



1
00:00:11,839 --> 00:00:09,080
sounds good okay first of all while we

2
00:00:17,720 --> 00:00:11,849
start by you getting just a brief

3
00:00:19,730 --> 00:00:17,730
description of what laminar flow is it's

4
00:00:23,269 --> 00:00:19,740
an interesting question to give a brief

5
00:00:28,370 --> 00:00:23,279
description in essence what we're trying

6
00:00:31,099 --> 00:00:28,380
to do is control the boundary layer so

7
00:00:33,049 --> 00:00:31,109
that it looks a lot like a simple

8
00:00:34,580 --> 00:00:33,059
simple-minded way it would be if you

9
00:00:36,049 --> 00:00:34,590
looked at a car that was in a smoke

10
00:00:38,119 --> 00:00:36,059
tunnel and you see the commercials on TV

11
00:00:40,639 --> 00:00:38,129
and you see the smoke waves going over

12
00:00:42,650 --> 00:00:40,649
the car and they're nice and smooth and

13
00:00:44,959 --> 00:00:42,660

then later on they burst and they become

14

00:00:46,250 --> 00:00:44,969

a big bubble the laminar flow part is a

15

00:00:48,350 --> 00:00:46,260

place where they're smooth where the air

16

00:00:50,750 --> 00:00:48,360

actually flows over the wing in a very

17

00:00:53,360 --> 00:00:50,760

smooth manner you know in a low drag

18

00:00:56,150 --> 00:00:53,370

configuration in a more efficient way

19

00:00:59,510 --> 00:00:56,160

it's all air foils have some laminar and

20

00:01:01,099 --> 00:00:59,520

have some turbulent flow on them in the

21

00:01:02,510 --> 00:01:01,109

area where it's laminar it's basically

22

00:01:08,149 --> 00:01:02,520

the more efficient portion of the

23

00:01:09,950 --> 00:01:08,159

airfoil another common phenomenon that

24

00:01:12,140 --> 00:01:09,960

people can relate to laminar flow would

25

00:01:13,370 --> 00:01:12,150

be a cigarette smoke it's the portion of

26
00:01:15,830 --> 00:01:13,380
the cigarette smoke that comes off of

27
00:01:18,499 --> 00:01:15,840
the cigarette real straight and smooth

28
00:01:21,950 --> 00:01:18,509
and tightly wound and then later on it

29
00:01:25,429 --> 00:01:21,960
bursts and there's this big smoke spot

30
00:01:26,870 --> 00:01:25,439
in the middle of or smoke ball in the

31
00:01:28,520 --> 00:01:26,880
middle of off of the cigarette that's

32
00:01:30,740 --> 00:01:28,530
the turbulent section the straight piece

33
00:01:34,249 --> 00:01:30,750
is where the laminar flow is so it's the

34
00:01:36,020 --> 00:01:34,259
tightly wound well organized smooth air

35
00:01:46,480 --> 00:01:36,030
for airflow that you're talking about

36
00:01:54,950 --> 00:01:53,240
associated with supersonic well probably

37
00:01:58,310 --> 00:01:54,960
the biggest difference in supersonic

38
00:02:00,860 --> 00:01:58,320

laminar flow is that is the airfoils and

39

00:02:03,530 --> 00:02:00,870

the wings tend to be more highly swept

40

00:02:06,050 --> 00:02:03,540

and that the leading edges are you know

41

00:02:09,249 --> 00:02:06,060

and the order of 35 to 70 degrees swept

42

00:02:12,410 --> 00:02:09,259

back from a 90 degree angle and

43

00:02:13,880 --> 00:02:12,420

typically a subsonic laminar flow

44

00:02:17,060 --> 00:02:13,890

airfoil doesn't have quite that much

45

00:02:19,070 --> 00:02:17,070

sweep and the sweep actually makes the

46

00:02:20,720 --> 00:02:19,080

airfoil it makes it more difficult to

47

00:02:23,570 --> 00:02:20,730

maintain laminar flow because you have a

48

00:02:25,250 --> 00:02:23,580

component of inbound air or an air

49

00:02:27,620 --> 00:02:25,260

molecule that's coming towards the swept

50

00:02:29,390 --> 00:02:27,630

wing part of it goes straight back but

51
00:02:31,490 --> 00:02:29,400
part of it goes out towards the wingtip

52
00:02:33,080 --> 00:02:31,500
and that's called cross flow and cross

53
00:02:34,490 --> 00:02:33,090
flow is the phenomenon that makes

54
00:02:35,960 --> 00:02:34,500
supersonic laminar flow was one of the

55
00:02:37,820 --> 00:02:35,970
phenomenon that makes supersonic laminar

56
00:02:40,720 --> 00:02:37,830
flow more difficult to maintain than

57
00:02:44,720 --> 00:02:40,730
subsonic laminar flow it's much more

58
00:02:46,880 --> 00:02:44,730
much more force a larger forcing

59
00:02:48,290 --> 00:02:46,890
function if you will for supersonic

60
00:02:50,410 --> 00:02:48,300
laminar flow than it is for subsonic

61
00:02:53,000 --> 00:02:50,420
laminar flow there's also another

62
00:02:54,949 --> 00:02:53,010
another concern and it has to do with

63
00:02:57,650 --> 00:02:54,959

the size of a leading edge radius and

64

00:02:59,840 --> 00:02:57,660

the fact that the attachment line or the

65

00:03:01,729 --> 00:02:59,850

place where the pressure actually

66

00:03:03,530 --> 00:03:01,739

separate the molecules actually

67

00:03:05,360 --> 00:03:03,540

separates some go over the top some go

68

00:03:07,970 --> 00:03:05,370

over the bottom that area would be

69

00:03:10,100 --> 00:03:07,980

called the stagnation point or the whole

70

00:03:12,550 --> 00:03:10,110

line of those would be called the

71

00:03:14,750 --> 00:03:12,560

attachment line and that attachment line

72

00:03:16,610 --> 00:03:14,760

controlling exactly where that is on a

73

00:03:17,960 --> 00:03:16,620

swept wing and a supersonic wing is a

74

00:03:20,330 --> 00:03:17,970

little bit more difficult than it is

75

00:03:22,790 --> 00:03:20,340

necessarily on the subsonic wing so

76
00:03:24,770 --> 00:03:22,800
we're again supersonic wings tend to be

77
00:03:27,229 --> 00:03:24,780
swept highly making it much more

78
00:03:28,670 --> 00:03:27,239
difficult to control exactly where the

79
00:03:32,110 --> 00:03:28,680
attachment-line occurs so those are the

80
00:03:34,759 --> 00:03:32,120
two things that make it more difficult

81
00:03:36,740 --> 00:03:34,769
the pressure distribution itself is a

82
00:03:38,949 --> 00:03:36,750
lot more difficult to maintain you in

83
00:03:40,789 --> 00:03:38,959
order to maintain it in a laminar flow

84
00:03:42,199 --> 00:03:40,799
conducive a pressure distribution

85
00:03:44,210 --> 00:03:42,209
conducive to laminar flow you actually

86
00:03:46,280 --> 00:03:44,220
have to shape the airfoil properly and

87
00:03:48,080 --> 00:03:46,290
the shaping of that airfoil is part of

88
00:03:50,830 --> 00:03:48,090

the art and that's of learning how to

89

00:03:53,210 --> 00:03:50,840

how to make supersonic laminar flow work

90

00:03:54,140 --> 00:03:53,220

and it turns out that it needs some

91

00:03:57,080 --> 00:03:54,150

augmentation

92

00:04:00,619 --> 00:03:57,090

subsonic laminar flow can occur does

93

00:04:02,300 --> 00:04:00,629

occur easily relatively easily in the

94

00:04:04,610 --> 00:04:02,310

natural state you can actually maintain

95

00:04:06,949 --> 00:04:04,620

subsonic laminar flow back to fairly

96

00:04:08,750 --> 00:04:06,959

high percentage percentage quartz 35 40

97

00:04:10,220 --> 00:04:08,760

percent quart they've been a number of

98

00:04:11,390 --> 00:04:10,230

experiments where we've done that flight

99

00:04:13,520 --> 00:04:11,400

experiments where we've done that and

100

00:04:16,060 --> 00:04:13,530

they've been you know Windtunnel

101

00:04:18,469 --> 00:04:16,070

experiments with them supersonically

102

00:04:20,180 --> 00:04:18,479

there hasn't been very much research in

103

00:04:23,870 --> 00:04:20,190

it it's we know that we can get laminar

104

00:04:25,370 --> 00:04:23,880

flow to you know an inch or so back now

105

00:04:26,930 --> 00:04:25,380

we're trying to maintain it further aft

106

00:04:29,029 --> 00:04:26,940

and in order to maintain the laminar

107

00:04:30,920 --> 00:04:29,039

flow further aft we have to come up with

108

00:04:33,650 --> 00:04:30,930

some method of augmentation and that's

109

00:04:35,420 --> 00:04:33,660

why we're using suction to actually pull

110

00:04:37,550 --> 00:04:35,430

the boundary layer in essence pull the

111

00:04:39,140 --> 00:04:37,560

boundary layer back down and re-laminar

112

00:04:42,469 --> 00:04:39,150

eyes the boundary layer and hopefully we

113

00:04:45,409 --> 00:04:42,479

can maintain a pressure distribution by

114

00:04:46,939 --> 00:04:45,419

augmenting with suction to keep laminar

115

00:04:49,939 --> 00:04:46,949

flow extending further and further aft

116

00:04:52,040 --> 00:04:49,949

along a wing surface and obviously if

117

00:04:54,290 --> 00:04:52,050

you maintain laminar flow for a larger

118

00:04:56,060 --> 00:04:54,300

distance you can reduce the drag of an

119

00:04:57,860 --> 00:04:56,070

airfoil if you can reduce the drag you

120

00:04:59,600 --> 00:04:57,870

can increase your fuel efficiency if you

121

00:05:01,540 --> 00:04:59,610

can increase your fuel efficiency you

122

00:05:03,770 --> 00:05:01,550

can increase your payload capability and

123

00:05:05,060 --> 00:05:03,780

you know it's just a whole raft of

124

00:05:20,659 --> 00:05:05,070

things that come out of being able to

125

00:05:22,820 --> 00:05:20,669

maintain laminar flow indirectly yes

126
00:05:24,920 --> 00:05:22,830
what we have done thus far with one of

127
00:05:26,750 --> 00:05:24,930
the f-16xl number one which was a

128
00:05:28,969 --> 00:05:26,760
cooperative experiment with Rockwell

129
00:05:31,790 --> 00:05:28,979
International North American aircraft

130
00:05:35,480 --> 00:05:31,800
rockwell and nasa langley and nasa

131
00:05:37,820 --> 00:05:35,490
dryden onto a limited extent actually

132
00:05:39,200 --> 00:05:37,830
NASA Ames was also involved in some of

133
00:05:42,800 --> 00:05:39,210
the computational work that went along

134
00:05:45,140 --> 00:05:42,810
with this we have demonstrated that you

135
00:05:47,270 --> 00:05:45,150
can maintain laminar flow back to

136
00:05:50,060 --> 00:05:47,280
roughly 25 percent coordinates under

137
00:05:51,589 --> 00:05:50,070
certain conditions the next experiment

138
00:05:53,659 --> 00:05:51,599

that we planned for the second airplane

139

00:05:56,719 --> 00:05:53,669

is to maintain laminar flow further aft

140

00:05:59,180 --> 00:05:56,729

back as far as 50 to 60 percent chord so

141

00:06:01,129 --> 00:05:59,190

yes we are doing it stepwise the first

142

00:06:03,950 --> 00:06:01,139

experiment showed us that it was in fact

143

00:06:06,159 --> 00:06:03,960

achievable and in fact it might be a

144

00:06:09,409 --> 00:06:06,169

little easier in certain areas to do

145

00:06:10,730 --> 00:06:09,419

than we anticipated the real world tends

146

00:06:11,990 --> 00:06:10,740

to be a little bit more forgiving it

147

00:06:13,339 --> 00:06:12,000

appears you know from a flight

148

00:06:15,350 --> 00:06:13,349

perspective the real world is more

149

00:06:19,430 --> 00:06:15,360

forgiving than the computational or the

150

00:06:20,810 --> 00:06:19,440

theoretical world says it should be but

151

00:06:23,180 --> 00:06:20,820

we haven't gotten enough of an

152

00:06:25,550 --> 00:06:23,190

understanding as to exactly why we're

153

00:06:27,170 --> 00:06:25,560

able to do what we're doing we know we

154

00:06:28,790 --> 00:06:27,180

can do it now we have to try to figure

155

00:06:32,480 --> 00:06:28,800

out exactly what is the phenomenon that

156

00:06:34,670 --> 00:06:32,490

we're actually able to to control to

157

00:06:36,980 --> 00:06:34,680

make us get laminar flow to 25% cord

158

00:06:39,350 --> 00:06:36,990

meanwhile we want to extend that yes

159

00:06:42,440 --> 00:06:39,360

back to 50 or 60% cord which is a big

160

00:06:44,060 --> 00:06:42,450

driver in the design process for the

161

00:06:45,500 --> 00:06:44,070

high-speed civil transport airplane if

162

00:06:47,270 --> 00:06:45,510

we can achieve when I'm going to flow

163

00:06:49,459 --> 00:06:47,280

that far back we have actually

164

00:06:52,250 --> 00:06:49,469

correlated unit Reynolds numbers to a

165

00:06:54,649 --> 00:06:52,260

large enough number that the theoretical

166

00:06:56,480 --> 00:06:54,659

people and the designers for the

167

00:06:58,490 --> 00:06:56,490

high-speed civil transport have a lot of

168

00:07:01,700 --> 00:06:58,500

confidence that when they scale this up

169

00:07:04,730 --> 00:07:01,710

to the full size vehicle the scaling

170

00:07:06,709 --> 00:07:04,740

will actually be fairly accurate but on

171

00:07:08,570 --> 00:07:06,719

a high-speed civil transport they may

172

00:07:10,730 --> 00:07:08,580

not have laminar flow back to 50 or 60

173

00:07:12,680 --> 00:07:10,740

percent cord but if we can achieve it to

174

00:07:14,330 --> 00:07:12,690

50 to 60 percent cord now we know we

175

00:07:15,980 --> 00:07:14,340

understand the phenomenon well enough to

176

00:07:23,209 --> 00:07:15,990

be able to use it to our advantage on a

177

00:07:24,769 --> 00:07:23,219

high-speed civil transport primary

178

00:07:28,580 --> 00:07:24,779

driver is that it has a configuration

179

00:07:31,070 --> 00:07:28,590

that is close to the configuration that

180

00:07:32,899 --> 00:07:31,080

the high-speed civil transport is right

181

00:07:34,370 --> 00:07:32,909

now on the on the table it looks like

182

00:07:36,920 --> 00:07:34,380

it's going to look like it's a very

183

00:07:39,110 --> 00:07:36,930

small airplane but it has a 70 degree

184

00:07:41,510 --> 00:07:39,120

swept wing and the high-speed civil

185

00:07:43,070 --> 00:07:41,520

transport designs right now appear that

186

00:07:46,550 --> 00:07:43,080

the wing is going to be roughly a 70

187

00:07:48,290 --> 00:07:46,560

degree sweep the cord is not long enough

188

00:07:51,469 --> 00:07:48,300

it's but it was an airplane that was

189

00:07:53,450 --> 00:07:51,479

available with the right sweep angle for

190

00:07:54,589 --> 00:07:53,460

a test section and so that appeared to

191

00:07:56,450 --> 00:07:54,599

be the right place to start

192

00:07:58,040 --> 00:07:56,460

it's the only one of the few airplanes

193

00:07:59,570 --> 00:07:58,050

that are available right now to do that

194

00:08:01,070 --> 00:07:59,580

type of work and that's the other reason

195

00:08:03,950 --> 00:08:01,080

why the airplane was selected it was

196

00:08:06,019 --> 00:08:03,960

actually available back in 85 the Air

197

00:08:07,399 --> 00:08:06,029

Force and General Dynamics parked the

198

00:08:11,270 --> 00:08:07,409

airplanes and said they had no more use

199

00:08:12,650 --> 00:08:11,280

for the airplane and in 88 NASA thought

200

00:08:14,029 --> 00:08:12,660

that they could use an airplane and

201
00:08:15,350 --> 00:08:14,039
meanwhile the Air Force was looking for

202
00:08:18,619 --> 00:08:15,360
somebody to either take it off their

203
00:08:19,080 --> 00:08:18,629
hands or to or the Air Force was going

204
00:08:20,939 --> 00:08:19,090
to destroy

205
00:08:23,430 --> 00:08:20,949
the airplane so we said we've got to use

206
00:08:24,750 --> 00:08:23,440
four we'd like to have the airplane the

207
00:08:26,310 --> 00:08:24,760
airplanes are actually loaned to us they

208
00:08:27,570 --> 00:08:26,320
don't belong to NASA they belong to the

209
00:08:29,490 --> 00:08:27,580
Air Force and they're just on loan to

210
00:08:37,260 --> 00:08:29,500
the to NASA for the duration of the

211
00:08:40,380 --> 00:08:37,270
flight experiment well we actually

212
00:08:42,540 --> 00:08:40,390
collect on the order of 250 to 300

213
00:08:45,210 --> 00:08:42,550

pieces of data telemetry to the ground

214

00:08:46,940 --> 00:08:45,220

we display to our engineers somewhere in

215

00:08:50,370 --> 00:08:46,950

the order of about a hundred and fifty

216

00:08:52,820 --> 00:08:50,380

among the parameters were displaying to

217

00:08:54,570 --> 00:08:52,830

our engineers or the pressures

218

00:08:56,250 --> 00:08:54,580

coefficients of pressure it's actually

219

00:08:58,620 --> 00:08:56,260

the pressure is measured and then we

220

00:09:01,110 --> 00:08:58,630

went into a computer to display in a

221

00:09:03,329 --> 00:09:01,120

pressure distribution format what the

222

00:09:07,070 --> 00:09:03,339

pressure distribution looks like we also

223

00:09:09,630 --> 00:09:07,080

measure and display to our engineers

224

00:09:11,640 --> 00:09:09,640

whether the flow is laminar or turbulent

225

00:09:13,740 --> 00:09:11,650

when we use a thing called a device

226

00:09:17,340 --> 00:09:13,750

called a hot film anemometer or hot film

227

00:09:21,600 --> 00:09:17,350

sensor which in essence is a piece of a

228

00:09:24,000 --> 00:09:21,610

strain gauge bridge and by the way it's

229

00:09:25,590 --> 00:09:24,010

manipulated and can condition the signal

230

00:09:26,850 --> 00:09:25,600

is conditioned we can actually tell

231

00:09:30,360 --> 00:09:26,860

whether we have laminar or turbulent

232

00:09:32,310 --> 00:09:30,370

flow at a specific discreet location

233

00:09:35,160 --> 00:09:32,320

along the wing where these things are

234

00:09:37,320 --> 00:09:35,170

located those are the two primary pieces

235

00:09:40,290 --> 00:09:37,330

of information that we collect we also

236

00:09:42,750 --> 00:09:40,300

collect data on the suction levels how

237

00:09:44,970 --> 00:09:42,760

much suction are we doesn't require to

238

00:09:47,160 --> 00:09:44,980

maintain the laminar flow at those in

239

00:09:48,570 --> 00:09:47,170

under those various conditions and of

240

00:09:51,060 --> 00:09:48,580

course the conditions themselves are

241

00:09:54,180 --> 00:09:51,070

recorded whether what our mock mock

242

00:09:57,180 --> 00:09:54,190

altitude airspeed angle-of-attack angle

243

00:09:59,070 --> 00:09:57,190

of sideslip all of those are recorded

244

00:10:00,900 --> 00:09:59,080

and telemetry to the ground so that the

245

00:10:03,420 --> 00:10:00,910

researchers can tell whether or not we

246

00:10:05,220 --> 00:10:03,430

are on the conditions that we need to

247

00:10:15,290 --> 00:10:05,230

examine whether or not laminar flow

248

00:10:22,530 --> 00:10:17,820

first three or four percent granulation

249

00:10:25,890 --> 00:10:22,540

what do you learn from that helps most

250

00:10:27,870 --> 00:10:25,900

of what they have done thus far they're

251
00:10:29,370 --> 00:10:27,880
they're the beginning of the experiment

252
00:10:31,710 --> 00:10:29,380
they're the ones that say well if you

253
00:10:34,020 --> 00:10:31,720
can shape your airfoil this way if you

254
00:10:35,910 --> 00:10:34,030
can if you can build a contour if you

255
00:10:38,940 --> 00:10:35,920
can build an experiment that looks like

256
00:10:40,530 --> 00:10:38,950
this you are most likely going to be

257
00:10:41,820 --> 00:10:40,540
able to get through the hardest part of

258
00:10:43,410 --> 00:10:41,830
the region the hardest part of the

259
00:10:45,750 --> 00:10:43,420
experiment which is to get the leading

260
00:10:47,610 --> 00:10:45,760
edge to be laminar if you can maintain

261
00:10:49,140 --> 00:10:47,620
laminar at the leading edge the rest of

262
00:10:51,510 --> 00:10:49,150
it will probably fall out you may have

263
00:10:53,730 --> 00:10:51,520

to manipulate your experiment just a

264

00:10:56,910 --> 00:10:53,740

little bit but the further are and will

265

00:10:59,340 --> 00:10:56,920

follow so what we really get out of them

266

00:11:01,950 --> 00:10:59,350

is verification of some of the theories

267

00:11:05,310 --> 00:11:01,960

that the design theories for our

268

00:11:07,680 --> 00:11:05,320

experiment so the design starts whether

269

00:11:09,240 --> 00:11:07,690

it's and a lot of times that is the

270

00:11:10,710 --> 00:11:09,250

computational fluid dynamics people

271

00:11:14,010 --> 00:11:10,720

start working on what they think is a

272

00:11:17,010 --> 00:11:14,020

good design then they might fly a small

273

00:11:18,480 --> 00:11:17,020

experiment in one of the tunnels and

274

00:11:20,850 --> 00:11:18,490

when they think they have something that

275

00:11:22,890 --> 00:11:20,860

really is does show promise then we'll

276

00:11:24,180 --> 00:11:22,900

scale it up to an airplane and do a

277

00:11:26,280 --> 00:11:24,190

flight experiment which will be the

278

00:11:28,230 --> 00:11:26,290

in-flight validation of what the wind

279

00:11:30,840 --> 00:11:28,240

tunnel said and what the computational

280

00:11:33,690 --> 00:11:30,850

fluid dynamics work said oftentimes we

281

00:11:36,000 --> 00:11:33,700

don't get to 100% correlation in there

282

00:11:37,890 --> 00:11:36,010

in the data what we get is is some

283

00:11:40,500 --> 00:11:37,900

differences in terms of what we get for

284

00:11:43,170 --> 00:11:40,510

real time our flight data and we take

285

00:11:45,120 --> 00:11:43,180

that turn it back into the computational

286

00:11:46,650 --> 00:11:45,130

fluid dynamics folks or to the wind

287

00:11:49,140 --> 00:11:46,660

tunnel people and say well our data

288

00:11:51,600 --> 00:11:49,150

shows this but our configuration looks

289

00:11:52,920 --> 00:11:51,610

like this why don't you run it again put

290

00:11:54,720 --> 00:11:52,930

it through your tunnel again or put it

291

00:11:56,010 --> 00:11:54,730

through your code and see whether or not

292

00:11:57,540 --> 00:11:56,020

you can figure out what the difference

293

00:11:59,460 --> 00:11:57,550

is between what we got and what you got

294

00:12:01,470 --> 00:11:59,470

in terms of results so there's not

295

00:12:05,190 --> 00:12:01,480

always 100% correlation but we use this

296

00:12:06,810 --> 00:12:05,200

as an iterative process often times they

297

00:12:08,670 --> 00:12:06,820

don't get the same answers we get and

298

00:12:10,470 --> 00:12:08,680

they're convinced that their part is

299

00:12:12,150 --> 00:12:10,480

exactly right so we have to go back and

300

00:12:13,740 --> 00:12:12,160

find out what it is and arcs our piece

301
00:12:16,350 --> 00:12:13,750
of the experiment that might be

302
00:12:17,910 --> 00:12:16,360
different so it's you know it takes a

303
00:12:20,310 --> 00:12:17,920
lot of communication a lot of talking

304
00:12:21,900 --> 00:12:20,320
between the computational fluid dynamics

305
00:12:23,910 --> 00:12:21,910
people and the wind tunnel people and

306
00:12:24,690 --> 00:12:23,920
the flight experiment people and the

307
00:12:26,190 --> 00:12:24,700
applications

308
00:12:27,600 --> 00:12:26,200
people and the instrumentation people

309
00:12:28,800 --> 00:12:27,610
everybody has to talk to everybody in

310
00:12:30,630 --> 00:12:28,810
order to make sure that we really are

311
00:12:33,330 --> 00:12:30,640
doing the experiment we all think we're

312
00:12:35,040 --> 00:12:33,340
doing and and we have had on occasion

313
00:12:36,990 --> 00:12:35,050

some differences of opinion in terms of

314

00:12:38,370 --> 00:12:37,000

what we are doing and what we think

315

00:12:40,710 --> 00:12:38,380

we're doing and what somebody else

316

00:12:42,510 --> 00:12:40,720

thinks for doing so it does it's a

317

00:12:44,820 --> 00:12:42,520

difficult process to keep iterating

318

00:12:58,140 --> 00:12:44,830

everybody's data until we get

319

00:13:06,450 --> 00:12:58,150

correlation their work is what is most

320

00:13:08,030 --> 00:13:06,460

important and what that's a positive

321

00:13:09,750 --> 00:13:08,040

thing because that person is very

322

00:13:12,390 --> 00:13:09,760

enthusiastic about what they're doing

323

00:13:22,650 --> 00:13:12,400

and that's where their heart is but what

324

00:13:24,660 --> 00:13:22,660

I see but it's really funny to talk to

325

00:13:26,310 --> 00:13:24,670

somebody do you know who Bernie Spencer

326

00:13:27,000 --> 00:13:26,320

in Spanish I know the name but I don't

327

00:13:28,710 --> 00:13:27,010

know him personally

328

00:13:42,240 --> 00:13:28,720

he's a wind tunnel guy he did a lot of

329

00:13:46,680 --> 00:13:42,250

testing to rephrase that Bernie we kick

330

00:13:49,110 --> 00:13:46,690

all we need anyway it's I mean it is

331

00:13:50,820 --> 00:13:49,120

that's a tough problem you know the and

332

00:13:53,850 --> 00:13:50,830

we have you know we have our growing

333

00:13:56,490 --> 00:13:53,860

pains trying to correlate a you know

334

00:13:59,300 --> 00:13:56,500

make a flight experiment add the most

335

00:14:01,950 --> 00:13:59,310

value to an overall program like this

336

00:14:03,780 --> 00:14:01,960

because everybody does have their empire

337

00:14:05,430 --> 00:14:03,790

if you will and everybody wants to make

338

00:14:08,760 --> 00:14:05,440

sure that their piece gets gets added

339

00:14:11,600 --> 00:14:08,770

into the equation why it is an important

340

00:14:13,740 --> 00:14:11,610

part of the validation process and

341

00:14:16,860 --> 00:14:13,750

especially when you're dealing with a

342

00:14:19,830 --> 00:14:16,870

phenomenon that we don't understand yet

343

00:14:21,090 --> 00:14:19,840

there are some kinds of technologies

344

00:14:22,530 --> 00:14:21,100

that can be done you know

345

00:14:24,030 --> 00:14:22,540

computationally or in the wind tunnels

346

00:14:25,980 --> 00:14:24,040

but I think we're in an area now where

347

00:14:28,170 --> 00:14:25,990

we don't know enough and we need some

348

00:14:29,970 --> 00:14:28,180

flight data to correlate with and I

349

00:14:31,320 --> 00:14:29,980

think overall the program does recognize

350

00:14:33,240 --> 00:14:31,330

that and everybody involved in the

351
00:14:36,450 --> 00:14:33,250
program recognizes that but flights also

352
00:14:37,550 --> 00:14:36,460
very expensive and that's that's a real

353
00:14:38,750 --> 00:14:37,560
drawback any time

354
00:14:40,130 --> 00:14:38,760
anybody looks at trying to do a flight

355
00:14:42,170 --> 00:14:40,140
experiment they say Who am I we're going

356
00:14:43,610 --> 00:14:42,180
to spend millions of dollars doing this

357
00:14:45,680 --> 00:14:43,620
flight experiment and we could do the

358
00:14:47,540 --> 00:14:45,690
same experiment in a wind tunnel or in a

359
00:14:51,380 --> 00:14:47,550
in the computational world for

360
00:14:53,870 --> 00:14:51,390
considerably less and convincing

361
00:14:56,600 --> 00:14:53,880
everybody that you still need the flight

362
00:14:58,640 --> 00:14:56,610
data is sometimes difficult you know so

363
00:15:00,950 --> 00:14:58,650

when you talk about your computational

364

00:15:02,750 --> 00:15:00,960

people or your wind tunnel people and

365

00:15:04,269 --> 00:15:02,760

you talk about your air applications

366

00:15:06,530 --> 00:15:04,279

maybe your flight applications people

367

00:15:08,510 --> 00:15:06,540

getting a meeting of the minds is the

368

00:15:10,640 --> 00:15:08,520

hardest thing you know getting everybody

369

00:15:13,160 --> 00:15:10,650

to say yes this is the very important

370

00:15:16,160 --> 00:15:13,170

thing for us to do is really difficult

371

00:15:17,329 --> 00:15:16,170

and it hasn't been flawless so far in

372

00:15:19,160 --> 00:15:17,339

this program although we're getting

373

00:15:21,110 --> 00:15:19,170

better we're definitely working hard

374

00:15:22,640 --> 00:15:21,120

harder to make sure we're all part of

375

00:15:24,140 --> 00:15:22,650

the big piece of the piece of the

376

00:15:38,540 --> 00:15:24,150

program and I think it's starting to

377

00:15:41,030 --> 00:15:38,550

show well we have we've collected

378

00:15:44,140 --> 00:15:41,040

sufficient amount of laminar flow or

379

00:15:46,010 --> 00:15:44,150

laminar turbulent transition data and a

380

00:15:47,810 --> 00:15:46,020

significant amount of pressure

381

00:15:53,480 --> 00:15:47,820

distribution data to be able to show

382

00:15:55,700 --> 00:15:53,490

that with minor anomalies we can we

383

00:15:58,760 --> 00:15:55,710

cannot we do understand how the pressure

384

00:15:59,810 --> 00:15:58,770

distribution is has been developed you

385

00:16:00,740 --> 00:15:59,820

know there are some things in the

386

00:16:03,200 --> 00:16:00,750

pressure distribution we don't

387

00:16:04,310 --> 00:16:03,210

understand but we're beginning to

388

00:16:05,870 --> 00:16:04,320

believe that some of that's our

389

00:16:08,060 --> 00:16:05,880

instrumentation measurement technique

390

00:16:09,920 --> 00:16:08,070

rather than it has anything to do with

391

00:16:12,260 --> 00:16:09,930

the phenomenon called supersonic laminar

392

00:16:14,900 --> 00:16:12,270

flow which is good I mean it's what it's

393

00:16:16,640 --> 00:16:14,910

done for us is it's it's improved our

394

00:16:18,620 --> 00:16:16,650

instrumentation technique capability as

395

00:16:21,680 --> 00:16:18,630

well which will make the next experiment

396

00:16:24,500 --> 00:16:21,690

a better experiment in transition where

397

00:16:27,440 --> 00:16:24,510

transition location occurs we have been

398

00:16:29,960 --> 00:16:27,450

able to show that the codes that have

399

00:16:31,610 --> 00:16:29,970

that developed that this airfoil shape

400

00:16:33,230 --> 00:16:31,620

was developed by are not a hundred

401
00:16:35,030 --> 00:16:33,240
percent representative of what really

402
00:16:36,470 --> 00:16:35,040
happens in the real world but they're

403
00:16:38,510 --> 00:16:36,480
close enough there's some things that

404
00:16:41,230 --> 00:16:38,520
some phenomenon that they didn't

405
00:16:46,220 --> 00:16:41,240
anticipate in the code development that

406
00:16:48,110 --> 00:16:46,230
need to be revisited it's on it's fair

407
00:16:49,730 --> 00:16:48,120
to say we did not predict the results we

408
00:16:50,390 --> 00:16:49,740
got you know the computational fluid

409
00:16:52,730 --> 00:16:50,400
then

410
00:16:54,230 --> 00:16:52,740
the Windtunnel results did not predict

411
00:16:57,680 --> 00:16:54,240
the results we got out the first part of

412
00:17:02,030 --> 00:16:57,690
the ship one experiment but they

413
00:17:03,680 --> 00:17:02,040

predicted enough of the information in a

414

00:17:06,050 --> 00:17:03,690

satisfactory manner that we now have

415

00:17:08,630 --> 00:17:06,060

something to do some checks and balances

416

00:17:10,730 --> 00:17:08,640

against as I said earlier now is time

417

00:17:12,500 --> 00:17:10,740

for the CFD folks and for the Windtunnel

418

00:17:15,020 --> 00:17:12,510

folks to go back and look at the

419

00:17:16,460 --> 00:17:15,030

differences between what they thought we

420

00:17:18,050 --> 00:17:16,470

were going to flight test and what we

421

00:17:19,790 --> 00:17:18,060

flight tested and see whether or not

422

00:17:22,910 --> 00:17:19,800

they can we can start correlating the

423

00:17:25,160 --> 00:17:22,920

differences between the two most

424

00:17:26,780 --> 00:17:25,170

importantly I think the flight

425

00:17:30,230 --> 00:17:26,790

experiment has shown that yes you can

426

00:17:32,150 --> 00:17:30,240

get laminar flow and it's not as may not

427

00:17:34,580 --> 00:17:32,160

be as difficult to do under these

428

00:17:36,290 --> 00:17:34,590

circumstances as we anticipated it

429

00:17:37,490 --> 00:17:36,300

wouldn't I mean there was a lot of a lot

430

00:17:39,830 --> 00:17:37,500

of apprehension that we were going to

431

00:17:41,360 --> 00:17:39,840

have to do a lot of provide a lot of

432

00:17:44,150 --> 00:17:41,370

suction for example in order to maintain

433

00:17:46,190 --> 00:17:44,160

laminar flow and we're not providing all

434

00:17:48,020 --> 00:17:46,200

that extraordinary in a really large

435

00:17:49,730 --> 00:17:48,030

amount we're definitely providing

436

00:17:52,610 --> 00:17:49,740

suction but the amount is not as much as

437

00:17:55,130 --> 00:17:52,620

people predicted it would be so we are

438

00:17:57,950 --> 00:17:55,140

starting to show you know that that this

439

00:18:00,080 --> 00:17:57,960

is a handleable problem it's not out of

440

00:18:02,690 --> 00:18:00,090

our out of our capability which is a

441

00:18:05,090 --> 00:18:02,700

very big confidence builder that we can

442

00:18:06,950 --> 00:18:05,100

get from here to there without and

443

00:18:10,330 --> 00:18:06,960

without having to go over the impossible

444

00:18:12,530 --> 00:18:10,340

you know the impossible Ridge first so

445

00:18:14,210 --> 00:18:12,540

basically what we've done so far is just

446

00:18:15,860 --> 00:18:14,220

provide the data to validate what we've

447

00:18:18,290 --> 00:18:15,870

done so you know what the the

448

00:18:21,740 --> 00:18:18,300

theoretical people have done so far and

449

00:18:23,090 --> 00:18:21,750

then that gives them the step the

450

00:18:25,190 --> 00:18:23,100

confidence step they need that they can

451
00:18:27,230 --> 00:18:25,200
go the next you know they can go to the

452
00:18:28,610 --> 00:18:27,240
next level of complexity and start

453
00:18:30,290 --> 00:18:28,620
understanding a little bit more about

454
00:18:32,660 --> 00:18:30,300
you know the difference is the

455
00:18:35,990 --> 00:18:32,670
difference between cross flow and you

456
00:18:38,540 --> 00:18:36,000
know you do the n factor computational

457
00:18:39,800 --> 00:18:38,550
results and those kinds of those kinds

458
00:18:41,750 --> 00:18:39,810
of computational theories that they're

459
00:18:44,240 --> 00:18:41,760
using they're getting enough data to

460
00:18:45,890 --> 00:18:44,250
validate that the theories are valid

461
00:18:47,180 --> 00:18:45,900
theories they just need they need to be

462
00:18:50,920 --> 00:18:47,190
tweaked up and tuned up just a little

463
00:18:56,720 --> 00:18:54,590

what you need for laminar flow control

464

00:18:58,370 --> 00:18:56,730

and what you're finding to achieve the

465

00:19:01,100 --> 00:18:58,380

best possible results how does that

466

00:19:03,260 --> 00:19:01,110

eventually affect what they need in a

467

00:19:05,300 --> 00:19:03,270

sonic sonic boom area or in the high

468

00:19:07,730 --> 00:19:05,310

lift area their needs are obviously

469

00:19:11,750 --> 00:19:07,740

different yeah their needs are different

470

00:19:16,400 --> 00:19:11,760

and in fact the integration of laminar

471

00:19:18,490 --> 00:19:16,410

flow high left sonic boom or shaping is

472

00:19:22,340 --> 00:19:18,500

going to be a very difficult task

473

00:19:24,350 --> 00:19:22,350

because they don't meet those those at

474

00:19:26,420 --> 00:19:24,360

least those three phenomenon don't meet

475

00:19:28,550 --> 00:19:26,430

at the same place so it's going to be a

476
00:19:32,390 --> 00:19:28,560
compromise everybody is going to have to

477
00:19:34,450 --> 00:19:32,400
say through whatever whatever validation

478
00:19:37,370 --> 00:19:34,460
testing they do I can tolerate this much

479
00:19:41,390 --> 00:19:37,380
detriment to my best performance

480
00:19:44,150 --> 00:19:41,400
condition and still get some gain it's

481
00:19:46,040 --> 00:19:44,160
it's the added value added equation

482
00:19:47,540 --> 00:19:46,050
really more than anything else it's if I

483
00:19:49,790 --> 00:19:47,550
have some laminar flow under certain

484
00:19:51,890 --> 00:19:49,800
circumstances but I give it up during

485
00:19:55,640 --> 00:19:51,900
the approach and landing phase or the

486
00:19:58,850 --> 00:19:55,650
take-off phase if I have a sonic boom

487
00:20:03,200 --> 00:19:58,860
but it's not as offensive as a very

488
00:20:05,180 --> 00:20:03,210

sharp sonic boom and if I have you know

489

00:20:06,890 --> 00:20:05,190

a noise footprint from the Heil you know

490

00:20:09,320 --> 00:20:06,900

because of the high lift phenomenon

491

00:20:12,410 --> 00:20:09,330

that's half of what you know meets the

492

00:20:15,430 --> 00:20:12,420

fa r criteria but it's not the not as

493

00:20:17,660 --> 00:20:15,440

good as I really want it that whole

494

00:20:21,350 --> 00:20:17,670

compromise and that whole integration

495

00:20:23,330 --> 00:20:21,360

issue has not really been addressed yet

496

00:20:24,890 --> 00:20:23,340

it's everybody recognizes we're going to

497

00:20:26,600 --> 00:20:24,900

have to compromise high lift and and

498

00:20:28,880 --> 00:20:26,610

supersonic laminar flow are almost

499

00:20:31,700 --> 00:20:28,890

mutually exclusive for certain parts of

500

00:20:32,990 --> 00:20:31,710

a flight regime but you don't need

501
00:20:35,780 --> 00:20:33,000
supersonic laminar flow when you're

502
00:20:38,540 --> 00:20:35,790
subsonic so maybe it's not that big a

503
00:20:41,810 --> 00:20:38,550
deal you know maybe we can work around

504
00:20:44,630 --> 00:20:41,820
that one and so I think that that we

505
00:20:46,310 --> 00:20:44,640
have to understand the conditions where

506
00:20:47,930 --> 00:20:46,320
supersonic laminar flow occurs we have

507
00:20:49,280 --> 00:20:47,940
to understand the conditions for getting

508
00:20:51,830 --> 00:20:49,290
good high lift performance

509
00:20:53,000 --> 00:20:51,840
characteristics and then once we

510
00:20:54,800 --> 00:20:53,010
understand both of those we can

511
00:20:57,800 --> 00:20:54,810
integrate the requirements for both in

512
00:21:00,140 --> 00:20:57,810
such a way that we don't destroy you

513
00:21:02,180 --> 00:21:00,150

know 75% of the capability in either

514

00:21:03,890 --> 00:21:02,190

case the worst thing you could have is a

515

00:21:04,140 --> 00:21:03,900

poorly integrated airplane one that does

516

00:21:06,660 --> 00:21:04,150

ever

517

00:21:08,370 --> 00:21:06,670

think poorly what we're hoping for is an

518

00:21:13,260 --> 00:21:08,380

airplane that has all the technologies

519

00:21:16,080 --> 00:21:13,270

put together in such a way that we've

520

00:21:17,880 --> 00:21:16,090

maximized you know all the parameters at

521

00:21:33,030 --> 00:21:17,890

the same time and you're not gonna get a

522

00:21:34,350 --> 00:21:33,040

hundred percent of any other what do you

523

00:21:42,030 --> 00:21:34,360

feel like the purpose of all your

524

00:21:45,630 --> 00:21:42,040

research the database will probably be

525

00:21:47,280 --> 00:21:45,640

used for years to come to validate B be

526

00:21:50,100 --> 00:21:47,290

a lot of test case data to validate

527

00:21:55,980 --> 00:21:50,110

development of new computational codes

528

00:21:58,350 --> 00:21:55,990

and and theoretical codes the area we're

529

00:22:00,990 --> 00:21:58,360

dabbling in now supersonic laminar flow

530

00:22:02,940 --> 00:22:01,000

is an area that is is brand-new you know

531

00:22:06,570 --> 00:22:02,950

there was some experiments done in years

532

00:22:08,970 --> 00:22:06,580

gone by there's some x21 criteria that

533

00:22:11,760 --> 00:22:08,980

people believe in there's some work that

534

00:22:15,030 --> 00:22:11,770

was done on a 104 you know back in the I

535

00:22:17,880 --> 00:22:15,040

guess was the early 60s those two

536

00:22:20,610 --> 00:22:17,890

experiments were enough to set establish

537

00:22:22,890 --> 00:22:20,620

some criteria for whether or not

538

00:22:24,780 --> 00:22:22,900

supersonic laminar flow is or laminar

539

00:22:27,900 --> 00:22:24,790

flow and supersonic laminar flow were

540

00:22:29,250 --> 00:22:27,910

achievable what we have done and what we

541

00:22:31,590 --> 00:22:29,260

will be doing through the Excel

542

00:22:32,790 --> 00:22:31,600

experiment besides validating some of

543

00:22:34,170 --> 00:22:32,800

the codes that the high-speed civil

544

00:22:36,510 --> 00:22:34,180

transport is going to use for design

545

00:22:39,240 --> 00:22:36,520

methodology we will actually fill the

546

00:22:42,150 --> 00:22:39,250

database that will allow researchers for

547

00:22:45,540 --> 00:22:42,160

future generation airplanes augment the

548

00:22:47,430 --> 00:22:45,550

designs in other ways not just for the

549

00:22:49,350 --> 00:22:47,440

point design called the high-speed civil

550

00:22:52,410 --> 00:22:49,360

transport but perhaps for some other

551
00:22:54,090 --> 00:22:52,420
vehicles some other more focused more

552
00:22:58,050 --> 00:22:54,100
highly specialized vehicle that could

553
00:23:01,020 --> 00:22:58,060
take advantage of an airfoil or a

554
00:23:02,460 --> 00:23:01,030
pressure distribution development for

555
00:23:03,990 --> 00:23:02,470
another region of flight that maybe we

556
00:23:08,670 --> 00:23:04,000
haven't thought too much about to date

557
00:23:11,550 --> 00:23:08,680
so the database by itself is is going to

558
00:23:13,080 --> 00:23:11,560
be valuable to everybody it's it's

559
00:23:14,700 --> 00:23:13,090
certainly designed to help the

560
00:23:16,290 --> 00:23:14,710
high-speed civil transport but to

561
00:23:17,520 --> 00:23:16,300
understand the phenomenon transition

562
00:23:20,100 --> 00:23:17,530
physics and

563
00:23:21,510 --> 00:23:20,110

and you know attachment-line phenomenon

564

00:23:23,130 --> 00:23:21,520

and that type of thing that's the

565

00:23:24,360 --> 00:23:23,140

importance that's some of the important

566

00:23:26,670 --> 00:23:24,370

data that will come out of this

567

00:23:28,830 --> 00:23:26,680

I mean we've played we've been in the

568

00:23:30,210 --> 00:23:28,840

laminar flow business for well if you

569

00:23:31,890 --> 00:23:30,220

read some of the some accounts we've

570

00:23:34,500 --> 00:23:31,900

been in laminar flow since beginning of

571

00:23:35,880 --> 00:23:34,510

NASA or NACA actually there was some

572

00:23:39,000 --> 00:23:35,890

laminar flow work done in the begin

573

00:23:40,350 --> 00:23:39,010

during the NACA days I personally have

574

00:23:43,890 --> 00:23:40,360

been in the laminar flow business since

575

00:23:46,050 --> 00:23:43,900

1979 and it's been subsonic laminar flow

576
00:23:48,690 --> 00:23:46,060
up till now and there's always new

577
00:23:50,580 --> 00:23:48,700
things to look at there's always the

578
00:23:52,770 --> 00:23:50,590
effect of once you you know you take a

579
00:23:54,300 --> 00:23:52,780
known configuration now you start

580
00:23:57,210 --> 00:23:54,310
varying vary any of the parameters

581
00:24:00,240 --> 00:23:57,220
instead of having 70° sweep let's look

582
00:24:02,370 --> 00:24:00,250
at the effect of 75° sweep instead of

583
00:24:04,650 --> 00:24:02,380
having maximum suction let's look at

584
00:24:06,150 --> 00:24:04,660
less suction instead of having two

585
00:24:08,370 --> 00:24:06,160
degrees angle of attack let's look at

586
00:24:09,960 --> 00:24:08,380
you know three degrees or 1 degree angle

587
00:24:12,450 --> 00:24:09,970
of attack there's a whole raft of

588
00:24:13,980 --> 00:24:12,460

parameters there that that when you're

589

00:24:16,500 --> 00:24:13,990

when you're focused on a vehicle that

590

00:24:19,560 --> 00:24:16,510

has a certain flight regime you tend to

591

00:24:21,360 --> 00:24:19,570

only look within that window and will

592

00:24:23,630 --> 00:24:21,370

collect enough data that you can look at

593

00:24:27,330 --> 00:24:23,640

the effect of changing the various

594

00:24:35,360 --> 00:24:27,340

parameters and use that to validate

595

00:24:40,380 --> 00:24:38,400

both f-16xl airplanes are hangared right

596

00:24:48,840 --> 00:24:40,390

now although Friday we'll be flying the

597

00:24:50,850 --> 00:24:48,850

first airplane again so excel ship ship

598

00:24:53,550 --> 00:24:50,860

one which is the one that we started the

599

00:24:57,210 --> 00:24:53,560

NASA Rockwell North American aircraft

600

00:25:00,840 --> 00:24:57,220

experiment with is going into a phase

601
00:25:02,820 --> 00:25:00,850
we'll call it a phase 2 experimentation

602
00:25:06,330 --> 00:25:02,830
where we are actually trying to document

603
00:25:08,810 --> 00:25:06,340
collect significantly more data on the

604
00:25:11,880 --> 00:25:08,820
suction requirements for laminar flow

605
00:25:14,640 --> 00:25:11,890
phase one was basically can we can we

606
00:25:17,700 --> 00:25:14,650
achieve laminar flow back to you know 25

607
00:25:19,440 --> 00:25:17,710
or 30 percent cord phase 2 is understand

608
00:25:21,170 --> 00:25:19,450
the the suction distribution that's

609
00:25:24,720 --> 00:25:21,180
required to do that

610
00:25:26,160 --> 00:25:24,730
so yes the ship one is in a second phase

611
00:25:29,790 --> 00:25:26,170
where we're collecting another set of

612
00:25:30,470 --> 00:25:29,800
data when that's complete the airplane

613
00:25:33,620 --> 00:25:30,480

in fact will

614

00:25:35,510 --> 00:25:33,630

turned back to transferred back to NASA

615

00:25:37,130 --> 00:25:35,520

Langley where they will begin the high

616

00:25:40,100 --> 00:25:37,140

lift experiment where they will actually

617

00:25:43,100 --> 00:25:40,110

start looking into the configuration

618

00:25:44,780 --> 00:25:43,110

requirements for high left for the

619

00:25:48,890 --> 00:25:44,790

supersonic our high speed Scylla

620

00:25:50,870 --> 00:25:48,900

transport and Dryden in Langley will be

621

00:25:52,250 --> 00:25:50,880

working together on that experiment with

622

00:25:53,539 --> 00:25:52,260

Langley being the lead most of the

623

00:25:54,950 --> 00:25:53,549

flight activity occurring back at

624

00:25:56,750 --> 00:25:54,960

Langley and the modification activity

625

00:25:59,390 --> 00:25:56,760

occurring there we will provide the

626
00:26:02,000 --> 00:25:59,400
support as necessary to get that

627
00:26:05,150 --> 00:26:02,010
airplane in the air back there the

628
00:26:08,180 --> 00:26:05,160
second airplane ship 2 is the

629
00:26:10,909 --> 00:26:08,190
centerpiece of the laminar flow control

630
00:26:13,130 --> 00:26:10,919
phase of the high-speed research program

631
00:26:15,409 --> 00:26:13,140
and that airplane currently is

632
00:26:17,659 --> 00:26:15,419
configured with a passive glove which is

633
00:26:21,070 --> 00:26:17,669
no suction at all it's just a foam and

634
00:26:22,820 --> 00:26:21,080
fiberglass glove on the right wing and

635
00:26:24,980 --> 00:26:22,830
with that we'll be examining

636
00:26:29,480 --> 00:26:24,990
attachment-line criteria pressure

637
00:26:31,130 --> 00:26:29,490
distribution verification since they

638
00:26:33,350 --> 00:26:31,140

predicted that they designed the shape

639

00:26:34,640 --> 00:26:33,360

based on codes and we're going to go out

640

00:26:36,080 --> 00:26:34,650

and see if that shape really is

641

00:26:38,570 --> 00:26:36,090

providing the pressure distribution we

642

00:26:40,280 --> 00:26:38,580

had hoped for transition data where is

643

00:26:42,799 --> 00:26:40,290

laminar flow occurring on a passive

644

00:26:44,690 --> 00:26:42,809

surface that's shaped to be conducive to

645

00:26:47,240 --> 00:26:44,700

laminar flow in a supersonic flight

646

00:26:48,919 --> 00:26:47,250

environment and that's that's probably a

647

00:26:51,260 --> 00:26:48,929

four to six month flight program that we

648

00:26:52,730 --> 00:26:51,270

have planned there and at the term at

649

00:26:54,470 --> 00:26:52,740

the completion of that flight program

650

00:26:58,330 --> 00:26:54,480

that airplane will go back into

651
00:27:00,980 --> 00:26:58,340
modification for the installation of the

652
00:27:04,090 --> 00:27:00,990
big experiment if you will and that's

653
00:27:06,380 --> 00:27:04,100
the one where we'll be putting a glove

654
00:27:07,789 --> 00:27:06,390
suction glove on the airplane it'll go

655
00:27:11,150 --> 00:27:07,799
on the left wing of the airplane it'll

656
00:27:13,310 --> 00:27:11,160
be it'll go roughly back to 50 or 60

657
00:27:15,169 --> 00:27:13,320
percent cord and that one will use

658
00:27:19,880 --> 00:27:15,179
suction to try to maintain laminar flow

659
00:27:22,100 --> 00:27:19,890
that far back these gloves are basically

660
00:27:24,169 --> 00:27:22,110
almost full span for the 70 degrees

661
00:27:26,030 --> 00:27:24,179
swept portion of the wing the wing is

662
00:27:28,190 --> 00:27:26,040
the airplanes claim to fame is it's the

663
00:27:31,010 --> 00:27:28,200

cranked arrow it's got a 70 degree swept

664

00:27:33,080 --> 00:27:31,020

portion and then it bends three-quarters

665

00:27:35,270 --> 00:27:33,090

the way out to the wingtip it bends to a

666

00:27:37,520 --> 00:27:35,280

50 degree sweep and the section inboard

667

00:27:38,780 --> 00:27:37,530

of the 50 degree sweep is where we put

668

00:27:42,380 --> 00:27:38,790

all of the experiments because that's

669

00:27:44,150 --> 00:27:42,390

where our 70 degrees is so the second

670

00:27:46,430 --> 00:27:44,160

airplane will be a very busy airplane

671

00:27:48,200 --> 00:27:46,440

it's we're hoping to collect the entire

672

00:27:50,960 --> 00:27:48,210

database for the high speed civil

673

00:27:54,470 --> 00:27:50,970

transport laminar flow control effort by

674

00:27:55,820 --> 00:27:54,480

the end of fiscal year 95 and of course

675

00:27:57,740 --> 00:27:55,830

we don't have the glove on the airplane

676
00:28:05,000 --> 00:27:57,750
yet so you know we've got a lot of work

677
00:28:07,010 --> 00:28:05,010
ahead of us to try to get it all done it

678
00:28:08,900 --> 00:28:07,020
is on it is on and in fact we're hoping

679
00:28:12,170 --> 00:28:08,910
to have the first flight for that

680
00:28:14,180 --> 00:28:12,180
airplane in that configuration before

681
00:28:15,710 --> 00:28:14,190
the before the end of August and we're

682
00:28:17,330 --> 00:28:15,720
hopeful that it'll actually be the first

683
00:28:31,810 --> 00:28:17,340
or second week of August I will actually

684
00:28:38,180 --> 00:28:35,510
the glove itself is of course the skin

685
00:28:41,300 --> 00:28:38,190
is porous it's a piece of titanium sheet

686
00:28:43,250 --> 00:28:41,310
that has 2,500 holes per square inch

687
00:28:48,860 --> 00:28:43,260
laser drilled holes per square inch and

688
00:28:51,410 --> 00:28:48,870

then beneath that is a corrugated

689

00:28:53,510 --> 00:28:51,420

substructure and it's we call it flutes

690

00:28:55,220 --> 00:28:53,520

and basically what it looks like is a

691

00:28:57,200 --> 00:28:55,230

piece of cardboard if you will if you

692

00:28:59,180 --> 00:28:57,210

look at the cardboard corrugations

693

00:29:01,490 --> 00:28:59,190

that's basically what's underneath and

694

00:29:03,230 --> 00:29:01,500

we sucked the air span-wise using a

695

00:29:05,420 --> 00:29:03,240

suction pump that's located in the

696

00:29:06,980 --> 00:29:05,430

fuselage of the airplane we sucked the

697

00:29:09,860 --> 00:29:06,990

air through the hole the porous holes

698

00:29:11,360 --> 00:29:09,870

span-wise and then in this case we're

699

00:29:13,580 --> 00:29:11,370

just dumping it overboard because we

700

00:29:15,110 --> 00:29:13,590

have no use for it in a high-speed civil

701
00:29:17,960 --> 00:29:15,120
transport there may be some use for that

702
00:29:19,340 --> 00:29:17,970
air somewhere else but not in this case

703
00:29:20,450 --> 00:29:19,350
we're not worried about total

704
00:29:24,710 --> 00:29:20,460
integration we're just worried about

705
00:29:27,830 --> 00:29:24,720
determining laminar flow requirements so

706
00:29:32,860 --> 00:29:27,840
when we regulate the suction level what

707
00:29:35,960 --> 00:29:32,870
we really do is reduce the suction pump

708
00:29:37,430 --> 00:29:35,970
pumping capability now we haven't done

709
00:29:39,290 --> 00:29:37,440
any of that yet all we're trying to do

710
00:29:41,120 --> 00:29:39,300
is document how much suction we have

711
00:29:43,340 --> 00:29:41,130
right now for the results we've gotten

712
00:29:45,740 --> 00:29:43,350
right now we have a fast-paced program

713
00:29:49,160 --> 00:29:45,750

here that we may delete some of the some

714

00:29:50,750 --> 00:29:49,170

of the nice-to-have objectives and one

715

00:29:53,600 --> 00:29:50,760

of those things is to look at the effect

716

00:29:55,130 --> 00:29:53,610

of changing the suction level and we we

717

00:29:57,350 --> 00:29:55,140

may run out of time to be able to

718

00:29:59,360 --> 00:29:57,360

do that in which case we'll we'll get