55.275 --> 00:20:59.625
Uh, outside of the cab, we tested the, our hardware for EMI,

404
00:20:59.625 --> 00:21:01.425
so it didn't interfere with any airplane systems.

405
00:21:02.395 --> 00:21:04.415
Um, and there was a significant lag reduction effort.

406
00:21:04.835 --> 00:21:08.425
Um, we knew that getting the lag is low as we could,

407
00:21:08.815 --> 00:21:11.625
it's gonna impact on the success of this project.

408
00:21:12.295 --> 00:21:14.235
Um, so we went through many iterations with

409
00:21:15.565 --> 00:21:17.525
STI on the F reality side,

410
00:21:17.525 --> 00:21:18.565
and we were able to reduce some

411
00:21:18.565 --> 00:21:20.645
of the lag from our data system side.

412
00:21:24.395 --> 00:21:27.535
Um, during the test, we limited ourselves in normal load

413
00:21:27.535 --> 00:21:28.655
factor, pitch and speed.

414
00:21:28.795 --> 00:21:30.535
Uh, those are in the table from the top right

415
00:21:30.635 --> 00:21:32.215
for both flaps up and flaps down.

416
00:21:33.175 --> 00:21:35.905
Um, these conditions were flowing

417
00:21:35.905 --> 00:21:39.665
that altitudes higher than the typical high risk low

418
00:21:39.865 --> 00:21:43.735
altitude PIO maneuvers essentially removed equations.

419

00:21:44.865 --> 00:21:48.885
Um, we imposed weather requirements, no turbulence day VMC,

420
00:21:49.025 --> 00:21:52.915
uh, fairly typical s and c maneuver requirements.

421
00:21:53.635 --> 00:21:55.695
Um, but unique to this, uh,

422
00:21:55.695 --> 00:21:57.645
that safety pilot I mentioned there was

423
00:21:57.645 --> 00:21:58.685
three pilots on a given story.

424
00:21:58.955 --> 00:22:00.775
One of those pilots never dawned the headset,

425
00:22:01.435 --> 00:22:05.465
and that was to avoid any negative physiological impacts

426
00:22:05.465 --> 00:22:09.775
of wearing a headset, any air sickness.

427
00:22:10.715 --> 00:22:12.815
And we sequenced our conditions conservatively.

428
00:22:13.165 --> 00:22:17.175
Um, we pilots flew, uh, conditions

429
00:22:17.175 --> 00:22:20.135
with the PFD prior to ever donning the air headset.

430
00:22:21.125 --> 00:22:24.485
Um, and then when they done the AR headset, we did, uh,

431
00:22:24.785 --> 00:22:26.205
the higher dynamic flaps,

432
00:22:26.205 --> 00:22:28.045
down maneuvers prior to flaps up maneuvers.

433
00:22:28.985 --> 00:22:30.585
And we had regularly scheduled breaks

434
00:22:30.645 --> 00:22:33.025
to avoid fatigue and air sickness for the whole.

435
00:22:36.685 --> 00:22:37.765
Um, so what did we get outta this?

436
00:22:38.225 --> 00:22:40.375
Um, the primary goal was improve safety.

437
00:22:40.475 --> 00:22:41.375
And we essentially did that

438
00:22:41.375 --> 00:22:42.655
by removing the ground from the equation.

439
00:22:43.115 --> 00:22:46.505
Um, uh, aside from that,

440
00:22:47.125 --> 00:22:49.785
we show the potential for improved test efficiency.

441
00:22:50.295 --> 00:22:54.315
Um, typical low altitude PIO maneuvers require runway,

442
00:22:55.305 --> 00:22:58.265
uh, and that runway requires a lot of coordination,

443
00:22:59.035 --> 00:23:01.285
less coordination with airports a TC traffic.

444
00:23:02.065 --> 00:23:04.245
Um, and also you have less dependence on weather.

445
00:23:04.305 --> 00:23:06.645
If you have a plan to go out to a particular airport

446

00:23:06.745 --> 00:23:09.875
and you get blown out, uh, factor,

447
00:23:09.975 --> 00:23:12.175
you can just go find some clean air with Woody around you.

448
00:23:14.215 --> 00:23:16.435
Um, and all those conditions can be performed at just

449
00:23:16.435 --> 00:23:18.235
that same airspace once you're there.

450
00:23:19.255 --> 00:23:21.095
Um, another side effect

451
00:23:21.155 --> 00:23:24.015
of this improved test efficiency is the ecological impact

452
00:23:24.015 --> 00:23:25.485
of decreased fuel burn.

453
00:23:28.785 --> 00:23:30.905
Um, so lessons learned, uh, the system showed potential.

454
00:23:31.405 --> 00:23:33.905
Um, are we gonna use augmented reality

455
00:23:34.005 --> 00:23:35.945
for all future Boeing PIO testing?

456
00:23:36.845 --> 00:23:38.425
No, not with this iteration.

457
00:23:38.845 --> 00:23:41.935
Um, but it could be a potential in the future.

458
00:23:43.195 --> 00:23:47.805
Um, the physical impacts of this particular headset, um,

459
00:23:49.125 --> 00:23:51.455
could be alleviated with a helmet.

460
00:23:52.165 --> 00:23:55.425
Uh, it was quite bulky, uh, quite fatiguing for pilots

461
00:23:55.445 --> 00:23:57.065
and particularly those who wore glasses.

462
00:23:59.075 --> 00:24:03.245
Um, the largest obstacle yet to overcome

463
00:24:03.245 --> 00:24:05.245
with this particular system was the lag.

464
00:24:05.545 --> 00:24:09.635
Um, can imagine it's hard for pilots to distinguish

465
00:24:10.175 --> 00:24:13.115
the lag in the system with the fued reality combined.

466
00:24:13.945 --> 00:24:16.015
Separate that from the lag in the airplane, um,

467
00:24:16.015 --> 00:24:18.415
which is really what we're asking them to, to evaluate.

468
00:24:19.955 --> 00:24:23.295
Um, but aside from that, pilots uh, agreed

469
00:24:23.295 --> 00:24:24.875
that it's compelling.

470
00:24:25.055 --> 00:24:26.435
Um, and it has, it has potential.

471
00:24:29.535 --> 00:24:32.465
That is our project. I'll open the floor with any questions.

472
00:24:41.635 --> 00:24:43.375
Hey, Really interesting. Thanks for this.

473

00:24:43.555 --> 00:24:46.855
Uh, how do you re there's, you know, there's some potential

474
00:24:46.915 --> 00:24:49.935
for, uh, the visual system to have delays, uh,

475
00:24:49.935 --> 00:24:53.695
for the visual system to be different in terms of, uh,

476
00:24:53.915 --> 00:24:56.055
say a depth perception, you know, near a runway,

477
00:24:56.155 --> 00:24:58.615
you don't really have it, I don't think on goggles.

478
00:24:58.755 --> 00:25:01.735
Uh, how do you remove that from the results?

479
00:25:05.225 --> 00:25:07.205
Um, really good question.

480
00:25:07.785 --> 00:25:09.765
And I'm not sure we a hundred percent know the answer.

481
00:25:09.865 --> 00:25:13.545
We, we worked really hard on, uh,

482
00:25:13.865 --> 00:25:15.145
a lot of that, some of that.

483
00:25:15.375 --> 00:25:18.905
Once we locked in a, a headset to use for this experiment,

484
00:25:18.905 --> 00:25:21.465
we were kind of stuck and we've identified some areas

485
00:25:21.465 --> 00:25:24.185
that we need to figure out an improvement

486
00:25:24.185 --> 00:25:25.865
or get a different product for the next time.

487
00:25:26.225 --> 00:25:28.165
'cause those are some clear concerns.

488
00:25:30.245 --> 00:25:32.825
So yeah, that's, that's one area that, uh,

489
00:25:32.885 --> 00:25:33.945
can be very difficult.

490
00:25:34.005 --> 00:25:36.465
But overall, uh, the headset that we did have,

491
00:25:36.845 --> 00:25:39.585
it created some really good depth perception the way they

492
00:25:39.855 --> 00:25:42.585
layered, they had like a two layer display, uh,

493
00:25:42.615 --> 00:25:43.795
in there that helped a lot.

494
00:25:47.505 --> 00:25:49.875
Kevin? Yeah, I a couple questions. First.

495
00:25:49.905 --> 00:25:52.835
This, you've come a far a long way since the

496
00:25:52.895 --> 00:25:54.115
hotdog and the PFD,

497
00:25:54.135 --> 00:25:55.135
So I, we still do that.

498
00:25:55.595 --> 00:25:58.065
Commend you on that. That's, um, and I,

499
00:25:58.225 --> 00:26:01.065
'cause I, I've always found doing peo testing a target

500

00:26:01.165 --> 00:26:04.505
to track, uh, helps induce

501
00:26:04.605 --> 00:26:06.785
or the raise the gains not

502
00:26:06.925 --> 00:26:09.545
so artificially when we're doing offset landing testing.

503
00:26:09.925 --> 00:26:12.705
Uh, even though 400 feet into large

504
00:26:13.345 --> 00:26:15.065
airplane seam pretty low

505
00:26:15.065 --> 00:26:16.305
and dynamic at the grounds there,

506
00:26:16.645 --> 00:26:18.065
it just wasn't quite enough.

507
00:26:18.125 --> 00:26:21.065
So I always felt that I was artificially driving my gains up

508
00:26:21.805 --> 00:26:23.305
and the, uh, but

509
00:26:23.305 --> 00:26:26.105
during max demonstrated cross wind testing when it's all the

510
00:26:26.105 --> 00:26:27.825
gains are there and the dynamics are there,

511
00:26:28.245 --> 00:26:31.275
we were never allowed to consider that as PAO

512
00:26:31.395 --> 00:26:33.515
'cause we would always mitigate the PIO risk

513
00:26:34.015 --> 00:26:35.025
with like no wins.

514
00:26:35.125 --> 00:26:36.665
So that never jived with me.

515
00:26:37.085 --> 00:26:38.505
So I think this is, this is great.

516
00:26:38.845 --> 00:26:43.055
Uh, 15,000 foot, uh, elevation using,

517
00:26:43.285 --> 00:26:44.685
I guess you're early on this.

518
00:26:44.985 --> 00:26:48.845
How do you square that with the arrow effects down at

519
00:26:50.045 --> 00:26:52.225
sea level for the landing task and stuff like that?

520
00:26:52.435 --> 00:26:53.625
Right, is one question. Uh,

521
00:26:54.095 --> 00:26:56.585
This being the first time we had done it in a development,

522
00:26:56.685 --> 00:26:58.345
we took a conservative approach to the altitude.

523
00:26:58.445 --> 00:27:01.705
We knew, you know, if we're gonna stay up

524
00:27:01.705 --> 00:27:03.025
and away from the ground, we're never gonna

525
00:27:03.025 --> 00:27:04.105
get the ground effect piece.

526
00:27:04.815 --> 00:27:07.595
Uh, but we did discuss building down and going lower.

527

00:27:08.255 --> 00:27:10.835
We didn't, weren't able to fit that into this program.

528
00:27:11.255 --> 00:27:13.075
But I would like to see that in the next one.

529
00:27:13.235 --> 00:27:16.075
'cause there are some clear changes as you change altitude

530
00:27:16.075 --> 00:27:18.545
or speed or configuration.

531
00:27:18.885 --> 00:27:22.365
Uh, so I would like to really expand the matrix with any

532
00:27:22.365 --> 00:27:25.365
of this, but this was more of a proof of concept.

533
00:27:25.785 --> 00:27:27.525
Can we do this test than anything else?

534
00:27:28.435 --> 00:27:31.895
Okay. And the last one is, uh, have you presented this

535
00:27:31.895 --> 00:27:34.455
to the FFA for an acceptable means of compliance yet?

536
00:27:36.155 --> 00:27:38.095
No. I won't comment on whether they'll accept it or not.

537
00:27:39.435 --> 00:27:42.615
No. Right now the scope is Boeing testing only.

538
00:27:42.795 --> 00:27:45.505
But I would love to see this grow

539
00:27:45.505 --> 00:27:47.265
and get better. 'cause I think it's really cool.

540
00:27:47.745 --> 00:27:48.825
I do too. Okay, thanks.

541
00:27:55.785 --> 00:27:57.205
Really interesting concept guys.

542
00:27:57.505 --> 00:28:00.235
Uh, question, there's a lot

543
00:28:00.235 --> 00:28:02.715
of possibilities you can introduce now that you're not able

544
00:28:02.715 --> 00:28:04.115
to do with the actual physical testing.

545
00:28:04.175 --> 00:28:06.395
The jumping runway was a really great example.

546
00:28:07.015 --> 00:28:08.915
Do you have any other ideas you'd like

547
00:28:08.915 --> 00:28:10.275
to attempt in future tests?

548
00:28:11.365 --> 00:28:15.835
You guys have anything? Uh, if you can think

549
00:28:15.835 --> 00:28:19.655
of like a video game where you have targets, rings,

550
00:28:20.185 --> 00:28:21.925
you can't fly through, rings in a real airplane.

551
00:28:22.025 --> 00:28:24.605
But if we could put that in, like gamify the system to

552
00:28:26.455 --> 00:28:28.705
over here, fly way over here really quickly.

553
00:28:30.405 --> 00:28:31.625
At least one idea.

554

00:28:32.485 --> 00:28:34.655
Test pilots might be competitive.

555
00:28:42.125 --> 00:28:43.525
I, I don't know if you mentioned it or not,

556
00:28:43.585 --> 00:28:46.285
but, uh, man, this is fascinating technology to me there.

557
00:28:46.385 --> 00:28:49.045
I'm kind of wondering, um, have you thought about

558
00:28:49.105 --> 00:28:52.365
or applicability to uh, uh, the error fueling,

559
00:28:52.545 --> 00:28:54.005
uh, task kind of thing?

560
00:28:54.005 --> 00:28:57.605
There certainly a task that will highlight PAO tendencies.

561
00:28:57.745 --> 00:28:58.885
Now I know it's virtual reality,

562
00:28:58.885 --> 00:29:00.405
so you're not gonna get the actual, you know,

563
00:29:00.405 --> 00:29:03.525
the tanker receiver, uh, interrelation effects there.

564
00:29:03.585 --> 00:29:05.685
But just for a boom tracking demo

565
00:29:05.745 --> 00:29:07.285
and like the pre-contact position

566
00:29:07.345 --> 00:29:10.925
or maintaining a contact position there, uh, between uh,

567
00:29:10.925 --> 00:29:12.085
two larger airplanes there.

568
00:29:12.305 --> 00:29:13.565
Um, have you looked at that at all?

569
00:29:13.745 --> 00:29:16.245
And I'm wondering about the feasibility is like perhaps

570
00:29:16.245 --> 00:29:18.765
that becomes a buildup before a crew actually goes out

571
00:29:18.985 --> 00:29:21.085
and flies an airplane behind an actual tanker.

572
00:29:21.315 --> 00:29:24.645
They maybe maybe get to see some PIO tendencies, you know,

573
00:29:24.645 --> 00:29:26.285
just in the augmented reality world.

574
00:29:26.715 --> 00:29:29.605
Yeah, the, uh, STI and their development

575
00:29:29.605 --> 00:29:32.445
before we were involved, uh, actually had a specific

576
00:29:33.065 --> 00:29:35.205
air tanking scene that they did.

577
00:29:35.545 --> 00:29:39.005
We had our airto air with the 7 47, uh, similar,

578
00:29:39.505 --> 00:29:40.765
uh, in concept.

579
00:29:41.145 --> 00:29:42.705
I think it's a great idea to get p

580
00:29:42.805 --> 00:29:43.905
pilots familiar with that.

581

00:29:44.325 --> 00:29:47.065
Um, one of the things that we did learn during that

582
00:29:47.065 --> 00:29:49.745
that I didn't realize, uh, we had some pilot feedback on,

583
00:29:50.285 --> 00:29:52.345
um, you know, your perception

584
00:29:52.485 --> 00:29:55.265
and things, uh, at the edges of your vision

585
00:29:55.265 --> 00:29:57.865
because, uh, one's pilot specifically was like,

586
00:29:57.865 --> 00:30:00.585
when I'm doing this task outta the corner of my eye,

587
00:30:00.695 --> 00:30:02.825
look at my hands on the wheel to know where it is

588
00:30:02.825 --> 00:30:05.465
and I lose that with this particular headset.

589
00:30:05.925 --> 00:30:09.715
So field of view, the mixing of the reality is something

590
00:30:09.715 --> 00:30:13.165
that we need to look at if we want to continue this,

591
00:30:13.165 --> 00:30:14.285
but I think it'd be great for

592
00:30:14.285 --> 00:30:15.445
react prepping crews like that.

593
00:30:20.055 --> 00:30:23.265
Well thank you guys. It's, uh, fantastic

594
00:30:29.565 --> 00:30:31.025
and I gotta say it was refreshing

595
00:30:31.025 --> 00:30:32.745
to hear somebody else talk about legs.

596
00:30:32.905 --> 00:30:34.225
I was hoping you'd show some legs,

597
00:30:34.365 --> 00:30:37.335
but, uh, anyway, take what we can get.

598
00:30:37.605 --> 00:30:37.895
I'll.