



1
00:00:21,140 --> 00:00:19,520
hi I'm Beth Wilson and today I am with

2
00:00:24,140 --> 00:00:21,150
our chair of the Aeronautics Department

3
00:00:25,970 --> 00:00:24,150
Bob van der Linden Bob how are you today

4
00:00:27,380 --> 00:00:25,980
I'm fine thank you how are you good

5
00:00:29,330 --> 00:00:27,390
Bob can you tell me where we're sitting

6
00:00:33,229 --> 00:00:29,340
this morning we are sitting in the

7
00:00:36,259 --> 00:00:33,239
cockpit of a Boeing 747 and why do we

8
00:00:39,110 --> 00:00:36,269
have a Boeing 747 in our collection well

9
00:00:41,000 --> 00:00:39,120
we have a 747 here so our visitors can

10
00:00:42,590 --> 00:00:41,010
get some idea of the scale and scope of

11
00:00:44,389 --> 00:00:42,600
what a modern airliner looks like and

12
00:00:46,579 --> 00:00:44,399
now we only have the nose cone is that

13
00:00:49,220 --> 00:00:46,589

correct that's correct why just the nose

14

00:00:50,299 --> 00:00:49,230

cone well primarily because the rest of

15

00:00:52,069 --> 00:00:50,309

the airplane would not fit in this

16

00:00:53,750 --> 00:00:52,079

building and where do we get this

17

00:00:55,819 --> 00:00:53,760

airplane we got this airplane from

18

00:00:57,919 --> 00:00:55,829

Northwest Airlines and do you want to

19

00:00:59,779 --> 00:00:57,929

show me exactly how big the whole

20

00:01:05,000 --> 00:00:59,789

airplane is I hope you glad to thanks

21

00:01:07,969 --> 00:01:05,010

Bob so this is just 35 feet then yes and

22

00:01:10,819 --> 00:01:07,979

so what is the plane double that size

23

00:01:12,679 --> 00:01:10,829

it's a bit bigger than that well how do

24

00:01:25,310 --> 00:01:12,689

I start walking why don't you tell me

25

00:01:47,280 --> 00:01:35,969

here Bob keep going how about now Bob

26
00:01:52,990 --> 00:01:47,290
almost there how about no Bob there you

27
00:01:59,680 --> 00:01:56,770
okay so how do you get a plane this big

28
00:02:29,880 --> 00:01:59,690
off the ground that's the four forces of

29
00:02:35,740 --> 00:02:32,980
hi I'm Beth Wilson and I'm coming to you

30
00:02:38,020 --> 00:02:35,750
live from the America by air gallery

31
00:02:40,600 --> 00:02:38,030
at the National Air and Space Museum in

32
00:02:42,700 --> 00:02:40,610
Washington DC and in this gallery we

33
00:02:45,850 --> 00:02:42,710
take a look at the history of commercial

34
00:02:48,390 --> 00:02:45,860
aviation beginning with early male

35
00:02:52,360 --> 00:02:48,400
planes going all the way to our Boeing

36
00:02:54,580 --> 00:02:52,370
747 nose cone now Bob and I talked a

37
00:02:56,320 --> 00:02:54,590
little bit about how we get a plane this

38
00:02:58,600 --> 00:02:56,330

big off the ground and to help me to

39

00:03:00,699 --> 00:02:58,610

cover the four forces flight I've got

40

00:03:02,890 --> 00:03:00,709

Marty here Marty do you want to explain

41

00:03:04,240 --> 00:03:02,900

how we get something this big off the

42

00:03:06,420 --> 00:03:04,250

ground sure so we're gonna talk about

43

00:03:09,910 --> 00:03:06,430

the four forces of flight those are

44

00:03:11,320 --> 00:03:09,920

weight drag lift and thrust so let's

45

00:03:14,229 --> 00:03:11,330

start with what keeps us on the ground

46

00:03:16,300 --> 00:03:14,239

and that's weight so weight is simply

47

00:03:18,640 --> 00:03:16,310

gravity pulling us back down towards the

48

00:03:20,229 --> 00:03:18,650

ground now everybody look around

49

00:03:23,500 --> 00:03:20,239

is anybody floating around up there in

50

00:03:25,240 --> 00:03:23,510

the in the ceiling no gravity is doing

51
00:03:27,370 --> 00:03:25,250
its job it's pulling us back here to

52
00:03:29,620 --> 00:03:27,380
earth so in order to fly we've got to

53
00:03:32,440 --> 00:03:29,630
counteract that weight the next ones

54
00:03:34,150 --> 00:03:32,450
drag and drag is the opposite motion

55
00:03:35,949 --> 00:03:34,160
that we want to go so if we want to go

56
00:03:37,570 --> 00:03:35,959
forward drag pulls us back and that's

57
00:03:39,340 --> 00:03:37,580
caused by friction and differences in

58
00:03:40,660 --> 00:03:39,350
air pressure now that's kind of hard to

59
00:03:42,580 --> 00:03:40,670
understand so I've got a little

60
00:03:44,140 --> 00:03:42,590
demonstration here I've got two pieces

61
00:03:46,360 --> 00:03:44,150
of paper they're exactly the same

62
00:03:49,600 --> 00:03:46,370
but if I take this one and I wad it up

63
00:03:50,830 --> 00:03:49,610

and then drop them Newton's laws tell us

64

00:03:54,000 --> 00:03:50,840

that they should hit the ground at the

65

00:03:56,949 --> 00:03:54,010

exact same time but watch what happens

66

00:03:58,479 --> 00:03:56,959

the wadded-up paper hit way faster than

67

00:04:00,430 --> 00:03:58,489

the one that stayed flat and that's

68

00:04:02,860 --> 00:04:00,440

because of drag the friction of the air

69

00:04:05,229 --> 00:04:02,870

coming down with the flat one caused it

70

00:04:06,880 --> 00:04:05,239

to go slower so those are the two forces

71

00:04:08,680 --> 00:04:06,890

that keep us on the ground well that's

72

00:04:11,170 --> 00:04:08,690

very nice but that doesn't tell me how

73

00:04:13,270 --> 00:04:11,180

we get up into the air and stay there

74

00:04:14,680 --> 00:04:13,280

exactly so it takes two other forces to

75

00:04:16,539 --> 00:04:14,690

get us up into the air and to keep us

76

00:04:18,190 --> 00:04:16,549

there the first is lift lift is the

77

00:04:20,349 --> 00:04:18,200

force that pushes us up into the air

78

00:04:22,810 --> 00:04:20,359

it's mm and it's caused by differences

79

00:04:24,850 --> 00:04:22,820

in air pressure so let's take a look at

80

00:04:26,320 --> 00:04:24,860

this airfoil this is an airplane wing

81

00:04:28,540 --> 00:04:26,330

that's basically been chopped up like a

82

00:04:30,940 --> 00:04:28,550

loaf of bread the bottom of this wing is

83

00:04:33,070 --> 00:04:30,950

nice and flat the top is curved now

84

00:04:34,390 --> 00:04:33,080

pressure pushes down on all sides of

85

00:04:36,400 --> 00:04:34,400

this wing all the

86

00:04:38,470 --> 00:04:36,410

but as it flies through the air the air

87

00:04:40,660 --> 00:04:38,480

going over the top gets squeezed down

88

00:04:42,460 --> 00:04:40,670

and goes faster and that creates a

89

00:04:44,920 --> 00:04:42,470

low-pressure area over the top of the

90

00:04:47,440 --> 00:04:44,930

wing the high pressure underneath pushes

91

00:04:50,380 --> 00:04:47,450

that wing up into the air that's kind of

92

00:04:52,150 --> 00:04:50,390

confusing you guys get that let's try an

93

00:04:54,280 --> 00:04:52,160

example you guys all have a strip of

94

00:04:56,350 --> 00:04:54,290

paper in your hands hold those up we're

95

00:04:57,850 --> 00:04:56,360

gonna put them up above our top lip and

96

00:04:59,290 --> 00:04:57,860

we're gonna blow okay what do you think

97

00:05:04,750 --> 00:04:59,300

is gonna happen is it gonna go up or

98

00:05:06,070 --> 00:05:04,760

down it's gonna go okay let's see the

99

00:05:07,930 --> 00:05:06,080

paper went up and that's simply because

100

00:05:10,150 --> 00:05:07,940

we blew air underneath it and push that

101
00:05:12,280 --> 00:05:10,160
paper up now we're gonna hold that same

102
00:05:13,630 --> 00:05:12,290
piece of paper under our bottom lip and

103
00:05:15,280 --> 00:05:13,640
we're gonna blow over the top of it

104
00:05:15,510 --> 00:05:15,290
what's gonna happen is it gonna go up or

105
00:05:21,760 --> 00:05:15,520
down

106
00:05:24,130 --> 00:05:21,770
came up that's because we cause that air

107
00:05:26,200 --> 00:05:24,140
to go faster over the top and then and

108
00:05:28,090 --> 00:05:26,210
create a low-pressure area underneath we

109
00:05:31,090 --> 00:05:28,100
had higher pressure that push that paper

110
00:05:32,500 --> 00:05:31,100
up into the air so that's lift but

111
00:05:34,780 --> 00:05:32,510
that's not the only force that we need

112
00:05:35,650 --> 00:05:34,790
we also need thrust if you take a look

113
00:05:38,440 --> 00:05:35,660

at this propeller

114

00:05:40,240 --> 00:05:38,450

it's shaped like an airfoil when we turn

115

00:05:42,820 --> 00:05:40,250

that on its side it gives us forward

116

00:05:45,460 --> 00:05:42,830

motion which is thrust so lift gets us

117

00:05:48,010 --> 00:05:45,470

into the air thrust keeps us in the air

118

00:05:51,340 --> 00:05:48,020

okay and you said that propellers create

119

00:05:53,200 --> 00:05:51,350

thrust yes there's no propeller on this

120

00:05:55,330 --> 00:05:53,210

airplane there are not but a lot of the

121

00:05:57,070 --> 00:05:55,340

same concepts are used in jet engines if

122

00:05:59,170 --> 00:05:57,080

you look at this cutaway of an airplane

123

00:06:02,080 --> 00:05:59,180

jet engine you'll see that on the inside

124

00:06:04,570 --> 00:06:02,090

is a series of air foils just like this

125

00:06:07,900 --> 00:06:04,580

propeller and it pulls that air into the

126
00:06:09,760 --> 00:06:07,910
engine creating thrust so we create that

127
00:06:13,150 --> 00:06:09,770
thrust to get us up into the air

128
00:06:14,770 --> 00:06:13,160
now this plane is significantly

129
00:06:16,660 --> 00:06:14,780
different than the Wright brothers plane

130
00:06:18,880 --> 00:06:16,670
or any plane with a propeller the

131
00:06:21,370 --> 00:06:18,890
designs have changed dramatically in the

132
00:06:23,170 --> 00:06:21,380
last hundred years and the materials

133
00:06:25,390 --> 00:06:23,180
that we've used have changed a lot but

134
00:06:27,610 --> 00:06:25,400
those four forces of flight have stayed

135
00:06:29,740 --> 00:06:27,620
the same okay so every single airplane

136
00:06:31,660 --> 00:06:29,750
in this gallery relies on the four

137
00:06:32,950 --> 00:06:31,670
forces of flight to get us off the

138
00:06:34,780 --> 00:06:32,960

ground and to stay in the air it's

139

00:06:36,430 --> 00:06:34,790

exactly right okay and I think we have

140

00:06:39,460 --> 00:06:36,440

an online question can we get an online

141

00:06:43,930 --> 00:06:39,470

question how do you do helicopters work

142

00:06:45,580 --> 00:06:43,940

the same way as airplanes they do if we

143

00:06:47,050 --> 00:06:45,590

look at the propeller again you'll see

144

00:06:47,710 --> 00:06:47,060

that it looks very similar to what's on

145

00:06:49,840 --> 00:06:47,720

the top of hill

146

00:06:51,880 --> 00:06:49,850

copter it's got these air foils and when

147

00:06:53,440 --> 00:06:51,890

it spins it creates that low pressure on

148

00:06:55,210 --> 00:06:53,450

the top higher pressure underneath

149

00:06:57,070 --> 00:06:55,220

because the air going over the top is

150

00:06:58,870 --> 00:06:57,080

faster low pressure there

151
00:07:00,580 --> 00:06:58,880
high pressure underneath and it gives us

152
00:07:03,070 --> 00:07:00,590
lift that takes the helicopter up into

153
00:07:04,840 --> 00:07:03,080
the air so a helicopter is works the

154
00:07:08,380 --> 00:07:04,850
same way it's just a little different

155
00:07:11,050 --> 00:07:08,390
look exactly okay now today's show we're

156
00:07:15,250 --> 00:07:11,060
going to talk about composites but

157
00:07:16,930 --> 00:07:15,260
before we get started on the composite

158
00:07:19,240 --> 00:07:16,940
part of it I've got a 30 second

159
00:08:00,480 --> 00:07:19,250
challenge for you all so let's get

160
00:08:08,620 --> 00:08:03,820
okay so does anyone have a guess of what

161
00:08:10,930 --> 00:08:08,630
this might be just a guess

162
00:08:14,500 --> 00:08:10,940
give me a guess good what do you think

163
00:08:15,250 --> 00:08:14,510

it is it is it's part of an airplane

164

00:08:17,470 --> 00:08:15,260

okay

165

00:08:19,300 --> 00:08:17,480

this is actually part of a composite

166

00:08:22,720 --> 00:08:19,310

airplane and you can see it's like

167

00:08:26,650 --> 00:08:22,730

really light but it needs to be very

168

00:08:28,660 --> 00:08:26,660

strong in order to build an airplane out

169

00:08:30,280 --> 00:08:28,670

of it so we're gonna test this strength

170

00:08:32,110 --> 00:08:30,290

and to do that I need a volunteer out of

171

00:08:40,750 --> 00:08:32,120

the audience you want to come up come

172

00:08:47,230 --> 00:08:40,760

right here we have hold on a second we

173

00:08:50,860 --> 00:08:47,240

have this but we have to be safe because

174

00:08:52,570 --> 00:08:50,870

you know you're gonna hit this all right

175

00:08:56,170 --> 00:08:52,580

we don't want pieces to go flying into

176

00:09:00,190 --> 00:08:56,180

your eyes so on the count of three all

177

00:09:05,500 --> 00:09:00,200

right hit it as hard as you can one two

178

00:09:11,950 --> 00:09:05,510

three but that little hammer didn't do

179

00:09:15,040 --> 00:09:11,960

much but keep them on what do you think

180

00:09:23,770 --> 00:09:15,050

about this one do you guys think this is

181

00:09:29,410 --> 00:09:23,780

going to do it one two three what do you

182

00:09:32,110 --> 00:09:29,420

think no there's there's there's it

183

00:09:37,000 --> 00:09:32,120

didn't break did it so not only is it

184

00:09:40,570 --> 00:09:37,010

light but it's also strong right now we

185

00:09:43,060 --> 00:09:40,580

don't have a composite plane in our

186

00:09:45,190 --> 00:09:43,070

museum here but our friends at the

187

00:09:48,730 --> 00:09:45,200

Museum of Flight in Seattle do have a

188

00:09:51,430 --> 00:09:48,740

Boeing Dreamliner and they're chief

189

00:09:53,470 --> 00:09:51,440

curator Dan Hagedorn is going to show us

190

00:09:55,870 --> 00:09:53,480

some of that plane right now

191

00:09:57,670 --> 00:09:55,880

I'm an excellent curator here at the

192

00:09:58,470 --> 00:09:57,680

Museum of flying at historic Boeing

193

00:10:00,510 --> 00:09:58,480

Field

194

00:10:02,310 --> 00:10:00,520

the beautiful blowing 787 dreamliner

195

00:10:04,520 --> 00:10:02,320

that you see behind me represents the

196

00:10:06,870 --> 00:10:04,530

state-of-the-art in composite technology

197

00:10:08,190 --> 00:10:06,880

I'd like you to come on board with me

198

00:10:09,960 --> 00:10:08,200

and take a look at some of the wonderful

199

00:10:11,790 --> 00:10:09,970

things that composite technology is

200

00:10:16,200 --> 00:10:11,800

going to do for you as a member of the

201
00:10:17,730 --> 00:10:16,210
traveling public seven green wire one of

202
00:10:22,900 --> 00:10:17,740
the first thing to recognize is how

203
00:10:28,210 --> 00:10:25,210
traditional wrinkles

204
00:10:30,069 --> 00:10:28,220
vivid lines panel lines and so forth if

205
00:10:32,679 --> 00:10:30,079
you find on traditional metal build

206
00:10:34,350 --> 00:10:32,689
aircraft you will find about every six

207
00:10:36,540 --> 00:10:34,360
times on the year

208
00:10:38,250 --> 00:10:36,550
enjoy seed however where the different

209
00:10:40,450 --> 00:10:38,260
barrels as they call them or joined

210
00:10:43,180 --> 00:10:40,460
together to form the fuselage

211
00:10:45,730 --> 00:10:43,190
these were extremely smooth

212
00:10:50,189 --> 00:10:45,740
and extremely strong may contribute

213
00:10:55,120 --> 00:10:52,960

one of the most interesting engineering

214

00:10:55,689 --> 00:10:55,130

developments in the boeing 787

215

00:10:57,430 --> 00:10:55,699

dreamliner

216

00:11:00,519 --> 00:10:57,440

are its ranks which of course are also

217

00:11:02,379 --> 00:11:00,529

made of composite materials one thing

218

00:11:04,090 --> 00:11:02,389

that's noted by passengers and those on

219

00:11:06,220 --> 00:11:04,100

the ground like is the incredible degree

220

00:11:08,530 --> 00:11:06,230

of flex in the wing structure while the

221

00:11:09,879 --> 00:11:08,540

aircraft is in flight this often

222

00:11:13,290 --> 00:11:09,889

referred to when you look at the

223

00:11:15,970 --> 00:11:13,300

aircraft goes on as the Boeing smile

224

00:11:18,460 --> 00:11:15,980

when Boeing was testing the engineering

225

00:11:21,129 --> 00:11:18,470

on those wings they flexed as much as 25

226

00:11:23,139 --> 00:11:21,139

feet at the wingtips displaying not only

227

00:11:25,389 --> 00:11:23,149

the rigidity of the wings and their

228

00:11:27,040 --> 00:11:25,399

ability to flex but also the fact that

229

00:11:28,840 --> 00:11:27,050

they gave them much more comfortable

230

00:11:30,939 --> 00:11:28,850

ride to the passengers onboard the

231

00:11:36,970 --> 00:11:30,949

aircraft without any risk to the

232

00:11:39,639 --> 00:11:36,980

aircraft whatsoever okay okay so that is

233

00:11:41,410 --> 00:11:39,649

a quick view of a Boeing Dreamliner and

234

00:11:43,420 --> 00:11:41,420

we are going to talk more about

235

00:11:46,449 --> 00:11:43,430

composites now and I'm so lucky to have

236

00:11:48,340 --> 00:11:46,459

material engineer here Arlene Brown from

237

00:11:51,250 --> 00:11:48,350

the Boeing Company now we've been

238

00:11:53,980 --> 00:11:51,260

talking about airplane composites but

239

00:11:55,840 --> 00:11:53,990

obviously these aren't pieces of

240

00:11:58,689 --> 00:11:55,850

airplanes do you want to tell me why we

241

00:12:00,280 --> 00:11:58,699

have this out here yeah if you make

242

00:12:03,340 --> 00:12:00,290

something that big you really want to be

243

00:12:06,160 --> 00:12:03,350

able to recycle it right so it turns out

244

00:12:08,019 --> 00:12:06,170

plastics the type that are in water

245

00:12:11,079 --> 00:12:08,029

bottles for instance those will melt and

246

00:12:13,540 --> 00:12:11,089

they're easy to recycle but this is

247

00:12:16,120 --> 00:12:13,550

basically an epoxy composite in our

248

00:12:18,430 --> 00:12:16,130

airplane and so we needed to develop a

249

00:12:20,949 --> 00:12:18,440

method and so for instance the raw

250

00:12:24,160 --> 00:12:20,959

materials can turn into something like

251
00:12:26,319 --> 00:12:24,170
this if we have some excess or we can

252
00:12:28,180 --> 00:12:26,329
even take the actual finish composite

253
00:12:31,000 --> 00:12:28,190
parts like when we cut our circle out

254
00:12:33,189 --> 00:12:31,010
for the window and another company can

255
00:12:36,280 --> 00:12:33,199
go chop them up and turn them into parts

256
00:12:40,000 --> 00:12:36,290
and this is actually chopped fiber that

257
00:12:42,069 --> 00:12:40,010
originally came from a an airplane base

258
00:12:44,530 --> 00:12:42,079
okay so what you're telling me is that

259
00:12:46,300 --> 00:12:44,540
I'm not going to find a Dreamliner in

260
00:12:49,720 --> 00:12:46,310
one of those airplane graveyards you can

261
00:12:51,670 --> 00:12:49,730
recycle it exactly okay so I think what

262
00:12:54,670 --> 00:12:51,680
we'd like to do now is take a look at

263
00:12:58,150 --> 00:12:54,680

actually how we make the parts of the

264

00:13:00,670 --> 00:12:58,160

airplane using composites goo like epoxy

265

00:13:02,430 --> 00:13:00,680

resin is already on this slick carbon

266

00:13:05,470 --> 00:13:02,440

tape that is being put onto spools

267

00:13:07,990 --> 00:13:05,480

spools feed the custom carbon tape into

268

00:13:09,940 --> 00:13:08,000

a robot head this automated fiber

269

00:13:12,519 --> 00:13:09,950

placement process allows us to place a

270

00:13:14,470 --> 00:13:12,529

composite material where it's needed and

271

00:13:17,829 --> 00:13:14,480

in the direction we want for efficient

272

00:13:19,900 --> 00:13:17,839

design using heat and pressure the robot

273

00:13:22,150 --> 00:13:19,910

head lays the tape onto a rotating

274

00:13:24,639 --> 00:13:22,160

barrel the barrel is sealed under

275

00:13:26,319 --> 00:13:24,649

bagging materials and the air removed it

276

00:13:27,850 --> 00:13:26,329

is then baked in one of the world's

277

00:13:30,400 --> 00:13:27,860

largest autoclaves

278

00:13:33,040 --> 00:13:30,410

an autoclave is a giant oven that

279

00:13:35,170 --> 00:13:33,050

applies pressure once the part is done

280

00:13:37,509 --> 00:13:35,180

baking we remove it and take off the

281

00:13:39,370 --> 00:13:37,519

bagging the part is then inspected and

282

00:13:42,130 --> 00:13:39,380

joined to the other airplane sections

283

00:13:44,410 --> 00:13:42,140

this process allows us to make large

284

00:13:49,199 --> 00:13:44,420

integrated structure and minimizes waste

285

00:13:56,259 --> 00:13:53,110

okay Arlene so I have a piece of

286

00:13:58,090 --> 00:13:56,269

composite here but what you have are the

287

00:14:02,170 --> 00:13:58,100

raw material so do you want to tell us a

288

00:14:06,280 --> 00:14:02,180

little bit about what these are as

289

00:14:08,769 --> 00:14:06,290

compared to this oh I'd love to so this

290

00:14:12,850 --> 00:14:08,779

is epoxy resin otherwise known as glue

291

00:14:15,009 --> 00:14:12,860

and it actually is basically kind of a

292

00:14:17,769 --> 00:14:15,019

liquid form though when we we marry it

293

00:14:19,810 --> 00:14:17,779

up with the carbon fiber you just saw

294

00:14:21,639 --> 00:14:19,820

the carbon fiber on those spools going

295

00:14:24,460 --> 00:14:21,649

out and those spools actually have a

296

00:14:28,569 --> 00:14:24,470

little bit of this in that fiber and

297

00:14:31,870 --> 00:14:28,579

then what we make is something that we

298

00:14:33,819 --> 00:14:31,880

said we sometimes call prepreg and we

299

00:14:36,189 --> 00:14:33,829

take this material and this is what the

300

00:14:39,130 --> 00:14:36,199

form is when it goes into the basically

301
00:14:42,310 --> 00:14:39,140
the autoclave which is a giant oven when

302
00:14:46,949 --> 00:14:42,320
it comes out it looks like this okay so

303
00:14:52,960 --> 00:14:46,959
this baked is this but this is really

304
00:14:55,120 --> 00:14:52,970
smooth here but my piece it looks like

305
00:14:57,189 --> 00:14:55,130
it has fabric in it this this doesn't

306
00:14:59,829 --> 00:14:57,199
look the same what what's the difference

307
00:15:01,930 --> 00:14:59,839
between this and my actual airplane part

308
00:15:04,180 --> 00:15:01,940
well the thing that we call

309
00:15:06,819 --> 00:15:04,190
reinforcement instead of just being one

310
00:15:08,889 --> 00:15:06,829
piece of tow is actually woven into a

311
00:15:11,980 --> 00:15:08,899
fabric in kind of the same way that you

312
00:15:14,070 --> 00:15:11,990
close them for actually woven okay now

313
00:15:16,710 --> 00:15:14,080

the students that we

314

00:15:18,840 --> 00:15:16,720

here are from Jefferson Academy and they

315

00:15:20,430 --> 00:15:18,850

actually built some composite materials

316

00:15:21,780 --> 00:15:20,440

and ran some experiments would you like

317

00:15:34,800 --> 00:15:21,790

to take a look oh that would be terrific

318

00:15:39,610 --> 00:15:37,690

alright guys today we are gonna test our

319

00:15:41,020 --> 00:15:39,620

composites and I can't wait to see how

320

00:15:43,240 --> 00:15:41,030

you guys did in building them yesterday

321

00:15:45,790 --> 00:15:43,250

so let's review a little bit of

322

00:15:48,010 --> 00:15:45,800

composite is any material that's made of

323

00:15:49,510 --> 00:15:48,020

two or more materials put together and

324

00:15:51,730 --> 00:15:49,520

it gives it a different characteristic

325

00:15:53,350 --> 00:15:51,740

for example today we're going to be

326

00:15:54,190 --> 00:15:53,360

testing some composite materials that

327

00:15:55,870 --> 00:15:54,200

you guys made

328

00:16:01,740 --> 00:15:55,880

now the first test we're going to do is

329

00:16:04,960 --> 00:16:03,880

we're gonna take two pieces of cardstock

330

00:16:06,760 --> 00:16:04,970

and we're going to test them we're gonna

331

00:16:08,650 --> 00:16:06,770

lay them on top of each other and test

332

00:16:12,550 --> 00:16:08,660

how much strength they have is that a

333

00:16:14,410 --> 00:16:12,560

composite no it's just the same material

334

00:16:15,970 --> 00:16:14,420

it just happens to be two pieces of it

335

00:16:21,040 --> 00:16:15,980

what's the next thing that we're gonna

336

00:16:22,450 --> 00:16:21,050

test what are we gonna test next yeah

337

00:16:24,040 --> 00:16:22,460

we're gonna take two card stocks and you

338

00:16:26,980 --> 00:16:24,050

guys blew them together yesterday is

339

00:16:28,450 --> 00:16:26,990

that a composite material yeah because

340

00:16:30,280 --> 00:16:28,460

it's got two different materials

341

00:16:32,470 --> 00:16:30,290

combined and we're hoping that it

342

00:16:36,780 --> 00:16:32,480

increases the strength so what was the

343

00:16:40,570 --> 00:16:38,350

that's exactly right

344

00:16:42,850 --> 00:16:40,580

a layer cardstock glue a layer

345

00:16:44,890 --> 00:16:42,860

fiberglass cloth more glue and layer

346

00:16:46,600 --> 00:16:44,900

cardstock so let me show you guys how

347

00:16:48,430 --> 00:16:46,610

we're gonna set this up today and I'll

348

00:16:50,320 --> 00:16:48,440

use this as our example

349

00:16:52,180 --> 00:16:50,330

you guys all built your testing

350

00:16:53,260 --> 00:16:52,190

apparatus yesterday and the way that

351

00:16:55,630 --> 00:16:53,270

you're gonna do this is you're gonna

352

00:16:59,080 --> 00:16:55,640

come over here you're gonna reach in and

353

00:17:02,740 --> 00:16:59,090

pull your string up and then you're

354

00:17:04,900 --> 00:17:02,750

gonna slide this through it everybody

355

00:17:06,130 --> 00:17:04,910

see that then after you do that you're

356

00:17:08,829 --> 00:17:06,140

gonna come over here and you're very

357

00:17:10,720 --> 00:17:08,839

slowly remember very very slowly you're

358

00:17:13,390 --> 00:17:10,730

gonna pour that water into the funnel

359

00:17:15,610 --> 00:17:13,400

we're gonna weigh this before we start

360

00:17:18,220 --> 00:17:15,620

to get a baseline on it and then we're

361

00:17:19,660 --> 00:17:18,230

gonna weigh it after it it fails to see

362

00:17:21,790 --> 00:17:19,670

how much water it held see how much

363

00:18:52,100 --> 00:17:21,800

weight your composite was able to hold

364

00:18:58,740 --> 00:18:56,070

look at this guy's the paper cut before

365

00:19:01,140 --> 00:18:58,750

the composite gave away so the string on

366

00:19:02,940 --> 00:19:01,150

there actually cut into the paper before

367

00:19:05,039 --> 00:19:02,950

it had a chance for that composite to

368

00:19:08,060 --> 00:19:05,049

give away that's awesome

369

00:19:11,480 --> 00:19:08,070

your composite held up great how much

370

00:19:12,260 --> 00:19:11,490

a hundred and six that's amazing good

371

00:19:16,490 --> 00:19:12,270

job guys

372

00:19:19,010 --> 00:19:16,500

and this was the one you built okay so

373

00:19:20,420 --> 00:19:19,020

it looked like they were very successful

374

00:19:22,150 --> 00:19:20,430

with their composites the kids did a

375

00:19:23,780 --> 00:19:22,160

great job building the composites

376

00:19:25,160 --> 00:19:23,790

actually we've got one of them that's

377

00:19:26,390 --> 00:19:25,170

gonna share their results alia you want

378

00:19:32,930 --> 00:19:26,400

to share your results with us hang your

379

00:19:36,410 --> 00:19:32,940

experiments a composite increase I could

380

00:19:39,670 --> 00:19:36,420

father increase the amount of water of

381

00:19:43,460 --> 00:19:39,680

how much water it was hole into the jet

382

00:19:46,790 --> 00:19:43,470

so there was more it held more weight

383

00:19:48,680 --> 00:19:46,800

which one worked the best the two

384

00:19:52,010 --> 00:19:48,690

composite with the fabric between them

385

00:19:54,200 --> 00:19:52,020

okay so the big composite deposit worked

386

00:19:55,190 --> 00:19:54,210

yeah because posits really increased the

387

00:19:57,980 --> 00:19:55,200

amount of strength that they were able

388

00:20:02,450 --> 00:19:57,990

to hold okay and do you want to start us

389

00:20:04,820 --> 00:20:02,460

off with a question yes since I'm an

390

00:20:07,880 --> 00:20:04,830

Avery how can composite help me in my

391

00:20:11,090 --> 00:20:07,890

everyday life so how can composites help

392

00:20:13,700 --> 00:20:11,100

somebody that's in eighth grade oh well

393

00:20:15,500 --> 00:20:13,710

Sporting Goods in general there's a lot

394

00:20:17,210 --> 00:20:15,510

of stuff that's coming out it's not just

395

00:20:20,030 --> 00:20:17,220

to be shown here it's tennis racquets

396

00:20:23,320 --> 00:20:20,040

golf clubs hockey sticks all sorts of

397

00:20:26,150 --> 00:20:23,330

things bikes now that are all lighter

398

00:20:28,820 --> 00:20:26,160

you'll find that they actually might be

399

00:20:31,310 --> 00:20:28,830

in some of the electronics that you have

400

00:20:33,470 --> 00:20:31,320

for instance and if you've got somebody

401
00:20:35,690 --> 00:20:33,480
that's driving you to and from hopefully

402
00:20:38,060 --> 00:20:35,700
that you know as we get more composites

403
00:20:40,940 --> 00:20:38,070
in the cars it's helping to reduce the

404
00:20:45,100 --> 00:20:40,950
gas bill the fuel bill and now we have

405
00:20:51,200 --> 00:20:48,140
why're composite composites an

406
00:20:54,200 --> 00:20:51,210
improvement over metal for for building

407
00:20:55,790 --> 00:20:54,210
airplanes well what we saw earlier today

408
00:20:57,799 --> 00:20:55,800
was a demonstration of really how

409
00:20:59,810 --> 00:20:57,809
durable they are because you have pale

410
00:21:01,730 --> 00:20:59,820
bottles and things like that but you

411
00:21:03,980 --> 00:21:01,740
especially have people that drop tools

412
00:21:06,500 --> 00:21:03,990
and stuff like that sometimes so that's

413
00:21:09,740 --> 00:21:06,510

just one thing they also they don't

414

00:21:11,180 --> 00:21:09,750

corrode they're more fatigue resistant

415

00:21:13,280 --> 00:21:11,190

which is has to do with when the

416

00:21:15,980 --> 00:21:13,290

pressure goes out and in for instance on

417

00:21:18,410 --> 00:21:15,990

the airplane and there's lower

418

00:21:19,730 --> 00:21:18,420

maintenance costs this is like the for

419

00:21:21,890 --> 00:21:19,740

the Dreamliner and we talkin thirty

420

00:21:23,330 --> 00:21:21,900

percent lower maintenance costs because

421

00:21:25,549 --> 00:21:23,340

all of these different things that add

422

00:21:27,320 --> 00:21:25,559

up and the other thing is part count we

423

00:21:29,840 --> 00:21:27,330

have almost two thirds the park count

424

00:21:32,950 --> 00:21:29,850

because we've got these huge integrated

425

00:21:35,900 --> 00:21:32,960

structure barrels instead of you know

426

00:21:37,690 --> 00:21:35,910

one barrel might be replacing over you

427

00:21:40,549 --> 00:21:37,700

know fifteen hundred pieces of aluminum

428

00:21:43,820 --> 00:21:40,559

that would go in a normal fuselage how

429

00:21:52,970 --> 00:21:43,830

many parts are in a Dreamliner around

430

00:21:55,910 --> 00:21:52,980

2.3 million got it three million and we

431

00:22:00,049 --> 00:21:55,920

have another online question we're here

432

00:22:05,900 --> 00:22:00,059

why Arkham the same question we have

433

00:22:07,940 --> 00:22:05,910

yeah well I have them web where have

434

00:22:10,669 --> 00:22:07,950

composites made the most difference on

435

00:22:14,210 --> 00:22:10,679

an airplane that's a tough one

436

00:22:17,270 --> 00:22:14,220

so I'm gonna go with the the combination

437

00:22:20,240 --> 00:22:17,280

of the exterior we've had composites on

438

00:22:23,210 --> 00:22:20,250

the interiors for a very long time and

439

00:22:26,000 --> 00:22:23,220

so with the the Dreamliner we went on

440

00:22:28,910 --> 00:22:26,010

the outside and it wasn't just that it

441

00:22:30,980 --> 00:22:28,920

was lighter it was because you can shape

442

00:22:33,590 --> 00:22:30,990

it from an aerodynamic point of view as

443

00:22:35,510 --> 00:22:33,600

well and you can put some sections thin

444

00:22:36,560 --> 00:22:35,520

and some sections thick instead of

445

00:22:38,530 --> 00:22:36,570

having to use the same thickness

446

00:22:40,760 --> 00:22:38,540

everywhere because you have different

447

00:22:43,640 --> 00:22:40,770

requirements and different needs in

448

00:22:46,010 --> 00:22:43,650

different places okay so the composites

449

00:22:48,890 --> 00:22:46,020

are great for the outside but our friend

450

00:22:51,049 --> 00:22:48,900

Dan out at Seattle is going to tell us

451

00:22:53,150 --> 00:22:51,059

how it's making a difference for the

452

00:22:55,020 --> 00:22:53,160

passengers on the inside of the

453

00:23:00,970 --> 00:22:55,030

Dreamliner

454

00:23:02,950 --> 00:23:00,980

zero zero three here at the museum of

455

00:23:05,350 --> 00:23:02,960

flight at historic Boeing Field in

456

00:23:07,090 --> 00:23:05,360

Seattle Washington now we're going to be

457

00:23:08,410 --> 00:23:07,100

taking a look around the interior of the

458

00:23:10,480 --> 00:23:08,420

aircraft to show you some of the

459

00:23:12,580 --> 00:23:10,490

passenger accommodations that have been

460

00:23:15,190 --> 00:23:12,590

made possible by the composite structure

461

00:23:16,660 --> 00:23:15,200

of this aircraft as you make your way to

462

00:23:17,860 --> 00:23:16,670

your seat on the Dreamliner there's

463

00:23:20,260 --> 00:23:17,870

several things that will become apparent

464

00:23:21,970 --> 00:23:20,270
to you very quickly the first thing

465

00:23:23,920 --> 00:23:21,980
you're going to notice is how quiet it

466

00:23:25,510 --> 00:23:23,930
is aboard this aircraft both on the

467

00:23:28,330 --> 00:23:25,520
ground while you're waiting to take off

468

00:23:30,190 --> 00:23:28,340
as well as in flight the second thing

469

00:23:31,720 --> 00:23:30,200
you're going to notice is the incredible

470

00:23:33,670 --> 00:23:31,730
feeling of spaciousness that the

471

00:23:36,060 --> 00:23:33,680
aircraft provides to you as you make

472

00:23:38,290 --> 00:23:36,070
your way through your flight this is

473

00:23:40,960 --> 00:23:38,300
facilitated by the fact of the overhead

474

00:23:42,910 --> 00:23:40,970
lighting you here you see and behind me

475

00:23:44,650 --> 00:23:42,920
the the blue lighting effect that is

476

00:23:46,150 --> 00:23:44,660

prevalent on the aircraft as we have are

477

00:23:48,220 --> 00:23:46,160

sitting here but there's also a

478

00:23:50,680 --> 00:23:48,230

wonderful rainbow effect that has a very

479

00:23:52,210 --> 00:23:50,690

calming influence something that's far

480

00:23:53,830 --> 00:23:52,220

more subtle however that you're not

481

00:23:57,130 --> 00:23:53,840

going to notice right away is the

482

00:23:59,560 --> 00:23:57,140

incredible degree of atmospheric control

483

00:24:01,150 --> 00:23:59,570

to the aircraft has a direct result of

484

00:24:02,980 --> 00:24:01,160

the composite structure of the aircraft

485

00:24:05,290 --> 00:24:02,990

you're going to feel as though you're

486

00:24:06,760 --> 00:24:05,300

flying at a lower level and the humidity

487

00:24:08,770 --> 00:24:06,770

controls aboard the aircraft are

488

00:24:10,620 --> 00:24:08,780

directly controlled by the crew itself

489

00:24:13,300 --> 00:24:10,630

it's going to feel much more comfortable

490

00:24:14,650 --> 00:24:13,310

but last but not least as the overhead

491

00:24:18,370 --> 00:24:14,660

bin something that we're all familiar

492

00:24:20,650 --> 00:24:18,380

with they deploy very very nicely aboard

493

00:24:24,040 --> 00:24:20,660

this aircraft and more importantly

494

00:24:26,440 --> 00:24:24,050

they're quite large these are all a

495

00:24:29,350 --> 00:24:26,450

direct result of the composite structure

496

00:24:31,300 --> 00:24:29,360

of this aircraft one of the wonderful

497

00:24:33,220 --> 00:24:31,310

passenger amenities provided by the

498

00:24:35,530 --> 00:24:33,230

composite structure of the Dreamliner is

499

00:24:37,510 --> 00:24:35,540

not only the relative location but the

500

00:24:38,830 --> 00:24:37,520

size of the passenger windows that

501
00:24:41,440 --> 00:24:38,840
you'll find at every one of the

502
00:24:43,090 --> 00:24:41,450
passenger seats am I left here and I'm

503
00:24:45,490 --> 00:24:43,100
sitting on a seat at the relative

504
00:24:47,860 --> 00:24:45,500
elevation of most of the standard coach

505
00:24:50,020 --> 00:24:47,870
seats and first and business class seats

506
00:24:53,800 --> 00:24:50,030
on the Dreamliner you'll notice that I

507
00:24:55,390 --> 00:24:53,810
don't have to do this or this or this in

508
00:24:58,300 --> 00:24:55,400
order to look out the window and have a

509
00:25:00,400 --> 00:24:58,310
panoramic view remember those pesky pull

510
00:25:02,830 --> 00:25:00,410
up pull down shades that you found on

511
00:25:05,950 --> 00:25:02,840
conventional airliners not going to find

512
00:25:07,480 --> 00:25:05,960
those on the 787 dreamliner instead

513
00:25:09,549 --> 00:25:07,490

every single passenger

514

00:25:11,530 --> 00:25:09,559

with the aircraft using this very simple

515

00:25:14,380 --> 00:25:11,540

control right below the portal right

516

00:25:16,900 --> 00:25:14,390

here controls a relative clarity or

517

00:25:20,200 --> 00:25:16,910

opaqueness of their individual window

518

00:25:22,000 --> 00:25:20,210

you can darken it you can lighten it and

519

00:25:23,830 --> 00:25:22,010

the relative degree of darkening is

520

00:25:26,560 --> 00:25:23,840

completely at the control of the

521

00:25:28,270 --> 00:25:26,570

individual passenger they can also be

522

00:25:29,710 --> 00:25:28,280

controlled from a central location by

523

00:25:32,740 --> 00:25:29,720

the flight attendants and the crew if

524

00:25:34,900 --> 00:25:32,750

necessary but in the final analysis

525

00:25:38,169 --> 00:25:34,910

every passenger has complete control

526

00:25:41,950 --> 00:25:38,179

over the relative clarity of the portal

527

00:25:44,320 --> 00:25:41,960

that they're sitting next to so Arlene

528

00:25:47,410 --> 00:25:44,330

one of the things that really intrigued

529

00:25:48,940 --> 00:25:47,420

me when we saw the inside is the larger

530

00:25:51,010 --> 00:25:48,950

windows because you know we're used to

531

00:25:53,410 --> 00:25:51,020

the small ones how come we can make the

532

00:25:55,780 --> 00:25:53,420

larger windows on the composite airplane

533

00:25:59,080 --> 00:25:55,790

that really goes back to that whole

534

00:26:01,900 --> 00:25:59,090

video we've got this huge composite

535

00:26:04,060 --> 00:26:01,910

barrel it's all in one material but

536

00:26:06,160 --> 00:26:04,070

we're able to lay in extra material

537

00:26:08,549 --> 00:26:06,170

around the window frames oh okay we

538

00:26:11,380 --> 00:26:08,559

don't have to penalize the whole thing

539

00:26:13,600 --> 00:26:11,390

for just those holes okay that's

540

00:26:15,100 --> 00:26:13,610

interesting and we have some audience

541

00:26:19,270 --> 00:26:15,110

questions so let's start with our

542

00:26:22,390 --> 00:26:19,280

audience how long does it takes to big a

543

00:26:25,630 --> 00:26:22,400

composite how long does it take to make

544

00:26:29,530 --> 00:26:25,640

a composite well a lot depends on what

545

00:26:31,180 --> 00:26:29,540

the size is and so there were some parts

546

00:26:32,890 --> 00:26:31,190

you could make in a half an hour and

547

00:26:35,500 --> 00:26:32,900

then you you know bake it for a few

548

00:26:37,600 --> 00:26:35,510

hours and some could could take days

549

00:26:39,460 --> 00:26:37,610

depends on what your size is and how

550

00:26:43,870 --> 00:26:39,470

complex it is and we have an online

551
00:26:46,480 --> 00:26:43,880
question what type of composite products

552
00:26:48,340 --> 00:26:46,490
can we expect in the future has the

553
00:26:52,419 --> 00:26:48,350
Space Agency helped in the development

554
00:26:55,770 --> 00:26:52,429
of composite materials so I'll take the

555
00:26:58,600 --> 00:26:55,780
second one first because the Space Age

556
00:27:00,910 --> 00:26:58,610
really was instrumental it was super

557
00:27:02,890 --> 00:27:00,920
important especially early on for

558
00:27:04,390 --> 00:27:02,900
developing the materials and you'd be

559
00:27:06,220 --> 00:27:04,400
surprised at the number of things that

560
00:27:08,290 --> 00:27:06,230
you're working on in the space arena

561
00:27:11,169 --> 00:27:08,300
that ultimately end up in the everyday

562
00:27:13,360 --> 00:27:11,179
world okay so very important and we do

563
00:27:15,850 --> 00:27:13,370

make things that we're metal rockets now

564

00:27:17,440 --> 00:27:15,860

we'll have for instance composite parts

565

00:27:18,310 --> 00:27:17,450

too so we're making those lighter and

566

00:27:22,630 --> 00:27:18,320

easier to live

567

00:27:24,520 --> 00:27:22,640

okay so we have one quick question can

568

00:27:26,650 --> 00:27:24,530

anything damage like a pause it can

569

00:27:29,410 --> 00:27:26,660

anything damage a composite yes

570

00:27:31,870 --> 00:27:29,420

so although we hammered it we were

571

00:27:33,970 --> 00:27:31,880

designing for people to drop tools and

572

00:27:36,730 --> 00:27:33,980

that sort of thing right but if you had

573

00:27:39,490 --> 00:27:36,740

something like a forklift and you run it

574

00:27:41,260 --> 00:27:39,500

in it will still go go through the side

575

00:27:43,620 --> 00:27:41,270

so they're not indestructible they're

576

00:27:46,690 --> 00:27:43,630

not indestructible and that reminds me

577

00:27:48,520 --> 00:27:46,700

there are a lot of different types of

578

00:27:51,040 --> 00:27:48,530

composites and plastics and I want to

579

00:27:53,040 --> 00:27:51,050

warn you we we custom-designed to the

580

00:27:55,450 --> 00:27:53,050

material that you saw us hammering on it

581

00:27:57,190 --> 00:27:55,460

doesn't mean necessarily that every

582

00:28:01,210 --> 00:27:57,200

composite you see you can treat that way

583

00:28:05,160 --> 00:28:01,220

okay well thank you so much Arlene this

584

00:28:07,540 --> 00:28:05,170

has been really very educational and

585

00:28:12,850 --> 00:28:07,550

that is all the time we have for this

586

00:28:15,190 --> 00:28:12,860

system and I'd like to thank our friends

587

00:28:16,660 --> 00:28:15,200

at the Museum of Flight in Seattle for

588

00:28:20,200 --> 00:28:16,670

the wonderful tour of their Dreamliner

589

00:28:22,990 --> 00:28:20,210

and my new co-host Marty and I'd also

590

00:28:25,810 --> 00:28:23,000

like to thank the Boeing Company and I