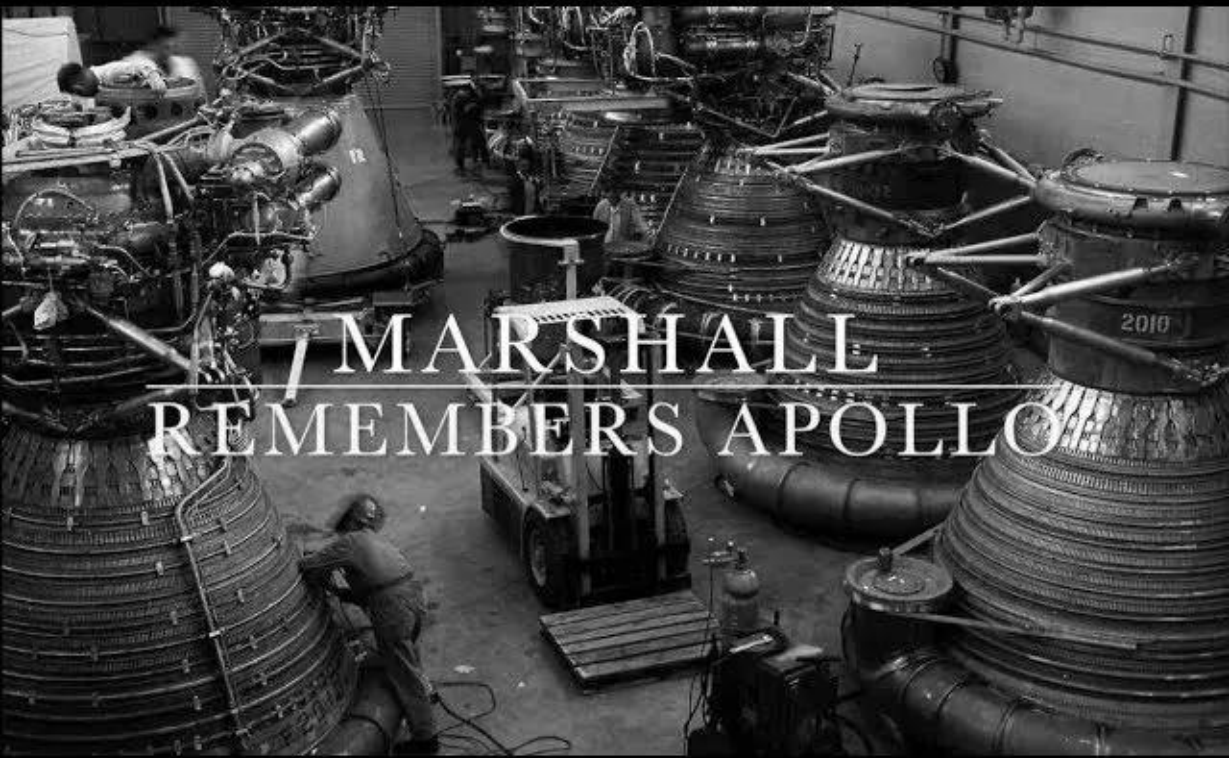
MARSHALL
REMEMBERS APOLLO

1
00:00:19,670 --> 00:00:16,480
[Music]

2
00:00:23,659 --> 00:00:19,680
actually I was raised in Madison County

3
00:00:27,769 --> 00:00:23,669
I was raised down at Newmarket and went

4
00:00:32,269 --> 00:00:27,779
school out there went to I went to

5
00:00:35,240 --> 00:00:32,279
Auburn got interested in a lady and she

6
00:00:37,310 --> 00:00:35,250
was an underclassman so I ended up

7
00:00:40,759 --> 00:00:37,320
staying at Auburn and getting a master's

8
00:00:43,009 --> 00:00:40,769
degree and and we eventually got married

9
00:00:45,890 --> 00:00:43,019
so you know things of all things worked

10
00:00:50,240 --> 00:00:45,900
out pretty good I graduated from high

11
00:00:55,250 --> 00:00:50,250
school here in 1953 so prior to that we

12
00:00:58,130 --> 00:00:55,260
moved to Huntsville when I was six years

13
00:01:00,770 --> 00:00:58,140

old my mom dad brought her dad in

14
00:01:04,090 --> 00:01:00,780
connect account II and so they moved up

15
00:01:08,179 --> 00:01:04,100
here data had his job with the state and

16
00:01:11,570 --> 00:01:08,189
it was during the war and so we knew

17
00:01:15,590 --> 00:01:11,580
things that was going on daddy then took

18
00:01:17,690 --> 00:01:15,600
us out to a new market and to keep me

19
00:01:21,230 --> 00:01:17,700
and my brothers and sisters off the

20
00:01:23,660 --> 00:01:21,240
streets of us feel and it was an old

21
00:01:26,600 --> 00:01:23,670
grown over place and so they ended up

22
00:01:29,270 --> 00:01:26,610
putting us to work and that's the way we

23
00:01:32,810 --> 00:01:29,280
stayed out of trouble mother always had

24
00:01:36,230 --> 00:01:32,820
something for us to do well I got a BS

25
00:01:38,020 --> 00:01:36,240
degree in 57 there wasn't a really lot

26
00:01:41,630 --> 00:01:38,030
of people around knocking on my door

27
00:01:45,620 --> 00:01:41,640
trying to recruit me I'd found this girl

28
00:01:47,840 --> 00:01:45,630
down there that I was dating and turned

29
00:01:51,469 --> 00:01:47,850
out I was started dating her and I was a

30
00:01:54,260 --> 00:01:51,479
senior and she's a freshman and so I had

31
00:01:56,120 --> 00:01:54,270
a friend of mine there my roommate he

32
00:02:00,649 --> 00:01:56,130
said well why don't we just go to

33
00:02:03,110 --> 00:02:00,659
graduate school and so we went over and

34
00:02:07,029 --> 00:02:03,120
checked and it turned out that at that

35
00:02:10,160 --> 00:02:07,039
point in time Albarn was just starting

36
00:02:13,190 --> 00:02:10,170
master's program in mechanical

37
00:02:16,759 --> 00:02:13,200
engineering and we just graduated with

38
00:02:20,960 --> 00:02:16,769

BS in mechanicals and they took a couple

39
00:02:23,720 --> 00:02:20,970
of us from Auburn and let us go into

40
00:02:26,920 --> 00:02:23,730
that graduating class and then I took a

41
00:02:29,649 --> 00:02:26,930
job down in Pensacola working

42
00:02:32,289 --> 00:02:29,659
or at that time Kim strand Monsanto

43
00:02:36,190 --> 00:02:32,299
later bought Amaya I came back up to

44
00:02:38,740 --> 00:02:36,200
Huntsville on on vacation from down

45
00:02:41,949 --> 00:02:38,750
there running to a guy dined you down at

46
00:02:44,199 --> 00:02:41,959
Auburn and he was asking me what I was

47
00:02:46,149 --> 00:02:44,209
doing I told him asked him what he's

48
00:02:50,500 --> 00:02:46,159
doing he told me he said you know that

49
00:02:52,690 --> 00:02:50,510
we're we're going and I have a space

50
00:02:55,599 --> 00:02:52,700
program said you need to come up here

51
00:02:57,490 --> 00:02:55,609
and get involved in that and I said I

52
00:02:58,960 --> 00:02:57,500
don't even know anybody there or

53
00:03:00,819 --> 00:02:58,970
anything about that

54
00:03:03,190 --> 00:03:00,829
he said well hey I'll give you an

55
00:03:06,009 --> 00:03:03,200
application and it said you fill it out

56
00:03:09,129 --> 00:03:06,019
and I'll take it in and put it in the

57
00:03:11,470 --> 00:03:09,139
right place and we'll see here where it

58
00:03:15,159 --> 00:03:11,480
goes turned out he was actually working

59
00:03:18,190 --> 00:03:15,169
for Chrysler at the time so I just made

60
00:03:21,699 --> 00:03:18,200
the application sent it in they called

61
00:03:23,500 --> 00:03:21,709
me a phone interview and I came came up

62
00:03:29,440 --> 00:03:23,510
and interviewed and went to work for

63
00:03:31,750 --> 00:03:29,450

Chrysler in December 1961 well when I

64
00:03:37,059 --> 00:03:31,760
was eloping I took all of my electives

65
00:03:39,250 --> 00:03:37,069
in structures materials and concrete and

66
00:03:43,420 --> 00:03:39,260
the ideas that I'm gonna be a stress guy

67
00:03:46,539 --> 00:03:43,430
you know take a job well when I come to

68
00:03:48,969 --> 00:03:46,549
Chrysler and told Chrysler I warned in

69
00:03:52,750 --> 00:03:48,979
the stress job they said we don't have

70
00:03:54,789 --> 00:03:52,760
any vacancies in that but we see that

71
00:03:57,249 --> 00:03:54,799
you've got a good background and and

72
00:04:00,249 --> 00:03:57,259
heat transfer and that type thing here

73
00:04:05,229 --> 00:04:00,259
so we have some work requirements in

74
00:04:07,059 --> 00:04:05,239
there and if we have an opening in the

75
00:04:10,229 --> 00:04:07,069
stress group and you're not happy and

76
00:04:14,020 --> 00:04:10,239
this fluid and thermal group where will

77
00:04:17,199 --> 00:04:14,030
will let you change you know and so I

78
00:04:20,560 --> 00:04:17,209
started to work in a and the first job I

79
00:04:22,749 --> 00:04:20,570
had was designing a calorimeter that

80
00:04:26,830 --> 00:04:22,759
where you could determine what the heat

81
00:04:31,860 --> 00:04:26,840
flux was and so I was out trying to

82
00:04:36,310 --> 00:04:31,870
design and have built a prototype for a

83
00:04:39,610 --> 00:04:36,320
calorimeter and I don't think I know how

84
00:04:40,510 --> 00:04:39,620
to design but the guy come into my boss

85
00:04:44,529 --> 00:04:40,520
come into me

86
00:04:48,309 --> 00:04:44,539
in one day and said said hey said we've

87
00:04:51,369 --> 00:04:48,319
got a request from the government to

88
00:04:54,100 --> 00:04:51,379

send us some more people out on out on

89
00:04:57,460 --> 00:04:54,110
the arsenal and said you'd be out there

90
00:05:00,129 --> 00:04:57,470
working with NASA and you'd be on the

91
00:05:03,399 --> 00:05:00,139
arsenal and said we've already shown

92
00:05:05,800 --> 00:05:03,409
them your resume and they think you'd

93
00:05:10,899 --> 00:05:05,810
fit the bill are you willing to go out

94
00:05:12,670 --> 00:05:10,909
and interview well I said yeah I won I

95
00:05:15,850 --> 00:05:12,680
just getting started with them I didn't

96
00:05:18,100 --> 00:05:15,860
know anybody particular anything and so

97
00:05:20,830 --> 00:05:18,110
I went out there and they let me

98
00:05:23,710 --> 00:05:20,840
interview with a couple of guys what I'm

99
00:05:25,480 --> 00:05:23,720
was a external heat transfer we're doing

100
00:05:28,719 --> 00:05:25,490
base heating and that type of thing here

101
00:05:31,450 --> 00:05:28,729
which I knew nothing about and the other

102
00:05:34,450 --> 00:05:31,460
one was doing internal flow and heat

103
00:05:40,059 --> 00:05:34,460
transfer you know inside the mole on his

104
00:05:41,980 --> 00:05:40,069
vehicle and so they both said I they

105
00:05:44,140 --> 00:05:41,990
were I was acceptable they were both

106
00:05:47,350 --> 00:05:44,150
looking for people so I took the one

107
00:05:50,980 --> 00:05:47,360
with the internal flow in it in the

108
00:05:54,490 --> 00:05:50,990
vehicle in it in tanks I started to work

109
00:05:58,059 --> 00:05:54,500
in there and absolutely the first day I

110
00:05:59,740 --> 00:05:58,069
think I went in unto the job and it may

111
00:06:04,360 --> 00:05:59,750
not have been absolutely the first day

112
00:06:07,059 --> 00:06:04,370
but I walked into the office and the guy

113
00:06:10,769 --> 00:06:07,069

told him supervisor told me said well

114
00:06:15,040 --> 00:06:10,779
they ran a static test last night on SAT

115
00:06:18,879 --> 00:06:15,050
11 and said late in the burn said they

116
00:06:21,820 --> 00:06:18,889
lost tank pressure up to 11 psi second

117
00:06:25,120 --> 00:06:21,830
and said they're boarded to test he said

118
00:06:28,409 --> 00:06:25,130
go figure out what went wrong and I

119
00:06:32,260 --> 00:06:28,419
didn't know from nothing you know so but

120
00:06:35,700 --> 00:06:32,270
he said you know he said go down talk to

121
00:06:40,209 --> 00:06:35,710
him burglars and burglar had a

122
00:06:44,260 --> 00:06:40,219
experimental shop there in what's 46:10

123
00:06:47,019 --> 00:06:44,270
our four to six twelve now maybe and so

124
00:06:49,389 --> 00:06:47,029
I went down there and looking for some

125
00:06:51,899 --> 00:06:49,399
way I can make a a model that we could

126
00:06:53,679 --> 00:06:51,909
test the flow in it or something and

127
00:06:56,109 --> 00:06:53,689
walked in and if

128
00:06:58,509 --> 00:06:56,119
first guy I saw was the guy that led

129
00:07:01,359 --> 00:06:58,519
been in school but down over kind of

130
00:07:04,149 --> 00:07:01,369
named Hugh Campbell and he'd been up

131
00:07:06,609 --> 00:07:04,159
here a couple of three years and he took

132
00:07:08,859 --> 00:07:06,619
me in and says let's go see what we can

133
00:07:12,579 --> 00:07:08,869
find so we went out through the boneyard

134
00:07:17,559 --> 00:07:12,589
and you know he and I we picked up stuff

135
00:07:21,579 --> 00:07:17,569
plate made a flow test rig so we started

136
00:07:23,529 --> 00:07:21,589
running the tests and the way the flow

137
00:07:27,309 --> 00:07:23,539
was set up was running the tests on the

138
00:07:30,249 --> 00:07:27,319

Saturn one and so it has the center LOX

139
00:07:34,479 --> 00:07:30,259
tank and around the outside it's got

140
00:07:37,899 --> 00:07:34,489
full fuel and for oxidizer and from the

141
00:07:41,290 --> 00:07:37,909
outboard oxidizer tanks they fed the in

142
00:07:43,089 --> 00:07:41,300
inboard tank filled out bore tank well

143
00:07:45,399 --> 00:07:43,099
they were worried about getting flow

144
00:07:47,319 --> 00:07:45,409
when it comes from the inboard tank into

145
00:07:50,619 --> 00:07:47,329
the outboard thing they were worried

146
00:07:53,559 --> 00:07:50,629
about it having some to face flowing and

147
00:07:57,069 --> 00:07:53,569
entrained vapor so to keep that from

148
00:08:01,059 --> 00:07:57,079
happening they went in and ran the pipe

149
00:08:03,339 --> 00:08:01,069
up into any outboard tank well you don't

150
00:08:05,919 --> 00:08:03,349
have to be a genius to figure it out is

151
00:08:08,829 --> 00:08:05,929
that if you take a hose and stick it in

152
00:08:11,350 --> 00:08:08,839
the tub of water and point it up when

153
00:08:14,799 --> 00:08:11,360
you drop the level after a while that

154
00:08:20,040 --> 00:08:14,809
thing becomes a fountain and and we were

155
00:08:22,509 --> 00:08:20,050
using hot oxygen to pressurize the

156
00:08:25,959 --> 00:08:22,519
liquid oxygen when you sprayed that

157
00:08:27,850 --> 00:08:25,969
liquid oxygen into the Elledge area it

158
00:08:31,540 --> 00:08:27,860
just took all the heat out of the gas

159
00:08:36,069 --> 00:08:31,550
and the gas pressure just went like it

160
00:08:37,959 --> 00:08:36,079
fell off a cliff and so you know bingos

161
00:08:40,449 --> 00:08:37,969
within a week you know we had the

162
00:08:42,459 --> 00:08:40,459
explanation and I knew what was doing

163
00:08:45,160 --> 00:08:42,469

went out and looked at the literature

164
00:08:47,079 --> 00:08:45,170
and figure out what you do and so we

165
00:08:49,240 --> 00:08:47,089
went in and then and the solution to

166
00:08:51,519 --> 00:08:49,250
that what's go in and we paid up a

167
00:08:53,949 --> 00:08:51,529
little cool ahead you might have seen

168
00:08:56,290 --> 00:08:53,959
them it's a little diffuser type thing

169
00:08:58,900 --> 00:08:56,300
upside down and so as soon as the flow

170
00:09:01,689 --> 00:08:58,910
would come across and up it'd be

171
00:09:04,030 --> 00:09:01,699
reflected back down into the liquid

172
00:09:07,120 --> 00:09:04,040
again and wouldn't spray up into the

173
00:09:10,900 --> 00:09:07,130
elegy area and so that became

174
00:09:16,060 --> 00:09:10,910
the the solution that they flew for the

175
00:09:18,370 --> 00:09:16,070
first the Saturn one flies the Saturn

176
00:09:20,710 --> 00:09:18,380
one bees when they came along different

177
00:09:24,280 --> 00:09:20,720
they changed the manifold in the bottom

178
00:09:25,840 --> 00:09:24,290
and and it put a sump on the bottom on

179
00:09:28,240 --> 00:09:25,850
the outboard tanks where they could

180
00:09:33,600 --> 00:09:28,250
bring it into the sump sand just have to

181
00:09:36,280 --> 00:09:33,610
bring it in into the tank itself so uh

182
00:09:39,160 --> 00:09:36,290
but you know but we fixed it in a I

183
00:09:40,720 --> 00:09:39,170
found out what they need to be fix you

184
00:09:43,360 --> 00:09:40,730
know within a period of I don't know a

185
00:09:51,780 --> 00:09:43,370
week or so you know man we we were

186
00:09:59,190 --> 00:09:55,860
the only thing that we had to do

187
00:10:02,610 --> 00:09:59,200
analysis with was a slide rule and Ammar

188
00:10:04,640 --> 00:10:02,620

shot or Frieden calculators there wasn't

189
00:10:08,490 --> 00:10:04,650
anything else you know we went through

190
00:10:13,290 --> 00:10:08,500
college and learned how to use slide

191
00:10:16,530 --> 00:10:13,300
rules and the best thing about the slide

192
00:10:20,400 --> 00:10:16,540
rule in that process is you have to

193
00:10:23,430 --> 00:10:20,410
estimate the answer and so when you run

194
00:10:25,530 --> 00:10:23,440
it out you're going to just get you can

195
00:10:28,220 --> 00:10:25,540
read three digits maybe four did you

196
00:10:30,900 --> 00:10:28,230
chip you're really good you know and so

197
00:10:32,910 --> 00:10:30,910
what we really did then is you got to

198
00:10:35,790 --> 00:10:32,920
know where to put the decimal place so

199
00:10:38,280 --> 00:10:35,800
you got to go in and estimate the answer

200
00:10:42,390 --> 00:10:38,290
and have an idea of what that answer is

201
00:10:46,410 --> 00:10:42,400
in order to put the decimal place and so

202
00:10:49,530 --> 00:10:46,420
that gives us a feel for the numbers and

203
00:10:53,340 --> 00:10:49,540
the one thing that I've learned and it's

204
00:10:56,310 --> 00:10:53,350
been a great help over the years is I

205
00:10:58,290 --> 00:10:56,320
still have a feel for numbers you know

206
00:10:59,700 --> 00:10:58,300
you go in your stick something in a

207
00:11:01,730 --> 00:10:59,710
computer and you get something out of

208
00:11:04,260 --> 00:11:01,740
the computer you don't necessarily know

209
00:11:10,680 --> 00:11:04,270
where it's right and maybe you made a

210
00:11:19,890 --> 00:11:14,040
well the the big issue for the thing

211
00:11:22,770 --> 00:11:19,900
here when we were working and the German

212
00:11:25,680 --> 00:11:22,780
team was here but their one goal and

213
00:11:27,780 --> 00:11:25,690

they want to go into the moon they they

214
00:11:31,020 --> 00:11:27,790
wanted to and they thought they might be

215
00:11:33,900 --> 00:11:31,030
but hey they won the military dictated

216
00:11:36,600 --> 00:11:33,910
that they could only work on things with

217
00:11:40,740 --> 00:11:36,610
a certain range and this type of thing

218
00:11:45,120 --> 00:11:40,750
here and when I guess Kennedy got

219
00:11:49,320 --> 00:11:45,130
involved with the things in in Cuba and

220
00:11:51,510 --> 00:11:49,330
then he had the Soviets pressing him and

221
00:11:54,150 --> 00:11:51,520
that type of thing here they thought he

222
00:11:56,280 --> 00:11:54,160
was a young kid and he you know they

223
00:12:00,390 --> 00:11:56,290
could take advantage of it he had to do

224
00:12:02,460 --> 00:12:00,400
something to keep the Europeans aligned

225
00:12:03,900 --> 00:12:02,470
with us rather they'll have them go all

226
00:12:08,610 --> 00:12:03,910
line up with the Russians

227
00:12:10,500 --> 00:12:08,620
so his idea and his advisors ideas was

228
00:12:14,670 --> 00:12:10,510
they go to the moon

229
00:12:18,800 --> 00:12:14,680
now when that did that really turned the

230
00:12:22,490 --> 00:12:18,810
Germans loose but from our perspective

231
00:12:25,790 --> 00:12:22,500
it turned out that we started designing

232
00:12:30,630 --> 00:12:25,800
was part of the design effort to design

233
00:12:33,540 --> 00:12:30,640
the Saturn 5 the Saturn 1b one go 1 1 b1

234
00:12:36,690 --> 00:12:33,550
will be big enough to go to the moon and

235
00:12:40,410 --> 00:12:36,700
so they started out and they had the f1

236
00:12:42,870 --> 00:12:40,420
engine that was in test and so we

237
00:12:45,080 --> 00:12:42,880
started designing they they baseline

238
00:12:49,410 --> 00:12:45,090

that engine and we started designing it

239
00:12:52,800 --> 00:12:49,420
as our job to design the feed systems

240
00:12:56,090 --> 00:12:52,810
the pressurization systems the things

241
00:12:58,500 --> 00:12:56,100
that how you get propellants on the

242
00:13:00,960 --> 00:12:58,510
vehicle and from the ground and how you

243
00:13:05,040 --> 00:13:00,970
get them and satisfy the engine

244
00:13:07,530 --> 00:13:05,050
requirements what sort of pressures you

245
00:13:10,830 --> 00:13:07,540
design and provide so that you can

246
00:13:13,830 --> 00:13:10,840
maintain structural integrity from both

247
00:13:17,310 --> 00:13:13,840
collapse and overpressure so those were

248
00:13:20,250 --> 00:13:17,320
all issues that we were designing I

249
00:13:22,570 --> 00:13:20,260
personally was designing primarily the

250
00:13:26,930 --> 00:13:22,580
fuel system the

251
00:13:28,400 --> 00:13:26,940
s1c and they say there's a c11 f1

252
00:13:31,430 --> 00:13:28,410
anything that was enough had to make

253
00:13:34,250 --> 00:13:31,440
twos now we had a c2 is 2f once you know

254
00:13:36,890 --> 00:13:34,260
and then eventually they every time you

255
00:13:42,620 --> 00:13:36,900
know we kept the same type designs but

256
00:13:43,730 --> 00:13:42,630
then we multiply and feed systems here

257
00:13:45,260 --> 00:13:43,740
but now we've got another one right

258
00:13:47,210 --> 00:13:45,270
beside it and then we've got another one

259
00:13:49,190 --> 00:13:47,220
over here and they've got another one

260
00:13:52,750 --> 00:13:49,200
over here I'm assuming we had four and

261
00:13:55,910 --> 00:13:52,760
we were designing it at all they were

262
00:13:58,250 --> 00:13:55,920
individually designed but then you had

263
00:14:01,010 --> 00:13:58,260

to put them collectively and integrate

264
00:14:04,730 --> 00:14:01,020
them and how do you control all the

265
00:14:06,610 --> 00:14:04,740
flows and pressures and and that type of

266
00:14:10,100 --> 00:14:06,620
thing yes so what that we were working

267
00:14:12,200 --> 00:14:10,110
that and then the great thing that they

268
00:14:15,530 --> 00:14:12,210
really do it is they decided to go and

269
00:14:18,110 --> 00:14:15,540
fill that middle spot with v engine and

270
00:14:24,629 --> 00:14:18,120
now we had all sorts of margins from

271
00:14:34,739 --> 00:14:28,919
you got the basic theories you got heat

272
00:14:36,809 --> 00:14:34,749
transfer and you got fluid flow

273
00:14:38,939 --> 00:14:36,819
conditions you can calculate fluid

274
00:14:41,119 --> 00:14:38,949
didn't making difference where what size

275
00:14:44,489 --> 00:14:41,129
the pipe is is just the numbers change

276
00:14:45,809 --> 00:14:44,499
but the process is the same and it's

277
00:14:49,769 --> 00:14:45,819
kind of the same way with the heat

278
00:14:54,329 --> 00:14:49,779
transfer you got the heat transfer you

279
00:14:57,229 --> 00:14:54,339
if you go through natural convection you

280
00:15:00,509 --> 00:14:57,239
got force convection you just figure out

281
00:15:02,519 --> 00:15:00,519
if you want to know how much heat you're

282
00:15:05,129 --> 00:15:02,529
going to transfer on the sidewall of the

283
00:15:09,210 --> 00:15:05,139
tank you go in and look for data in the

284
00:15:11,970 --> 00:15:09,220
literature for vertical surfaces and and

285
00:15:15,090 --> 00:15:11,980
so there's lots of data out there the

286
00:15:17,999 --> 00:15:15,100
the trick is and and the data has got

287
00:15:21,569 --> 00:15:18,009
plus or minus 20% only generally because

288
00:15:24,059 --> 00:15:21,579

that's the way you take data in the ways

289
00:15:26,910 --> 00:15:24,069
they would in a literature and so we go

290
00:15:29,220 --> 00:15:26,920
out and we'd guess the answer it's about

291
00:15:31,019 --> 00:15:29,230
we assume it's about like this and we're

292
00:15:33,419 --> 00:15:31,029
running numbers on it and then we go out

293
00:15:36,329 --> 00:15:33,429
and try to configure a test someplace

294
00:15:39,629 --> 00:15:36,339
that see if we can get a better number

295
00:15:42,239 --> 00:15:39,639
and see if we can squeeze down the

296
00:15:46,710 --> 00:15:42,249
variation is not plus amount of 20 it's

297
00:15:49,379 --> 00:15:46,720
plus a minus another smaller number but

298
00:15:52,139 --> 00:15:49,389
you you just keep reassuring yourself as

299
00:15:55,109 --> 00:15:52,149
you go along that the assumptions that

300
00:15:57,539 --> 00:15:55,119
you're making is good assumptions and

301
00:15:59,999 --> 00:15:57,549
after a while you've got the data that

302
00:16:01,559 --> 00:16:00,009
says instead of them you know we

303
00:16:06,950 --> 00:16:01,569
wandered around a little bit then but

304
00:16:15,110 --> 00:16:10,970
the Pogo problem was unforeseen we

305
00:16:16,970 --> 00:16:15,120
designed the feed systems and connected

306
00:16:22,010 --> 00:16:16,980
them to the engines and connected them

307
00:16:25,449 --> 00:16:22,020
to the structure and and all and we

308
00:16:29,449 --> 00:16:25,459
ground test-fired them but we didn't

309
00:16:32,990 --> 00:16:29,459
have any idea that there could be a

310
00:16:35,990 --> 00:16:33,000
coupling and an instability between the

311
00:16:38,389 --> 00:16:36,000
propulsion system and the structure in

312
00:16:42,710 --> 00:16:38,399
fact the Bennets the first thing that

313
00:16:44,570 --> 00:16:42,720

really come to our realization when the

314
00:16:47,300 --> 00:16:44,580
guys tell you about gourd and plant he

315
00:16:50,800 --> 00:16:47,310
read Aviation Week and he saw the in

316
00:16:54,560 --> 00:16:50,810
eleven failure on the Titan too and if

317
00:16:56,600 --> 00:16:54,570
it had a long feed line on it and he

318
00:16:59,210 --> 00:16:56,610
came in one morning and we started

319
00:17:02,050 --> 00:16:59,220
talking about maybe that long feed line

320
00:17:03,470 --> 00:17:02,060
has something to do with this

321
00:17:06,710 --> 00:17:03,480
instability

322
00:17:10,160 --> 00:17:06,720
now we don't calculate the feeds on

323
00:17:11,809 --> 00:17:10,170
frequency stored one at that time but

324
00:17:17,419 --> 00:17:11,819
the structures guys knew what their

325
00:17:21,290 --> 00:17:17,429
frequencies was and so Gordon says get

326
00:17:23,990 --> 00:17:21,300
on the plane find some guys at Denver go

327
00:17:27,380 --> 00:17:24,000
out and talk to those guys and let us

328
00:17:29,990 --> 00:17:27,390
let them see fat as likely to have be a

329
00:17:31,130 --> 00:17:30,000
problem that we had I get on the plane

330
00:17:34,280 --> 00:17:31,140
we go to Denver

331
00:17:38,810 --> 00:17:34,290
nicest guys you have want to meet they

332
00:17:40,970 --> 00:17:38,820
take we ended they for me with our

333
00:17:43,190 --> 00:17:40,980
configuration some I showed him sketches

334
00:17:46,400 --> 00:17:43,200
for the rest of it they cared me out

335
00:17:48,650 --> 00:17:46,410
they walked me through there how they

336
00:17:50,510 --> 00:17:48,660
did it an ALICE they were walk me

337
00:17:53,870 --> 00:17:50,520
through how they did their test program

338
00:17:57,549 --> 00:17:53,880

carried me up to this test and zonah on

339
00:17:59,870 --> 00:17:57,559
the hill took me in and showed me the

340
00:18:01,430 --> 00:17:59,880
accumulators that they were building and

341
00:18:05,780 --> 00:18:01,440
the stand pipes that they were building

342
00:18:08,090 --> 00:18:05,790
the solved their problem and where they

343
00:18:13,310 --> 00:18:08,100
changed the designs of the feed line you

344
00:18:19,669 --> 00:18:13,320
know and and so they give us a running

345
00:18:23,510 --> 00:18:19,679
start but this was probably 1964

346
00:18:26,320 --> 00:18:23,520
we're always cutting hardware components

347
00:18:32,840 --> 00:18:26,330
are out on design

348
00:18:35,270 --> 00:18:32,850
you can't analyze stability you can lies

349
00:18:39,549 --> 00:18:35,280
it but you can't find out stability as

350
00:18:42,289 --> 00:18:39,559
long as it's on the ground because the

351
00:18:44,840 --> 00:18:42,299
hold-down clamps are all this keeps the

352
00:18:46,180 --> 00:18:44,850
company occur you're only gonna see it

353
00:18:52,060 --> 00:18:46,190
in fight

354
00:18:56,450 --> 00:18:52,070
so I Marshall hardly Martin guys and

355
00:18:59,120 --> 00:18:56,460
they hired some put together a pogo team

356
00:19:04,100 --> 00:18:59,130
to go off and work it we've got out on

357
00:19:07,190 --> 00:19:04,110
the lab out here and we figured out what

358
00:19:09,770 --> 00:19:07,200
the feed line frequency is we found the

359
00:19:11,600 --> 00:19:09,780
feed line frequency out by thinking of

360
00:19:14,590 --> 00:19:11,610
the scylla gram and rolling it down in

361
00:19:16,940 --> 00:19:14,600
the hall I sarin test area and then

362
00:19:20,060 --> 00:19:16,950
expanding it greatly and then going

363
00:19:22,659 --> 00:19:20,070

through and reading the times what the

364
00:19:25,159 --> 00:19:22,669
frequency was and is the frequent change

365
00:19:27,770 --> 00:19:25,169
we go in and looked and see what was

366
00:19:30,380 --> 00:19:27,780
happening on pump Inlet condition and we

367
00:19:32,990 --> 00:19:30,390
had a plot of frequency versus pump

368
00:19:36,409 --> 00:19:33,000
Inlet filling the problems we went and

369
00:19:38,930 --> 00:19:36,419
we was right but it was the only data

370
00:19:42,500 --> 00:19:38,940
that we had and it came off a real

371
00:19:47,780 --> 00:19:42,510
system so we began to use it and did the

372
00:19:52,190 --> 00:19:47,790
do the analysis and it turns out that we

373
00:19:54,890 --> 00:19:52,200
had a an analysis that they won't should

374
00:19:58,700 --> 00:19:54,900
have like sixty B's of stability that's

375
00:20:04,400 --> 00:19:58,710
a factor of two well our analysis was

376
00:20:07,370 --> 00:20:04,410
showing about 1 DB of stability now it

377
00:20:09,650 --> 00:20:07,380
turns out that you know normally that

378
00:20:11,930 --> 00:20:09,660
wouldn't be very much but you know how

379
00:20:16,640 --> 00:20:11,940
good our model was we didn't know how

380
00:20:18,950 --> 00:20:16,650
good the propulsion data was I knew

381
00:20:20,480 --> 00:20:18,960
where I got it from and I was pretty

382
00:20:22,700 --> 00:20:20,490
confident in it I just didn't know were

383
00:20:24,289 --> 00:20:22,710
they exactly right a lot and then the

384
00:20:26,620 --> 00:20:24,299
structures guys they had pretty good

385
00:20:29,659 --> 00:20:26,630
data because they drawn the dynamic test

386
00:20:32,360 --> 00:20:29,669
vehicle and had their structure design

387
00:20:34,100 --> 00:20:32,370
and it normally couples for the first

388
00:20:36,880 --> 00:20:34,110

so they've heard they knew what that

389
00:20:40,340 --> 00:20:36,890
that was so we had a pretty good

390
00:20:41,540 --> 00:20:40,350
analysis except we didn't know where it

391
00:20:44,290 --> 00:20:41,550
was any good

392
00:20:48,650 --> 00:20:44,300
we won't a plane going down to the Cape

393
00:20:53,840 --> 00:20:48,660
for the L minus two day review and von

394
00:20:55,610 --> 00:20:53,850
Braun said let me see your charts so we

395
00:20:57,260 --> 00:20:55,620
gave him the charts and he was flipping

396
00:20:59,390 --> 00:20:57,270
through the charts and this type of

397
00:21:02,450 --> 00:20:59,400
thing here and when he came to that

398
00:21:04,190 --> 00:21:02,460
disability plot well that came down

399
00:21:07,640 --> 00:21:04,200
short and getting less and less as a

400
00:21:10,070 --> 00:21:07,650
pill and then finally going back and

401
00:21:15,770 --> 00:21:10,080
getting more stability again and it a

402
00:21:17,690 --> 00:21:15,780
minimum instant built out about 120 125

403
00:21:19,820 --> 00:21:17,700
seconds in that general timeframe my own

404
00:21:24,140 --> 00:21:19,830
memory exact number but von Braun said

405
00:21:26,150 --> 00:21:24,150
that won't never go and he said maybe we

406
00:21:29,920 --> 00:21:26,160
can take this area down here and we can

407
00:21:33,140 --> 00:21:29,930
crosshatch the aryans and argue that

408
00:21:35,540 --> 00:21:33,150
this is the range of the things here and

409
00:21:40,460 --> 00:21:35,550
charts it's got the curve on it that's

410
00:21:42,800 --> 00:21:40,470
just the worst case and so I had the job

411
00:21:45,560 --> 00:21:42,810
of going Andry plot in that chart and

412
00:21:49,250 --> 00:21:45,570
the guy that was making the presentation

413
00:21:51,770 --> 00:21:49,260

there he was made the presentation I got

414
00:21:53,480 --> 00:21:51,780
the charts made and I slipped it into

415
00:21:56,360 --> 00:21:53,490
the stack of charts where it was

416
00:21:58,310 --> 00:21:56,370
supposed to come up at and he was going

417
00:22:02,540 --> 00:21:58,320
on to his presentation until he come to

418
00:22:05,930 --> 00:22:02,550
that chart and boy it hit the fan and it

419
00:22:08,840 --> 00:22:05,940
was a roar in the room everybody was

420
00:22:16,990 --> 00:22:08,850
trying to talk it once and you know and

421
00:22:20,030 --> 00:22:17,000
so finally they they kind of agreed that

422
00:22:23,420 --> 00:22:20,040
that was there there was I was the case

423
00:22:24,890 --> 00:22:23,430
we didn't know how much margin it was we

424
00:22:26,930 --> 00:22:24,900
hadn't seen his on the ground because

425
00:22:29,330 --> 00:22:26,940
you can't see it on the ground and we

426
00:22:32,720 --> 00:22:29,340
hadn't had a flight yet and the first

427
00:22:38,120 --> 00:22:32,730
flight was going to be unmanned and so

428
00:22:41,060 --> 00:22:38,130
they decided we'll fly and we did and it

429
00:22:44,000 --> 00:22:41,070
turns out that we got very little

430
00:22:44,790 --> 00:22:44,010
instability but at the time we predicted

431
00:22:48,560 --> 00:22:44,800
men

432
00:22:52,620 --> 00:22:48,570
instability we got a little bit of

433
00:22:56,370 --> 00:22:52,630
vibration there and it's showed up and

434
00:22:58,260 --> 00:22:56,380
it turns out that they had from this

435
00:23:02,630 --> 00:22:58,270
heightened program they had worked and

436
00:23:05,490 --> 00:23:02,640
said that for the crew to be safe the

437
00:23:09,390 --> 00:23:05,500
vibration needs to be less than a

438
00:23:11,760 --> 00:23:09,400

quarter of a chi now we were below

439
00:23:13,680 --> 00:23:11,770
Accord over G I don't remember the exact

440
00:23:19,260 --> 00:23:13,690
number but we were less than a quarter G

441
00:23:21,240 --> 00:23:19,270
so it wasn't a big issue and so we ended

442
00:23:23,070 --> 00:23:21,250
up on the second flight we were

443
00:23:25,290 --> 00:23:23,080
basically went back through it again

444
00:23:28,080 --> 00:23:25,300
now the structure changed a little bit

445
00:23:30,240 --> 00:23:28,090
on the second flight the propulsion and

446
00:23:33,690 --> 00:23:30,250
the engines they were different but they

447
00:23:35,700 --> 00:23:33,700
were the same and so it turns out that

448
00:23:41,310 --> 00:23:35,710
on the on the second flight which was

449
00:23:42,390 --> 00:23:41,320
also unmanned we had a kind of a

450
00:23:45,240 --> 00:23:42,400
disaster

451
00:23:48,570 --> 00:23:45,250
on the whole thing first stage had a

452
00:23:51,540 --> 00:23:48,580
Pogo problem the second stage had one

453
00:23:53,100 --> 00:23:51,550
engine go out and when that one engine

454
00:23:55,920 --> 00:23:53,110
went out there were wires will cross

455
00:23:57,180 --> 00:23:55,930
today that pre valve shut and then when

456
00:23:59,700 --> 00:23:57,190
that was when I was going to acting shut

457
00:24:04,130 --> 00:23:59,710
the pre valve and already failed and so

458
00:24:10,260 --> 00:24:04,140
we had two engines out and then when the

459
00:24:13,500 --> 00:24:10,270
s4b start and it burned into own into

460
00:24:16,020 --> 00:24:13,510
orbit so and I think we had a panel to

461
00:24:19,290 --> 00:24:16,030
come off the slaw boy hi something like

462
00:24:23,490 --> 00:24:19,300
it so you know every stage had something

463
00:24:26,070 --> 00:24:23,500

go wrong and then they either right

464
00:24:28,740 --> 00:24:26,080
before right as they were in to they

465
00:24:31,670 --> 00:24:28,750
announced at the first flight next

466
00:24:35,100 --> 00:24:31,680
flight was go away all up in man's and

467
00:24:36,720 --> 00:24:35,110
so you know we got this problem now

468
00:24:41,310 --> 00:24:36,730
because on the second flight we showed a

469
00:24:46,020 --> 00:24:41,320
bigger instability and so now we had had

470
00:24:48,720 --> 00:24:46,030
to fix it and so it was fortunate we had

471
00:24:51,420 --> 00:24:48,730
and knew we might have a problem we'd

472
00:24:53,490 --> 00:24:51,430
already been working on fixes but nobody

473
00:24:55,030 --> 00:24:53,500
would let us implement it because they

474
00:24:57,730 --> 00:24:55,040
won sure we had a

475
00:25:02,080 --> 00:24:57,740
problem but we've been working on fence

476
00:25:04,420 --> 00:25:02,090
fixes up putting a gas in the line to

477
00:25:06,310 --> 00:25:04,430
change the feed line frequency you can't

478
00:25:09,160 --> 00:25:06,320
change your structure frequency it

479
00:25:10,750 --> 00:25:09,170
caused too much weight you know and so

480
00:25:12,490 --> 00:25:10,760
you got to change your propulsion

481
00:25:15,550 --> 00:25:12,500
frequency and you really can't change

482
00:25:18,100 --> 00:25:15,560
the engine itself because it's designed

483
00:25:22,390 --> 00:25:18,110
and qualified so you got to change

484
00:25:25,030 --> 00:25:22,400
something that's easy to change compared

485
00:25:28,300 --> 00:25:25,040
to those who and it's feed line turned

486
00:25:30,430 --> 00:25:28,310
out that we found we knew that - we

487
00:25:32,920 --> 00:25:30,440
could put helium in and we went so far

488
00:25:35,200 --> 00:25:32,930

as to know if we let that helium get out

489
00:25:37,600 --> 00:25:35,210
and got into the engine it wouldn't

490
00:25:40,960 --> 00:25:37,610
cause any problems so we knew that one

491
00:25:44,170 --> 00:25:40,970
an issue so we ended up on the third

492
00:25:46,900 --> 00:25:44,180
flight putting some helium in a in the

493
00:25:49,210 --> 00:25:46,910
prevail and the pre valve is a visor

494
00:25:53,890 --> 00:25:49,220
valve and it's got a cavity behind the

495
00:25:56,800 --> 00:25:53,900
floor liner so we could put the helium

496
00:25:59,080 --> 00:25:56,810
in and it worked like a charm I mean it

497
00:26:02,530 --> 00:25:59,090
was and you know it's well thank you

498
00:26:04,030 --> 00:26:02,540
just got lucky all but part of our luck

499
00:26:07,290 --> 00:26:04,040
was due to work because we'd been

500
00:26:10,120 --> 00:26:07,300
working and looking for a solution that

501
00:26:13,390 --> 00:26:10,130
didn't have fuss to either do that to

502
00:26:18,140 --> 00:26:13,400
completely redesign the vehicle turned

503
00:26:24,100 --> 00:26:22,220
I guess the first flight had really give

504
00:26:28,159 --> 00:26:24,110
us a lot of confidence in our analysis

505
00:26:30,260 --> 00:26:28,169
it had the had the frequency and had the

506
00:26:32,029 --> 00:26:30,270
minimum stability and right where we

507
00:26:35,779 --> 00:26:32,039
predicted it would be at so we had a

508
00:26:38,600 --> 00:26:35,789
good good confidence in it so we then

509
00:26:42,200 --> 00:26:38,610
had good confidence that if we change

510
00:26:44,890 --> 00:26:42,210
that frequency on the feed system it

511
00:26:49,820 --> 00:26:44,900
should decouple those system so we had

512
00:26:51,940 --> 00:26:49,830
had felt good about our fix and we knew

513
00:26:54,649 --> 00:26:51,950

that it had worked on the Jim and I are

514
00:26:58,279 --> 00:26:54,659
similar things had worked on the Jim and

515
00:27:00,560 --> 00:26:58,289
I so we had that confidence going far we

516
00:27:03,169 --> 00:27:00,570
had the Martin company and the other

517
00:27:05,600 --> 00:27:03,179
companies come in and they knew what we

518
00:27:07,970 --> 00:27:05,610
were doing and they looked at it and

519
00:27:11,740 --> 00:27:07,980
they agreed that that's a good solution

520
00:27:15,080 --> 00:27:11,750
so when we got ready to to fly that

521
00:27:18,200 --> 00:27:15,090
first manned flight we had confidence in

522
00:27:23,340 --> 00:27:18,210
that s1c stage polk over not been a

523
00:27:33,169 --> 00:27:28,409
I'm pretty even keel I have a bit of a

524
00:27:37,049 --> 00:27:33,179
personal philosophy if you have an issue

525
00:27:39,750 --> 00:27:37,059
you work the issue before the flight and

526
00:27:42,570 --> 00:27:39,760
if you now don't have your issue solved

527
00:27:46,710 --> 00:27:42,580
before the flight you know you can't fly

528
00:27:49,500 --> 00:27:46,720
and and if you agree to fly then the

529
00:27:52,200 --> 00:27:49,510
issue is in the control as far as I can

530
00:27:55,769 --> 00:27:52,210
do I've done really all I can do I can't

531
00:28:00,000 --> 00:27:55,779
do anymore I've done this now we got to

532
00:28:03,509 --> 00:28:00,010
go fight and so I didn't I didn't really

533
00:28:05,190 --> 00:28:03,519
worry about about flights and I know a

534
00:28:07,440 --> 00:28:05,200
lot of people go in and wring their

535
00:28:10,830 --> 00:28:07,450
hands and and all that but and it was

536
00:28:14,190 --> 00:28:10,840
one of those guys I'm gonna work hard

537
00:28:17,000 --> 00:28:14,200
and I'm gonna fix it if when I say we're

538
00:28:23,510 --> 00:28:17,010

ready to go I don't have any open issues

539
00:28:29,090 --> 00:28:26,060
the guy went to work for after I came

540
00:28:32,020 --> 00:28:29,100
when I first came in from Chrysler kind

541
00:28:38,210 --> 00:28:32,030
of named Charles who would Charles was a

542
00:28:41,840 --> 00:28:38,220
older guy that I was went over but he

543
00:28:42,680 --> 00:28:41,850
went to worked up at Langley and worked

544
00:28:47,140 --> 00:28:42,690
perfectly

545
00:28:52,400 --> 00:28:47,150
naca and then came to Marshall for the

546
00:28:55,100 --> 00:28:52,410
programs here with the Saturn programs

547
00:28:59,840 --> 00:28:55,110
in this type thing here and Charlie was

548
00:29:03,290 --> 00:28:59,850
a boy he was a stickler for details and

549
00:29:05,270 --> 00:29:03,300
he would give you the job he'd let you

550
00:29:08,900 --> 00:29:05,280
go off and work it when you come back

551
00:29:12,200 --> 00:29:08,910
he'd scrub you with a wire brush he'd

552
00:29:15,260 --> 00:29:12,210
asked every question that that he could

553
00:29:17,960 --> 00:29:15,270
think of and you had say he want to know

554
00:29:20,360 --> 00:29:17,970
where you get your data from where did

555
00:29:22,990 --> 00:29:20,370
you make your assumptions how did you

556
00:29:26,150 --> 00:29:23,000
know that's a good assumption he just

557
00:29:30,310 --> 00:29:26,160
looked at and picked it every detail of

558
00:29:33,050 --> 00:29:30,320
what he had but when you satisfied him

559
00:29:37,040 --> 00:29:33,060
he's ready to go because he was a

560
00:29:38,570 --> 00:29:37,050
harshest critic you had he was also the

561
00:29:44,450 --> 00:29:38,580
guy that the first time I made a

562
00:29:47,060 --> 00:29:44,460
presentation to a lab director here in

563
00:29:49,310 --> 00:29:47,070

town I'd been through that type of thing

564
00:29:53,290 --> 00:29:49,320
here and he'd scrubbed me and that's I

565
00:29:56,480 --> 00:29:53,300
think here and when I got up there the

566
00:29:59,740 --> 00:29:56,490
deputy lab director started in on my

567
00:30:02,990 --> 00:29:59,750
case every chart he had a bunch of

568
00:30:04,070 --> 00:30:03,000
questions to be asking about the third

569
00:30:06,290 --> 00:30:04,080
of four chart

570
00:30:08,600 --> 00:30:06,300
Charlie stood up back in the back of the

571
00:30:11,120 --> 00:30:08,610
room and told him says I've reviewed his

572
00:30:13,340 --> 00:30:11,130
presentation says I think it's in good

573
00:30:16,120 --> 00:30:13,350
shape I think he's gonna answer all your

574
00:30:19,250 --> 00:30:16,130
questions but in case he doesn't you

575
00:30:22,940 --> 00:30:19,260
cover him at the end and he pulled me

576
00:30:27,140 --> 00:30:22,950
off of me and pushing off being my I

577
00:30:31,160 --> 00:30:27,150
have never forgot it you know he was a

578
00:30:33,560 --> 00:30:31,170
guy that if you could satisfy him he'd

579
00:30:35,660 --> 00:30:33,570
stay with you and but but you had a

580
00:30:37,100 --> 00:30:35,670
satisfying cause he was gonna gonna

581
00:30:44,230 --> 00:30:37,110
probe you

582
00:30:52,029 --> 00:30:47,109
we were flying in the sixties we were

583
00:30:57,340 --> 00:30:52,039
flying the Saturday fives we were going

584
00:30:59,019 --> 00:30:57,350
to the moon and this thing of operations

585
00:31:01,509 --> 00:30:59,029
being different from the development

586
00:31:07,149 --> 00:31:01,519
that's a shuttle program that's I was

587
00:31:09,070 --> 00:31:07,159
not on Saturn program issue Apollo

588
00:31:13,299 --> 00:31:09,080

didn't do it that way we followed that

589
00:31:18,970 --> 00:31:13,309
thing we were looking at data on every

590
00:31:22,029 --> 00:31:18,980
flight and we had the people in hosk we

591
00:31:25,899 --> 00:31:22,039
got the data immediately we reviewed

592
00:31:29,399 --> 00:31:25,909
that data being NASA people we reviewed

593
00:31:33,879 --> 00:31:29,409
the data with our contractors and any

594
00:31:39,220 --> 00:31:33,889
problems we fixed a family fixed for the

595
00:31:45,880 --> 00:31:41,020
I felt a little bit about that but I'm

596
00:31:48,600 --> 00:31:45,890
not a great philosopher I consider

597
00:31:53,950 --> 00:31:48,610
myself an engineer we're solving

598
00:31:57,850 --> 00:31:53,960
problems and that when Apollo came along

599
00:32:01,090 --> 00:31:57,860
it was a solution to a problem

600
00:32:04,270 --> 00:32:01,100
and the the problem was that we had an

601
00:32:06,190 --> 00:32:04,280
edict from the president to put a man on

602
00:32:10,420 --> 00:32:06,200
the moon and bring him back safely in

603
00:32:15,220 --> 00:32:10,430
this decade it turns out that the world

604
00:32:20,100 --> 00:32:15,230
events the politics of the day and all

605
00:32:23,610 --> 00:32:20,110
just came together and with the people

606
00:32:29,650 --> 00:32:23,620
the Germans were a big portion of that

607
00:32:33,310 --> 00:32:29,660
they picked up a lot of good talent you

608
00:32:37,180 --> 00:32:33,320
know and education it affected education

609
00:32:40,750 --> 00:32:37,190
it affected kids going to school I think

610
00:32:45,730 --> 00:32:40,760
it captured a lot of the people's

611
00:32:50,020 --> 00:32:45,740
interest and it for that reason they was

612
00:32:54,760 --> 00:32:50,030
able to be successful now we did a lot

613
00:32:57,040 --> 00:32:54,770

of things that if we had a problem and

614
00:32:59,740 --> 00:32:57,050
we knew we needed to solve the problem

615
00:33:03,880 --> 00:32:59,750
we might start two or three programs

616
00:33:06,640 --> 00:33:03,890
that could potentially solve resolve

617
00:33:08,290 --> 00:33:06,650
that issue and it'd be signs of two or

618
00:33:11,050 --> 00:33:08,300
three different people and whoever got

619
00:33:13,120 --> 00:33:11,060
there is done first got to put theirs on

620
00:33:17,470 --> 00:33:13,130
a vehicle that creates a lot of

621
00:33:20,470 --> 00:33:17,480
competition cost probably money because

622
00:33:23,260 --> 00:33:20,480
they have funded money multiple streams

623
00:33:26,620 --> 00:33:23,270
so things here but schedule drove that

624
00:33:28,570 --> 00:33:26,630
and it's not you know want to get there

625
00:33:32,470 --> 00:33:28,580
someday you want to get there this

626
00:33:34,960 --> 00:33:32,480
decade and and it's a successful I

627
00:33:38,670 --> 00:33:34,970
thanked from the stack that we had a

628
00:33:43,270 --> 00:33:38,680
cold war that never turned to be hot and

629
00:33:46,000 --> 00:33:43,280
that we had competition there's such

630
00:33:48,730 --> 00:33:46,010
that I think the Europeans they lined up

631
00:33:51,910 --> 00:33:48,740
with the US and the lion

632
00:33:54,910 --> 00:33:51,920
the Soviets in this type of thing here I

633
00:33:57,850 --> 00:33:54,920
think from that standpoint it was

634
00:34:01,030 --> 00:33:57,860
successful but it was a moment in time

635
00:34:03,190 --> 00:34:01,040
that moment passed when we were

636
00:34:06,370 --> 00:34:03,200
successful on going to the moon and

637
00:34:10,419 --> 00:34:06,380
since 69 about that same time the

638
00:34:14,710 --> 00:34:10,429

Vietnam War began to heat up and they

639
00:34:17,680 --> 00:34:14,720
needed more money for the Vietnam War

640
00:34:20,050 --> 00:34:17,690
Apollo going to the moon was kind of

641
00:34:22,600 --> 00:34:20,060
finished it didn't need the bunny so

642
00:34:27,520 --> 00:34:22,610
there tried to turn that down turn the

643
00:34:30,550 --> 00:34:27,530
money up it's going to Vietnam so those

644
00:34:33,220 --> 00:34:30,560
are just things that in Vietnam catches

645
00:34:35,379 --> 00:34:33,230
the people's interest in that type of

646
00:34:37,840 --> 00:34:35,389
thing here so you got to have the

647
00:34:40,210 --> 00:34:37,850
commitment of the government you guys

648
00:34:43,720 --> 00:34:40,220
have a commitment of the interest of the

649
00:34:45,629 --> 00:34:43,730
people as the movie perfect storm it's

650
00:34:50,680 --> 00:34:45,639
probably that type of thing you know