1
00:00:02,002 --> 00:00:04,638
■ [music] ■

2
00:00:04,638 --> 00:00:05,873
(Chase Pilot) NASA ONE:
We have an ejection,

3
00:00:05,873 --> 00:00:08,208
we have an ejection.

4
00:00:10,644 --> 00:00:15,015
The aircraft is descending over
the North Base area.

5
00:00:18,585 --> 00:00:21,355
I have a chute.

6
00:00:22,823 --> 00:00:25,792
The pilot is out of his seat and
the chute is good.

7
00:00:26,593 --> 00:00:30,731
Control Room: NASA One, we copy.

8
00:00:30,731 --> 00:00:32,900
(Rogers Smith) We had a
highly competent team,

9
00:00:32,900 --> 00:00:34,201
very experienced, many flights
under their belt.

10
00:00:34,201 --> 00:00:38,372
We had a number of pilots that
flew the airplane.

11
00:00:38,372 --> 00:00:40,307
The pilot in particular that was
flying that day

12
00:00:40,307 --> 00:00:43,310
had been on the program from
the very beginning.

13
00:00:43,310 --> 00:00:46,580
Highly experienced
with the X-31.

14
00:00:46,580 --> 00:00:49,016
Each mishap has its own
circumstances

15
00:00:49,016 --> 00:00:51,318
and it's own sequence of events.

16
00:00:51,318 --> 00:00:54,688
But you find similar issues:

17
00:00:54,688 --> 00:00:57,524
communications, complacency,

18
00:00:57,524 --> 00:01:00,294
assumptions that haven't
been warranted.

19
00:01:00,294 --> 00:01:02,296
Human frailties.

20
00:01:02,296 --> 00:01:06,099
And you have to account for
these things in a program.

21
00:01:06,099 --> 00:01:08,001
(Rogers Smith) Just like a
chain.

22
00:01:08,001 --> 00:01:11,338
You make a chain when you have

any of these accidents.

23
00:01:11,338 --> 00:01:16,543
A chain of events. Any link of
the chain, if it were broken,

24
00:01:16,543 --> 00:01:18,512
you would not have an accident.

25
00:01:18,512 --> 00:01:19,947
This was the A team.

26
00:01:19,947 --> 00:01:22,849
We had the best people from
every discipline,

27
00:01:22,849 --> 00:01:24,584
from every organization.

28
00:01:24,584 --> 00:01:26,787
And we lost an airplane.

29
00:01:26,787 --> 00:01:28,822
So, if it can happen to the best
team.

30
00:01:28,822 --> 00:01:31,325
It can happen to any team.

31
00:01:43,537 --> 00:01:45,706
(female narrator) The X-31
research effort

32
00:01:45,706 --> 00:01:49,743
began in the late 1980s as an
international program

33
00:01:49,743 --> 00:01:50,944
involving DARPA, the U.S. Navy,

34
00:01:50,944 --> 00:01:52,379
Deutsche Aerospace,

35
00:01:52,379 --> 00:01:54,715
the German Federal Ministry of
Defense

36
00:01:54,715 --> 00:01:57,150
and Rockwell International.

37
00:01:57,150 --> 00:02:00,187
The program's goal was to
explore the tactical utility of

38
00:02:00,187 --> 00:02:03,156
a thrust-vectored aircraft
with advanced flight control

39
00:02:03,156 --> 00:02:06,560
systems, using an aircraft
designed and built specifically

40
00:02:06,560 --> 00:02:08,929
for that task.

41
00:02:08,929 --> 00:02:13,333
The X-31 was a real pioneering
program.

42
00:02:13,333 --> 00:02:16,303
In fact, the X-31 program
pretty much wrote the book

43
00:02:16,303 --> 00:02:19,806
on thrust-vectoring, along
with its sister program,

44
00:02:19,806 --> 00:02:22,909

the F-18 HARV.

45
00:02:22,909 --> 00:02:25,912
The initial X-31 flight
tests were conducted at

46
00:02:25,912 --> 00:02:29,816
Rockwell's facility in Palmdale,
California. But, in 1992,

47
00:02:29,816 --> 00:02:33,787
NASA and the U.S. Air
Force joined the X-31

48
00:02:33,787 --> 00:02:37,057
research team and the test
flight program was moved to

49
00:02:37,057 --> 00:02:39,226
the Dryden Flight Research
Center on

50
00:02:39,226 --> 00:02:42,662
Edwards Air Force Base. And
before too long,

51
00:02:42,662 --> 00:02:46,967
the X-31 was turning in some
extremely impressive results.

52
00:02:46,967 --> 00:02:51,872
[Jet engine]

53
00:02:51,872 --> 00:02:55,742
By any measure, the X-31 was a
highly successful program.

54
00:02:55,742 --> 00:02:59,479
It regularly flew several
flights a day, accumulating

55
00:02:59,479 --> 00:03:03,050
over 550 flights during the
course of the program,

56
00:03:03,050 --> 00:03:05,552
with a superlative
safety record.

57
00:03:05,552 --> 00:03:10,590
And yet, on the 19th of January
1995, on the very last

58
00:03:10,590 --> 00:03:16,363
scheduled flight of the X-31's
ship #1, disaster struck.

59
00:03:16,363 --> 00:03:17,898
This particular flight

60
00:03:17,898 --> 00:03:21,902
had been on the books for some
time to get done.

61
00:03:21,902 --> 00:03:25,138
And it was by our standards, an
absolutely routine flight.

62
00:03:25,138 --> 00:03:25,906
We were not expanding the
envelope.

63
00:03:25,906 --> 00:03:30,243
We were not trying anything new.

64
00:03:30,243 --> 00:03:31,645
We were flying a new pitot
static tube...

65

00:03:31,645 --> 00:03:35,715
but this was a routine mission,

66
00:03:35,715 --> 00:03:40,087
a routine task, a routine flight
environment with an experienced

67
00:03:40,087 --> 00:03:43,056
pilot and an experienced crew.

68
00:03:43,056 --> 00:03:44,691
But while the flight was
routine,

69
00:03:44,691 --> 00:03:48,295
there had been some changes
to the configuration of the X-31

70
00:03:48,295 --> 00:03:52,632
since its initial flights. In
particular, the original

71
00:03:52,632 --> 00:03:56,036
pitot tube, which supplies
airspeed information to the

72
00:03:56,036 --> 00:03:58,438
plane's flight control
computers, had been replaced

73
00:03:58,438 --> 00:04:03,310
with another kind of pitot tube
known as a "Kiel probe."

74
00:04:03,310 --> 00:04:06,379
The Kiel probe gave more
accurate airspeed data

75
00:04:06,379 --> 00:04:10,884
at high angles of attack, but it

was more vulnerable to icing --

76
00:04:10,884 --> 00:04:15,622
especially since the Kiel probe
on the X-31 did not have any

77
00:04:15,622 --> 00:04:17,157
pitot heat.

78
00:04:17,157 --> 00:04:18,959
(Fred Knox) We were never
to fly the airplane in ice.

79
00:04:18,959 --> 00:04:20,127
That was a prohibited
maneuver. So, if

80
00:04:20,127 --> 00:04:23,630
you're prohibited from flying in
ice, you don't need a heater.

81
00:04:23,630 --> 00:04:27,534
Normally, the conditions at
Edwards are warm and dry enough

82
00:04:27,534 --> 00:04:30,971
that icing, or pitot heat isn't
a concern.

83
00:04:30,971 --> 00:04:37,277
But January 19th, 1995 was not a
normal day.

84
00:04:37,277 --> 00:04:42,182
The unusual part of the day
was we had a high humidity

85
00:04:42,182 --> 00:04:45,418
at altitude actually conducive
for freezing conditions

86
00:04:45,418 --> 00:04:49,723
and the airplane was
operated for, in and out of some

87
00:04:49,723 --> 00:04:52,893
fairly high moisture content for
extended periods of time,

88
00:04:52,893 --> 00:04:55,529
lead to some indications in the
cockpit and the control room

89
00:04:55,529 --> 00:04:57,864
that was causing problems with
the air data system.

90
00:04:57,864 --> 00:05:05,338
[Jet engine]

91
00:05:05,338 --> 00:05:08,875
(Dana Purifoy) This particular
airplane had a limit to not fly

92
00:05:08,875 --> 00:05:11,077
through clouds,
through visible moisture.

93
00:05:11,077 --> 00:05:16,383
That day, we were flying very
close to and occasionally in

94
00:05:16,383 --> 00:05:19,853
and out of very thin cirrus
clouds. It didn't particularly
worry

95
00:05:19,853 --> 00:05:26,927
me because everything seemed to
be going along quite normally.

96
00:05:26,927 --> 00:05:33,833
But some minutes, like five,
before the airplane went out of

97
00:05:33,833 --> 00:05:39,773
control and the pilot jumped
out, the pilot observed that

98
00:05:39,773 --> 00:05:41,675
there was some moisture
around where he was.

99
00:05:41,675 --> 00:05:44,611
So he turned the pitot heat
switch on.

100
00:05:44,611 --> 00:05:47,447
Now clearly, when he turned the
pitot heat switch on,

101
00:05:47,447 --> 00:05:50,283
he expected that the pitot heat
would be working.

102
00:05:50,283 --> 00:05:53,887
About two and a half minutes
later, which is two and a half

103
00:05:53,887 --> 00:05:57,857
minutes before the accident,
he mentioned that fact

104
00:05:57,857 --> 00:06:02,062
to the control room.

105
00:06:15,775 --> 00:06:20,413
Mysteriously, to this day, the
control room gave him no
response.

106
00:06:20,413 --> 00:06:25,352
They had an internal discussion
as time, the clock clicked down.

107
00:06:25,352 --> 00:06:31,758
And internally it was commented
that the pitot heat was not
hooked up.

108
00:06:31,758 --> 00:06:35,862
But this vital piece of
information was not relayed

109
00:06:35,862 --> 00:06:37,764
to the pilot for more
than two minutes.

110
00:06:37,764 --> 00:06:40,900
And even when it was, the
information was not stated as

111
00:06:40,900 --> 00:06:44,004
clearly or strongly as it could
have been.

112
00:06:44,004 --> 00:06:46,306
Control Room: ....And pitot
heat.

113
00:06:46,306 --> 00:06:47,674
Pilot: We'll leave it on for
a moment.

114
00:06:47,674 --> 00:06:49,542
Control Room: Yeah, we think it
may not be hooked up.

115
00:06:49,542 --> 00:06:53,847
Pilot: It MAY not be hooked up?

That's good. I like this.

116
00:06:53,847 --> 00:06:57,350
We had side discussions that
should have been going on

117
00:06:57,350 --> 00:06:59,552
on the intercom so that
everybody in the control room

118
00:06:59,552 --> 00:07:02,155
was part of the conversation.

119
00:07:02,155 --> 00:07:04,891
Instead, we pulled our headsets
aside so that we could talk to

120
00:07:04,891 --> 00:07:07,394
each other because we were
sitting adjacent to each

121
00:07:07,394 --> 00:07:10,030
another. And that's another part
of just control room discipline

122
00:07:10,030 --> 00:07:12,198
that we broke down on.

123
00:07:12,198 --> 00:07:15,735
Meanwhile, the first signs of
trouble were beginning to
appear.

124
00:07:15,735 --> 00:07:22,075
So now the pilot sees an anomaly
in his airspeed.

125
00:07:22,075 --> 00:07:27,314
He's at 20 degrees angle of
attack, and he can see that.

126
00:07:27,314 --> 00:07:31,451
And he's says to the ground, and
I briefed this many times,

127
00:07:31,451 --> 00:07:36,122
he said, "I'm at 277,
I mean 207 knots."

128
00:07:36,122 --> 00:07:41,828
Pilot: The airspeed is off. I'm
reading 207 knots at 20
AOA

129
00:07:41,828 --> 00:07:45,765
....Ok, pitch doublet.

130
00:07:45,765 --> 00:07:50,103
Well, anybody that's been on the
program, and lots of people have

131
00:07:50,103 --> 00:07:51,805
been on many years,
would know that

132
00:07:51,805 --> 00:07:54,841
20 degrees angle of attack is
somewhere around 135 knots,

133
00:07:54,841 --> 00:07:59,412
140 knots. It's NOT 207 knots.

134
00:07:59,412 --> 00:08:02,782
Apparently, no one in the
control room caught the possible

135
00:08:02,782 --> 00:08:05,985
significance of that
discrepancy.

136
00:08:05,985 --> 00:08:07,654
And perhaps even more
importantly, neither

137
00:08:07,654 --> 00:08:12,025
did the chase pilot -- for the
simple reason that he couldn't

138
00:08:12,025 --> 00:08:14,861
hear any of the pilot's
transmissions.

139
00:08:14,861 --> 00:08:18,832
We had a mechanism of hot mic.

140
00:08:18,832 --> 00:08:20,600
It was very important to the
pilot of the X-31

141
00:08:20,600 --> 00:08:23,670
that he be able to talk to the
control room without having to

142
00:08:23,670 --> 00:08:25,672
press buttons at certain key
times,

143
00:08:25,672 --> 00:08:28,842
especially at high angles of
attack.

144
00:08:28,842 --> 00:08:30,744
Which was not going to be a
factor in this flight because

145
00:08:30,744 --> 00:08:33,980
it was going to go to about 20
degrees angle of attack.

146

00:08:33,980 --> 00:08:40,353
But, it was a general operating
procedure that was compounded

147
00:08:40,353 --> 00:08:44,357
because our hot mic system
didn't work always very well.

148
00:08:44,357 --> 00:08:47,594
And when it didn't work, it put
a lot of static in the earphones

149
00:08:47,594 --> 00:08:51,264
of the chase pilot who
wanted to hear the hot mic to

150
00:08:51,264 --> 00:08:53,166
know what's going on.

151
00:08:53,166 --> 00:08:56,736
So it was the one-sided nature
of the communication that

152
00:08:56,736 --> 00:08:59,806
kept me from having the
situational awareness

153
00:08:59,806 --> 00:09:04,177
to be able to step in and say,
"Hey, I'm reading X knots, and

154
00:09:04,177 --> 00:09:07,280
you guys are reading Y knots and
these two numbers should be the

155
00:09:07,280 --> 00:09:10,116
same and they're not."

156
00:09:10,116 --> 00:09:13,353
The X-31 did, indeed, have an

air data problem.

157
00:09:13,353 --> 00:09:16,689
The unheated Kiel probe had
frozen over in the cool,

158
00:09:16,689 --> 00:09:20,527
moist conditions, causing it to
start giving incorrect airspeed

159
00:09:20,527 --> 00:09:24,998
information to the X-31's flight
control computers.

160
00:09:24,998 --> 00:09:31,438
In terms of the accepted risk,
the failure of the pitot static

161
00:09:31,438 --> 00:09:33,907
system or damage to it was well
known. It was well understood.

162
00:09:33,907 --> 00:09:40,246
The pilot himself had simulated
the failure in simulations

163
00:09:40,246 --> 00:09:43,349
before we even got the airplane.
And it probably helped him

164
00:09:43,349 --> 00:09:45,518
understand that he had to
get out of the airplane because

165
00:09:45,518 --> 00:09:48,288
the time is short when
the airplane is diverging.

166
00:09:48,288 --> 00:09:53,293
And we went through quite a

thorough review of the hazards

167
00:09:53,293 --> 00:09:57,297
that we knew or could come up
with based upon the design of

168
00:09:57,297 --> 00:09:59,399
the flight control system.

169
00:09:59,399 --> 00:10:00,900
And we thought we had a good
handle on that.

170
00:10:00,900 --> 00:10:02,669
We thought we could lose the
whole nose boom.

171
00:10:02,669 --> 00:10:05,405
We could take a bird strike,
wipe out the whole nose boom

172
00:10:05,405 --> 00:10:09,943
and fly home safe. As a
result of that, we thought we

173
00:10:09,943 --> 00:10:14,581
had a pretty robust system.
The reason the team thought they

174
00:10:14,581 --> 00:10:18,585
HAD a robust system was the
X-31's flight control system

175
00:10:18,585 --> 00:10:21,621
was designed with three back-up
reversionary modes the

176
00:10:21,621 --> 00:10:24,691
pilot could select in the event
of an air data problem

177
00:10:24,691 --> 00:10:27,527
or other systems failures.

178
00:10:27,527 --> 00:10:32,565
So in the case, of if you saw
something that was not right

179
00:10:32,565 --> 00:10:34,601
or the control room saw
something that was not right

180
00:10:34,601 --> 00:10:36,102
with respect to the airspeed

181
00:10:36,102 --> 00:10:40,306
system, they could tell the
pilot to go to R3.

182
00:10:40,306 --> 00:10:44,711
R3 was a reversionary mode
that would have removed --
within 2 seconds

183
00:10:44,711 --> 00:10:49,182
-- the airspeed data inputs into
the flight control system.

184
00:10:49,182 --> 00:10:52,886
The control surface response to
pilot inputs would then be

185
00:10:52,886 --> 00:10:56,189
independent of airspeed allowing
the airplane to remain

186
00:10:56,189 --> 00:11:00,727
controllable for the remainder
of the flight back to the
landing.

187
00:11:00,727 --> 00:11:03,897
The accepted risk was
probably reasonable.

188
00:11:03,897 --> 00:11:08,535
But here's the kicker...the
consequences of a failure are so

189
00:11:08,535 --> 00:11:11,237
high here that you really needed

190
00:11:11,237 --> 00:11:14,040
to put some special attention on
this.

191
00:11:14,040 --> 00:11:19,312
The designer did by putting R3
in. But nobody on the test team,

192
00:11:19,312 --> 00:11:23,583
including the pilot, realized
that the X-31 was experiencing

193
00:11:23,583 --> 00:11:27,520
an air data problem that would
require implementing the R-3

194
00:11:27,520 --> 00:11:29,656
reversionary system.

195
00:11:29,656 --> 00:11:33,092
For several minutes we had
indications that airspeed was

196
00:11:33,092 --> 00:11:36,529
becoming poor, both in the
cockpit and the control room.

197

00:11:36,529 --> 00:11:40,333
In our last ditch catch,
nobody stood up and yelled,

198
00:11:40,333 --> 00:11:43,770
"Wait a minute, this can't be
right."

199
00:11:43,770 --> 00:11:45,471
Because had we realized what was
going on,

200
00:11:45,471 --> 00:11:47,874
the control system had the
ability to go to

201
00:11:47,874 --> 00:11:52,345
fixed flight control gains. And
with fixed flight control gains,

202
00:11:52,345 --> 00:11:54,280
it would not have been a
problem.

203
00:11:54,280 --> 00:11:56,249
They would have been able to
land the airplane safely.

204
00:11:56,249 --> 00:11:59,552
But we just never got enough
information to make the

205
00:11:59,552 --> 00:12:04,824
decision to do that. We had an
alternate airspeed indicator

206
00:12:04,824 --> 00:12:09,062
that used a different pitot tube
which would be less susceptible

207

00:12:09,062 --> 00:12:11,931
to icing than this special tube.

208
00:12:11,931 --> 00:12:17,904
It was at the pilot's right hand
knee. And he never looked at it.

209
00:12:17,904 --> 00:12:21,774
We had a lack of attention to
the reversionary modes.

210
00:12:21,774 --> 00:12:25,345
Gradually, we were not thinking.
We learned to depend on the

211
00:12:25,345 --> 00:12:28,982
control room -- they're going to
tell us when we need to go to R2

212
00:12:28,982 --> 00:12:36,489
or R1 or R3. We need to know as
pilots, which we kind of forgot,

213
00:12:36,489 --> 00:12:41,461
where are the safety nets. The
safety nets - push the right
button -

214
00:12:41,461 --> 00:12:46,666
didn't get the test data, but
you bring the aircraft back.

215
00:12:46,666 --> 00:12:52,605
So if we didn't understand
what was happening, we should

216
00:12:52,605 --> 00:12:56,643
have been constantly reminded,
push the button and talk about
it.

217
00:12:56,643 --> 00:13:00,380
The pilot obviously wasn't
concerned. He was experienced...

218
00:13:00,380 --> 00:13:02,715
Probably, if you look at the
control room, the pilot and

219
00:13:02,715 --> 00:13:04,684
everybody involved in that day's
activity, he was the most
experienced

220
00:13:04,684 --> 00:13:09,455
in that day's activity. He'd
been on the program since

221
00:13:09,455 --> 00:13:13,926
Palmdale. He noticed something
but he wasn't concerned.

222
00:13:13,926 --> 00:13:16,329
And he didn't ask for help
that I was aware of.

223
00:13:16,329 --> 00:13:19,399
So I think the control room
said, "Well, if he's not that

224
00:13:19,399 --> 00:13:22,001
panicked, I'm not that
panicked." And I think that fed

225
00:13:22,001 --> 00:13:23,803
off each other a little bit.

226
00:13:23,803 --> 00:13:26,572
The team moved on to the
final test point of the day

227
00:13:26,572 --> 00:13:28,741
-- a simple, automatic
control response test

228
00:13:28,741 --> 00:13:33,446
that required only a command
from the pilot to initiate.

229
00:13:33,446 --> 00:13:38,518
But once again, the airplane DID
NOT respond as expected.

230
00:13:38,518 --> 00:13:44,557
He hits the box, presses the
button and he says,
"I don't get anything."

231
00:13:44,557 --> 00:13:49,295
Well, he didn't get anything
because the box was designed not

232
00:13:49,295 --> 00:13:52,532
to put any input if you went
beyond a certain speed,

233
00:13:52,532 --> 00:13:55,968
like 200 knots. So it was seeing
the false airspeed of

234
00:13:55,968 --> 00:14:01,407
200 plus knots and when he
pushed the button, it didn't
work.

235
00:14:01,407 --> 00:14:09,682
Pilot: Three, two, one, go. Hmm.
It doesn't do anything.

236
00:14:09,682 --> 00:14:14,954
Well, it didn't work because

something was wrong!

237
00:14:14,954 --> 00:14:19,425
And, the control room came
back and finally just kind of

238
00:14:19,425 --> 00:14:22,895
ignored that and said, "It's
all okay and RTB now."

239
00:14:22,895 --> 00:14:28,167
It's almost like expecting to
hear that it went fine.

240
00:14:28,167 --> 00:14:31,971
After this program with hundreds
of flights and everything going
perfectly,

241
00:14:31,971 --> 00:14:35,141
in your mind, you're hearing
things that aren't happening.

242
00:14:35,141 --> 00:14:37,744
Everything's fine, it worked
fine, let's come home.

243
00:14:37,744 --> 00:14:40,379
The normal operation of the
system was expected that the

244
00:14:40,379 --> 00:14:43,449
system would identify
the problems itself

245
00:14:43,449 --> 00:14:46,452
that it would not be the people
on the ground identifying

246
00:14:46,452 --> 00:14:49,222

an air data problem
and calling for fixed gains.

247
00:14:49,222 --> 00:14:52,425
Although it was certainly
capable of doing that, the

248
00:14:52,425 --> 00:14:54,927
expectation would be that the
system would do its own

249
00:14:54,927 --> 00:14:58,064
self-diagnosis and identify
failures.

250
00:14:58,064 --> 00:15:00,800
But the failure we had was a
slow failure of the tube,

251
00:15:00,800 --> 00:15:02,602
slowly building the ice up.

252
00:15:02,602 --> 00:15:06,639
So the changes in the speed were
within perfectly reasonable

253
00:15:06,639 --> 00:15:07,974
numbers for a real airplane.

254
00:15:07,974 --> 00:15:11,077
The software's just not capable
of detecting that failure,

255
00:15:11,077 --> 00:15:12,678
for that system.

256
00:15:12,678 --> 00:15:17,450
There was one or two people that
actually knew that there was

257
00:15:17,450 --> 00:15:20,419
these little tiny areas that it
couldn't handle

258
00:15:20,419 --> 00:15:21,888
but that word never got out.
They never stood up and said,

259
00:15:21,888 --> 00:15:25,324
"Uh, boss, that's not quite
right.

260
00:15:25,324 --> 00:15:29,929
You can handle it over 95 or
99 percent of the area but
there's really a couple

261
00:15:29,929 --> 00:15:32,899
little areas that the automated
system can't handle."

262
00:15:32,899 --> 00:15:35,601
And that didn't come out until
after the accident.

263
00:15:35,601 --> 00:15:37,904
I never did get to talk to them
about it but I just kind of felt

264
00:15:37,904 --> 00:15:41,140
like they didn't want to stop
the program, thought it was of

265
00:15:41,140 --> 00:15:45,578
no real issue because of the
difficulty of getting to such

266
00:15:45,578 --> 00:15:48,014
a small area of the envelope.

267
00:15:48,014 --> 00:15:50,750
But as the X-31 began to descend
on its return to base,

268
00:15:50,750 --> 00:15:54,253
the problems caused by the
failure of its air data system

269
00:15:54,253 --> 00:15:57,623
became far more pronounced.

270
00:15:57,623 --> 00:16:02,295
We have frozen the
pitot tube now. And it's stuck.

271
00:16:02,295 --> 00:16:06,465
It's got what it had in it and
it's going to hold that
pressure.

272
00:16:06,465 --> 00:16:09,869
Now when you start
down with a frozen pitot tube,

273
00:16:09,869 --> 00:16:16,809
the airspeed, what you see, the
false airspeed that he saw, will

274
00:16:16,809 --> 00:16:20,479
decrease as he decreases
altitude.

275
00:16:20,479 --> 00:16:25,384
But we are seeing, "we", the
control room is seeing,

276
00:16:25,384 --> 00:16:28,154
they have a big display,

277

00:16:28,154 --> 00:16:31,858
the pilot is seeing every
time he turns his head,

278
00:16:31,858 --> 00:16:34,727
he's seeing the airspeed in the
HUD.

279
00:16:34,727 --> 00:16:39,599
And now, it's perhaps at one
point, it's at 150 knots.

280
00:16:39,599 --> 00:16:43,135
It cannot be at 150 knots!

281
00:16:43,135 --> 00:16:48,274
And then it's at 100 knots
and it cannot be at 100 knots!

282
00:16:48,274 --> 00:16:52,178
And going on down and finally
right just before the accident,

283
00:16:52,178 --> 00:16:56,582
it gets to 48 knots which is the
minimum it's going to read.

284
00:16:56,582 --> 00:17:04,357
But the control system in the
airplane is getting this wrong

285
00:17:04,357 --> 00:17:07,493
information and this is a
complex closed-loop system

286
00:17:07,493 --> 00:17:09,729
and when you put
too much gain in,

287
00:17:09,729 --> 00:17:13,733

it will start to get unstable
and it will start moving the

288
00:17:13,733 --> 00:17:15,902
controls, which it did in a
matter of seconds.

289
00:17:15,902 --> 00:17:22,275
And finally, it dramatically
pitches up, the pilot of course
tries to prevent that

290
00:17:22,275 --> 00:17:25,878
and I'm sure the instant
that he hit the forward stop and

291
00:17:25,878 --> 00:17:30,316
realized he was out of control,
he did the natural thing which

292
00:17:30,316 --> 00:17:32,351
was to eject from the airplane.

293
00:17:32,351 --> 00:17:37,623
We were RTB (return to base) and
I started to rejoin on the X-31.

294
00:17:37,623 --> 00:17:43,996
As I came up on his right side,
about 100 yards away and closing

295
00:17:43,996 --> 00:17:47,600
I saw the airplane start
to go into a small wing rock

296
00:17:47,600 --> 00:17:50,670
that progressively got larger
and larger. And, as I got

297
00:17:50,670 --> 00:17:55,641

within about 200 feet of him,
the airplane pitched up vertical

298
00:17:55,641 --> 00:17:58,477
and approximately the time that

299
00:17:58,477 --> 00:18:02,648
I passed abeam him, I saw the
pilot eject.

300
00:18:02,648 --> 00:18:05,685
Chase Pilot Dana Purifoy: Okay
NASA One, we have an ejection,

301
00:18:05,685 --> 00:18:07,353
we have an ejection.

302
00:18:07,353 --> 00:18:13,125
NASA One do you read? Yeah, we
copy Dana, we copy.

303
00:18:13,125 --> 00:18:19,398
Puriofy: Sport, NASA 584 has
ejected the aircraft and is
descending

304
00:18:19,398 --> 00:18:24,870
over the North Base area.

305
00:18:24,870 --> 00:18:30,943
I have a chute. Sport
NASA 850, how do you read?

306
00:18:30,943 --> 00:18:32,378
850, say it again please?

307
00:18:32,378 --> 00:18:36,549
Purifoy: Yes sir. NASA 584 has
ejected from his aircraft.

308
00:18:36,549 --> 00:18:39,385
The aircraft is descending
north of North Base.

309
00:18:39,385 --> 00:18:41,554
The pilot is in the chute
at this time,

310
00:18:41,554 --> 00:18:45,324
descending approximately
one mile north of North Base.

311
00:18:45,324 --> 00:18:47,860
854, copy.

312
00:18:47,860 --> 00:18:49,762
(John Bosworth) So there was
the knowledge and training in

313
00:18:49,762 --> 00:18:53,766
the simulation that taught the
pilot that when he started to

314
00:18:53,766 --> 00:18:55,401
see the airplane was
oscillating and

315
00:18:55,401 --> 00:18:57,903
was not controlled, he knew he
had to get out of the airplane

316
00:18:57,903 --> 00:19:01,007
very fast or else the airplane
would go into a tumble.

317
00:19:01,007 --> 00:19:05,711
And he did do that and that
saved his life. I also know
that the

318
00:19:05,711 --> 00:19:09,615
pilot, as he was ejecting from
the airplane, had thoughts of,

319
00:19:09,615 --> 00:19:14,754
"Maybe I should have tried a
reversionary mode." But at that

320
00:19:14,754 --> 00:19:17,056
point, if he would have
hesitated any longer, he would

321
00:19:17,056 --> 00:19:19,992
have been probably lost with the
airplane.

322
00:19:19,992 --> 00:19:23,062
Stoliker: I did not connect,
until after the plane departed,

323
00:19:23,062 --> 00:19:25,498
and while the plane was
tumbling, I made the connection:

324
00:19:25,498 --> 00:19:29,735
the pitot system had to be
frozen. And just didn't come

325
00:19:29,735 --> 00:19:31,303
to the realization soon enough

326
00:19:31,303 --> 00:19:34,006
to do anything about it in the
control room.

327
00:19:34,006 --> 00:19:37,376
Less than four minutes after the
first comment about pitot heat

328

00:19:37,376 --> 00:19:39,945
was recorded between the pilot
and the control room,

329
00:19:39,945 --> 00:19:43,983
the X-31 crashed just north
of Edwards Air Force Base.

330
00:19:43,983 --> 00:19:47,620
How could such a routine
operation have ended

331
00:19:47,620 --> 00:19:51,724
in disaster, when flights with
far higher risk had been

332
00:19:51,724 --> 00:19:53,526
completed safely?

333
00:19:53,526 --> 00:19:56,195
And more importantly, what
can we learn

334
00:19:56,195 --> 00:19:59,432
from the answers
to that question?

335
00:19:59,432 --> 00:20:03,169
Szalai: Every person involved in
an experimental flight research

336
00:20:03,169 --> 00:20:07,640
program should actually study
the mishaps of all experimental

337
00:20:07,640 --> 00:20:11,610
aircraft in the past twenty to
thirty years. There's a lot of

338
00:20:11,610 --> 00:20:14,914

things you can learn. Because human nature doesn't change.

339
00:20:14,914 --> 00:20:17,783
The processes don't change. It's always the same set of

340
00:20:17,783 --> 00:20:23,022
contributing factors. Just the names and the details change.

341
00:20:23,022 --> 00:20:28,761
Of the ten things, for example, that I would describe as causes,

342
00:20:28,761 --> 00:20:32,198
contributing causes of the mishap, six of them occurred

343
00:20:32,198 --> 00:20:37,002
prior to the day of flight. Four occurred within about two

344
00:20:37,002 --> 00:20:41,140
minutes. So, we had a better chance of working on the six

345
00:20:41,140 --> 00:20:43,542
than we did on the four.

346
00:20:43,542 --> 00:20:47,113
In some senses, the X-31 accident started six years

347
00:20:47,113 --> 00:20:50,249
earlier, when the plane was first developed and tested at

348
00:20:50,249 --> 00:20:51,951
Rockwell.

349
00:20:51,951 --> 00:20:54,220
Knox: We had a hazard analysis
from the initial design.

350
00:20:54,220 --> 00:20:57,823
And in the accident that had to
actually get dusted off.

351
00:20:57,823 --> 00:20:59,625
You should never have to dust
off one of those.

352
00:20:59,625 --> 00:21:03,996
Everybody familiar with the
program, at all those levels

353
00:21:03,996 --> 00:21:06,799
needs to have a really good
comfortable feeling of what

354
00:21:06,799 --> 00:21:10,436
those hazards are and what are
accepted in the risks.

355
00:21:10,436 --> 00:21:13,005
There was a redo of that
analysis as we moved to

356
00:21:13,005 --> 00:21:17,309
NASA in '92. And I think, that
it was clear after the accident

357
00:21:17,309 --> 00:21:20,012
that not everybody really
understood what that design

358
00:21:20,012 --> 00:21:22,882
was to the detail you
needed to understand

359
00:21:22,882 --> 00:21:24,984
the full risks of the program.

360
00:21:24,984 --> 00:21:28,354
Clearly, from 1990 to '95 you
have a large team turnover.

361
00:21:28,354 --> 00:21:30,789
We changed locations. We
expanded the objectives

362
00:21:30,789 --> 00:21:34,793
of the program and as time
rolls on and the new people

363
00:21:34,793 --> 00:21:37,897
come in, not everybody
has the same understanding or

364
00:21:37,897 --> 00:21:40,833
appreciation of the
kind of vehicle we're operating.

365
00:21:40,833 --> 00:21:44,837
It's a special airplane. It's
not the same risk as any other

366
00:21:44,837 --> 00:21:47,973
airplane and to operate
it everyday you

367
00:21:47,973 --> 00:21:50,409
really ought to have the same
appreciation for the risk.

368
00:21:50,409 --> 00:21:52,945
And I don't think we, as
a team, did a good job at

369
00:21:52,945 --> 00:21:55,281
keeping everybody that came to
the program with the same

370
00:21:55,281 --> 00:21:56,682
level of understanding

371
00:21:56,682 --> 00:21:58,884
of both the design and the risk
of the airplane.

372
00:21:58,884 --> 00:22:01,353
We shouldn't have had a
control room, a pilot and a

373
00:22:01,353 --> 00:22:04,957
team that day that didn't
understand that fundamental
fact.

374
00:22:04,957 --> 00:22:07,426
And it's not elaborate.

375
00:22:07,426 --> 00:22:08,527
It's just straight-forward.

376
00:22:08,527 --> 00:22:11,830
The airspeed I see in the HUD is
the airspeed the computer uses.

377
00:22:11,830 --> 00:22:13,666
If the airspeed I see
has got a problem,

378
00:22:13,666 --> 00:22:15,835
the airplane has got a
problem.

379
00:22:15,835 --> 00:22:18,938

And that fact didn't get
communicated correctly

380
00:22:18,938 --> 00:22:23,008
from the old team members to the
new team members and if it had,

381
00:22:23,008 --> 00:22:24,677
I don't think there would have
been anybody in that room that

382
00:22:24,677 --> 00:22:25,945
wouldn't have yelled "STOP"

383
00:22:25,945 --> 00:22:28,347
and jumped off that bridge to
make it happen.

384
00:22:28,347 --> 00:22:31,116
There were errors made.

385
00:22:31,116 --> 00:22:37,723
The pitot heat circuit breaker
was disabled but there was

386
00:22:37,723 --> 00:22:41,293
no placard in the cockpit to say
"NO PITOT HEAT."

387
00:22:41,293 --> 00:22:47,099
Notices of the configuration
were sent around but here

388
00:22:47,099 --> 00:22:50,536
also we probably lacked one step

389
00:22:50,536 --> 00:22:53,739
and that is to know that
everybody got the message.

390
00:22:53,739 --> 00:22:56,175
It's one thing to send
it out, it's another thing to

391
00:22:56,175 --> 00:22:58,978
verify that everyone has read
and understood it.

392
00:22:58,978 --> 00:23:01,513
And so that procedure was
changed, by the way,

393
00:23:01,513 --> 00:23:04,850
so that people ripped off the
bottom of the page

394
00:23:04,850 --> 00:23:07,353
and sent it back. I've seen it.

395
00:23:07,353 --> 00:23:11,357
Ironically, the X-31 program
also may have been a victim of

396
00:23:11,357 --> 00:23:13,659
its own success.

397
00:23:13,659 --> 00:23:16,428
Szalai: I never saw
complacency in this team.

398
00:23:16,428 --> 00:23:19,064
I went to tech briefs, crew
briefs and it was treated

399
00:23:19,064 --> 00:23:22,101
very professionally and
in fact, to some extent

400
00:23:22,101 --> 00:23:25,504

it was treated like an
experimental airplane

401
00:23:25,504 --> 00:23:26,672
every flight.

402
00:23:26,672 --> 00:23:27,673
But certainly you have

403
00:23:27,673 --> 00:23:31,443
to think that after hundreds of
flights, excellent results and

404
00:23:31,443 --> 00:23:33,145
the fact that none of these
hazards,

405
00:23:33,145 --> 00:23:35,648
these terrible things that
you predict could happen,

406
00:23:35,648 --> 00:23:41,120
has ever happened, it could
lead you to be less sensitive

407
00:23:41,120 --> 00:23:42,955
to things that are
happening.

408
00:23:42,955 --> 00:23:45,024
Maybe just a little bit of the
edge comes off.

409
00:23:45,024 --> 00:23:49,895
Those single point failures were
identified and we made some

410
00:23:49,895 --> 00:23:52,364
actual changes to the
design of the airplane

to account for that.

411
00:23:52,364 --> 00:23:55,868
Again, that was in 1989.

412
00:23:55,868 --> 00:23:58,537
Why all those were
there and what the concerns were

413
00:23:58,537 --> 00:24:02,675
and how to mitigate them or how
to worry about them became...

414
00:24:02,675 --> 00:24:04,877
we hadn't had any problems with
that for five years and I think

415
00:24:04,877 --> 00:24:09,348
again, the complacency just got
built into the team.

416
00:24:09,348 --> 00:24:11,517
It worked fine. We'd never
had a problem.

417
00:24:11,517 --> 00:24:14,687
And those little hairs on the
back of your neck weren't geared

418
00:24:14,687 --> 00:24:16,889
to stand up when people started
having air speed problems.

419
00:24:16,889 --> 00:24:20,326
Our control rooms used
to have a saying on them to,

420
00:24:20,326 --> 00:24:24,697
"Prepare for the unexpected and
expect to be unprepared."

421
00:24:24,697 --> 00:24:27,166
And I think that's
a truth in the flight test

422
00:24:27,166 --> 00:24:32,705
business that we need to keep
in mind continuously.

423
00:24:32,705 --> 00:24:36,508
I wish that sign was still up
there because that reminder

424
00:24:36,508 --> 00:24:39,345
needs to be enforced all the
time.

425
00:24:39,345 --> 00:24:41,714
Well certainly in the case of
the X-31 we were returning to

426
00:24:41,714 --> 00:24:44,683
base after two exhausting days,
7 flights.

427
00:24:44,683 --> 00:24:49,521
Ship 1 was now going into the
boneyard or at least it was

428
00:24:49,521 --> 00:24:52,858
being retired from the test
program and so we're finally

429
00:24:52,858 --> 00:24:54,259
finished.

430
00:24:54,259 --> 00:24:56,195
Was everybody paying attention
like they should be?

431
00:24:56,195 --> 00:25:01,133
Obviously not. And while the
X-31 program flights were

432
00:25:01,133 --> 00:25:05,003
highly successful, they did not
include an element that might

433
00:25:05,003 --> 00:25:08,807
have helped prime the program
team to take the one mitigating

434
00:25:08,807 --> 00:25:13,278
action that could have brought
the X-31 home safely.

435
00:25:13,278 --> 00:25:16,081
We've debated amongst ourselves
whether we actually would

436
00:25:16,081 --> 00:25:18,250
have been able to convince
anybody to use the

437
00:25:18,250 --> 00:25:22,187
fixed gains system because there
was not an obvious need for it.

438
00:25:22,187 --> 00:25:26,291
The pilot may have been better
prepared when things started to

439
00:25:26,291 --> 00:25:30,529
go awry to select fixed gains
but I don't know if we ever

440
00:25:30,529 --> 00:25:32,598
really would have
done it in that situation

441
00:25:32,598 --> 00:25:35,134
because we didn't
have a real problem.

442
00:25:35,134 --> 00:25:37,336
We DID have a real
problem but it hadn't

443
00:25:37,336 --> 00:25:39,605
been diagnosed as
a real problem.

444
00:25:39,605 --> 00:25:41,840
On a previous program,
the X-29 program,

445
00:25:41,840 --> 00:25:44,243
we had the same sort of thing.

446
00:25:44,243 --> 00:25:47,579
We had an analog reversion
mode, a digital reversion mode,

447
00:25:47,579 --> 00:25:50,149
and the normal mode of
the airplane.

448
00:25:50,149 --> 00:25:53,685
We routinely at every test point
selected those back up modes,

449
00:25:53,685 --> 00:25:58,023
flew them around so the pilots
were much more familiar and much

450
00:25:58,023 --> 00:26:00,893
more comfortable with selecting
those modes.

451

00:26:00,893 --> 00:26:04,329
On the X-31 program, we
never selected those modes

452
00:26:04,329 --> 00:26:08,467
intentionally, we only
used them when we had a sensor

453
00:26:08,467 --> 00:26:12,304
failure or when the system told
us to select those modes.

454
00:26:12,304 --> 00:26:15,541
On the day of the mishap itself,
there were additional links

455
00:26:15,541 --> 00:26:18,377
added to the chain.

456
00:26:18,377 --> 00:26:19,645
There were unusual weather
conditions

457
00:26:19,645 --> 00:26:21,814
that created an uncommon and
unexpected kind

458
00:26:21,814 --> 00:26:23,382
of flight hazard.

459
00:26:23,382 --> 00:26:25,884
And the team was working with
a flawed hot mic system

460
00:26:25,884 --> 00:26:28,921
that kept the chase pilot from
hearing critical communications

461
00:26:28,921 --> 00:26:31,757
from the X-31 pilot.

462
00:26:31,757 --> 00:26:36,061
So, some links in the chain are
already built there.

463
00:26:36,061 --> 00:26:37,129
Management links.

464
00:26:37,129 --> 00:26:39,531
The control room has now
talked internally,

465
00:26:39,531 --> 00:26:42,434
they've heard some things, they
haven't said anything.

466
00:26:42,434 --> 00:26:45,070
Some more links are built.

467
00:26:45,070 --> 00:26:47,239
We've got this chain is
building now.

468
00:26:47,239 --> 00:26:51,343
The chase pilot didn't
hear anything about this,

469
00:26:51,343 --> 00:26:55,180
he didn't know anything
was wrong with the airplane

470
00:26:55,180 --> 00:26:58,250
until he saw the airplane pitch
up and the pilot jump out.

471
00:26:58,250 --> 00:27:01,720
Whereas he could have stopped
this at any time.

472

00:27:01,720 --> 00:27:05,224
At any rate, it's a total team
concept and the

473
00:27:05,224 --> 00:27:07,125
chase pilot has to
be part of that team

474
00:27:07,125 --> 00:27:11,296
and the team has to
have total communication.

475
00:27:11,296 --> 00:27:15,734
So the use of a hot microphone
frequency that did not allow

476
00:27:15,734 --> 00:27:19,004
the chase pilot to stay up with
what was going on

477
00:27:19,004 --> 00:27:22,741
with the airplane was
essentially keeping me

478
00:27:22,741 --> 00:27:25,410
from doing my job at
least at a certain level.

479
00:27:25,410 --> 00:27:28,447
And that's one of
the things that we changed in

480
00:27:28,447 --> 00:27:32,885
the way we do business here at
Dryden is to allow the

481
00:27:32,885 --> 00:27:37,122
chase pilots either access to
the hot mic or to ensure that

482

00:27:37,122 --> 00:27:41,426
all critical communications are
transmitted so that all the

483
00:27:41,426 --> 00:27:45,697
players are kept up to speed
with what's going on.

484
00:27:45,697 --> 00:27:48,800
And that was a direct fall out
of how the X-31 operation

485
00:27:48,800 --> 00:27:50,502
was handled that day.

486
00:27:50,502 --> 00:27:52,905
If one or more of these
contributing factors had been

487
00:27:52,905 --> 00:27:55,507
caught and addressed prior to
January 19th,

488
00:27:55,507 --> 00:27:58,443
the chain of events leading
up the accident might

489
00:27:58,443 --> 00:28:01,713
have been broken before the
flight even took place.

490
00:28:01,713 --> 00:28:04,716
Yet there were still
opportunities to avoid the

491
00:28:04,716 --> 00:28:08,453
mishap, even in the last few
minutes of the X-31's flight.

492
00:28:08,453 --> 00:28:11,023

So why didn't the team
manage to recognize,

493
00:28:11,023 --> 00:28:15,527
communicate, and respond to the
X-31's pattern of anomalies

494
00:28:15,527 --> 00:28:17,095
in time?

495
00:28:17,095 --> 00:28:19,464
Stoliker: So we were seeing
inconsistencies between

496
00:28:19,464 --> 00:28:21,934
the data from the aircraft
system and what we knew of the

497
00:28:21,934 --> 00:28:25,571
physics of the problem that it
could not be, that you could not

498
00:28:25,571 --> 00:28:28,674
have that airspeed and that
angle of attack simultaneously.

499
00:28:28,674 --> 00:28:30,809
And for me, I just remember
thinking, "Gosh,

500
00:28:30,809 --> 00:28:33,645
I can't wait until we get the
data from this flight because I

501
00:28:33,645 --> 00:28:36,415
want to see what's going on." I
knew there was an anomaly.

502
00:28:36,415 --> 00:28:38,483
We had talked about it between

the engineers.

503
00:28:38,483 --> 00:28:41,320
We didn't talk about
it on the intercom though,

504
00:28:41,320 --> 00:28:44,623
it was sidebar conversations
in the control room.

505
00:28:44,623 --> 00:28:49,494
Well, many of us are
engineers and we see an issue

506
00:28:49,494 --> 00:28:51,029
and, "Oh, this is interesting, I
wonder what's causing that."

507
00:28:51,029 --> 00:28:52,664
And you start thinking
about it and trying to

508
00:28:52,664 --> 00:28:54,132
figure out what is the
answer.

509
00:28:54,132 --> 00:28:56,068
In the meantime the seconds
are clicking by.

510
00:28:56,068 --> 00:28:58,303
And really, the right response
is, "Something's going on.

511
00:28:58,303 --> 00:29:00,539
I don't understand, let's call a
halt here

512
00:29:00,539 --> 00:29:01,974
and let's just figure it out."

513
00:29:01,974 --> 00:29:03,942
We should have, at the first
call of an airspeed failure,

514
00:29:03,942 --> 00:29:07,512
just puckered up.
Whether you're RTB at that point

515
00:29:07,512 --> 00:29:10,015
or not, it wouldn't have
changed. The kind of failure

516
00:29:10,015 --> 00:29:12,951
that was occurring should have
triggered a lot of emotion

517
00:29:12,951 --> 00:29:14,519
anywhere in the flight envelope.

518
00:29:14,519 --> 00:29:16,822
In the case of any discrepancy,

519
00:29:16,822 --> 00:29:19,191
anything that doesn't sound
right, feel right, smell right,

520
00:29:19,191 --> 00:29:22,894
let's stop and think it over.
And I think that kind of

521
00:29:22,894 --> 00:29:26,365
attitude has been built in now
into the mission control room

522
00:29:26,365 --> 00:29:31,003
processes since then. We were
flying lots of flights.

523

00:29:31,003 --> 00:29:35,073
At the peak of the program
there would be days when

524
00:29:35,073 --> 00:29:36,875
there would be five flight days.
I think on that particular day

525
00:29:36,875 --> 00:29:39,511
we were only doing three
flights

526
00:29:39,511 --> 00:29:41,747
and it was the last flight
of the day.

527
00:29:41,747 --> 00:29:48,420
It was the last flight for the
first airplane and we had

528
00:29:48,420 --> 00:29:50,856
completed all the test points
for that mission.

529
00:29:50,856 --> 00:29:53,625
In addition, we were going
through the RTB or

530
00:29:53,625 --> 00:29:57,562
return to base checklist and at
that point, every one of us

531
00:29:57,562 --> 00:29:58,764
kind of relaxed.

532
00:29:58,764 --> 00:30:00,399
Like I said, what was going
through my mind is,

533
00:30:00,399 --> 00:30:02,934

"I can't wait to get this data.
Something funny is going on

534
00:30:02,934 --> 00:30:05,137
and I want to figure it out."

535
00:30:05,137 --> 00:30:07,172
And, that's another
lessoned learned

536
00:30:07,172 --> 00:30:09,741
and we talk about
it all the time,

537
00:30:09,741 --> 00:30:12,110
that the mission's not
over until the airplane's on the

538
00:30:12,110 --> 00:30:14,446
ground and the
engine's shut down.

539
00:30:14,446 --> 00:30:16,248
And you see it a lot in
the control rooms,

540
00:30:16,248 --> 00:30:19,685
you start getting ready to
land and everybody relaxes

541
00:30:19,685 --> 00:30:21,953
a little bit. And that's a
lesson I've carried

542
00:30:21,953 --> 00:30:24,322
with me is that you need to
continue the vigilance

543
00:30:24,322 --> 00:30:26,291
there on the flight.

544
00:30:26,291 --> 00:30:28,560
Communication is what
it's all about.

545
00:30:28,560 --> 00:30:32,030
We have to have the
communication links.

546
00:30:32,030 --> 00:30:33,832
We didn't have it
to the chase.

547
00:30:33,832 --> 00:30:36,568
Hot mic was a contributing
factor.

548
00:30:36,568 --> 00:30:40,038
We didn't have it in the control
room.

549
00:30:40,038 --> 00:30:41,840
We discussed things
internally,

550
00:30:41,840 --> 00:30:43,842
it was not transmitted to
the pilot.

551
00:30:43,842 --> 00:30:49,681
We have to have an
environment built where people

552
00:30:49,681 --> 00:30:55,153
can speak up when they THINK
something's wrong.

553
00:30:55,153 --> 00:30:56,955
They don't have to be
right.

554
00:30:56,955 --> 00:30:59,558
If they're concerned, they
should be able

555
00:30:59,558 --> 00:31:04,563
to speak their mind, put their
hand up and we stop the train

556
00:31:04,563 --> 00:31:09,134
and then we say, "No, you
weren't right, it's okay."

557
00:31:09,134 --> 00:31:11,737
Fine, we go on. We
didn't do that.

558
00:31:11,737 --> 00:31:13,572
We never stopped the train.

559
00:31:13,572 --> 00:31:18,310
We had a problem and we didn't
stop, not only testing,

560
00:31:18,310 --> 00:31:20,979
but we didn't stop
flying and come home.

561
00:31:20,979 --> 00:31:25,217
But you can't stop for every
problem. That's unrealistic.

562
00:31:25,217 --> 00:31:28,320
You have problems in flight. The
combination that went with that

563
00:31:28,320 --> 00:31:31,256
is that we didn't understand the
severity of the problem.

564
00:31:31,256 --> 00:31:34,226
So you have to understand your
vehicle and the consequences

565
00:31:34,226 --> 00:31:38,530
of failures. And if one of those
failures has a serious

566
00:31:38,530 --> 00:31:41,433
consequence, you need to stop
and come home.

567
00:31:41,433 --> 00:31:44,202
Clearly, there are lessons to be
learned in the entire

568
00:31:44,202 --> 00:31:47,672
progression of events that
led up to the X-31 mishap.

569
00:31:47,672 --> 00:31:52,544
And yet, the X-31 program did
not end with that crash.

570
00:31:52,544 --> 00:31:55,580
The next chapter of its story is
an equally important reminder

571
00:31:55,580 --> 00:31:58,950
of why flight test remains such
a valuable step in proving

572
00:31:58,950 --> 00:32:01,653
a concept or technology,
despite the hazards that

573
00:32:01,653 --> 00:32:04,389
come with the territory.

574

00:32:04,389 --> 00:32:07,759
The X-31 had been scheduled
to fly at the Paris Air Show

575
00:32:07,759 --> 00:32:10,095
in June of 1995.

576
00:32:10,095 --> 00:32:12,864
But after the loss of one
of the two X-31 ships

577
00:32:12,864 --> 00:32:14,733
less than six months
before the show,

578
00:32:14,733 --> 00:32:17,569
it seemed an
impossible goal.

579
00:32:17,569 --> 00:32:21,273
(Szalai) Having lost the
airplane, pretty much everyone

580
00:32:21,273 --> 00:32:23,041
thought, "That's it."

581
00:32:23,041 --> 00:32:27,279
Because flying the kind of
maneuvers that this airplane can

582
00:32:27,279 --> 00:32:31,249
do at 500 feet, sounded a lot
riskier to me after you lose

583
00:32:31,249 --> 00:32:33,952
an airplane.

584
00:32:33,952 --> 00:32:36,955
The team really talked a
lot about this and decided

585
00:32:36,955 --> 00:32:41,593
that it did not want to end this
program on a low note and so we

586
00:32:41,593 --> 00:32:46,331
made the decision to press on
with the Paris Air Show.

587
00:32:46,331 --> 00:32:51,670
A huge thing to sign up for
was to take an airplane

588
00:32:51,670 --> 00:32:53,605
that just crashed
and turn it around

589
00:32:53,605 --> 00:32:55,607
to go do a low altitude,
high angle of attack

590
00:32:55,607 --> 00:32:57,475
flight demonstration.

591
00:32:57,475 --> 00:32:59,411
That took a lot of guts on
everybody's part and a lot of

592
00:32:59,411 --> 00:33:01,613
good engineering
work to make that happen.

593
00:33:01,613 --> 00:33:07,385
We actually flew the X-31
84 days after the mishap.

594
00:33:07,385 --> 00:33:10,355
This required the board to
reach its conclusions,

595
00:33:10,355 --> 00:33:11,990
to write a report.

596
00:33:11,990 --> 00:33:16,795
For the team to react to all of
the issues and problems

597
00:33:16,795 --> 00:33:19,297
and contributing
factors brought up.

598
00:33:19,297 --> 00:33:22,467
Solve the problem and
get it into an airplane

599
00:33:22,467 --> 00:33:25,070
and get it qualified for first
flight.

600
00:33:25,070 --> 00:33:26,872
It was all done in 84
days.

601
00:33:26,872 --> 00:33:30,008
It does tell you about the
quality of the team.

602
00:33:38,850 --> 00:33:40,285
Air Show Announcer: A
totally different airplane

603
00:33:40,285 --> 00:33:43,521
which will demonstrate a most
remarkable flying ability.

604
00:33:43,521 --> 00:33:49,027
It is the X-31 technology
demonstrator.

605

00:33:49,027 --> 00:33:51,730
(Stoliker) You know, after the
mishap, I think the program

606
00:33:51,730 --> 00:33:53,498
made a spectacular
recovery and made one of the

607
00:33:53,498 --> 00:33:57,035
finest appearances ever at the
Paris Air Show.

608
00:33:57,035 --> 00:34:00,505
The airplane did things that
no other airplane could do.

609
00:34:00,505 --> 00:34:02,707
The Russians had demonstrated
post stall maneuvers

610
00:34:02,707 --> 00:34:05,744
with the Cobra but it was really
an open-looped maneuver.

611
00:34:05,744 --> 00:34:08,980
They pulled back on the stick
and then you flew out of it

612
00:34:08,980 --> 00:34:12,450
at the end whereas the X-31
just demonstrated the ability

613
00:34:12,450 --> 00:34:16,121
to control all axis
of the airplane, pitch, roll,

614
00:34:16,121 --> 00:34:18,823
and yaw simultaneously
while operating at the extremes

615

00:34:18,823 --> 00:34:21,226
of the flight envelope.

616
00:34:21,226 --> 00:34:24,863
(Smith) So, fantastic Air Show.

617
00:34:24,863 --> 00:34:28,867
Absolutely the most
spectacular I've ever seen

618
00:34:28,867 --> 00:34:31,202
and I saw every one of
them.

619
00:34:31,202 --> 00:34:33,772
And I stood with the crowd on
some of them and I was in the

620
00:34:33,772 --> 00:34:37,008
control tower on others and I
was right underneath it

621
00:34:37,008 --> 00:34:39,511
at other times. But to
be with the crowd

622
00:34:39,511 --> 00:34:43,581
and watch even hardened
veteran's, the military,

623
00:34:43,581 --> 00:34:49,387
had no concept of what it could
really do and seeing it was

624
00:34:49,387 --> 00:34:53,458
jaw-dropping for the crowd.
It was spectacular.

625
00:34:53,458 --> 00:34:57,128
The announcement that

the X-31 was next to fly,

626
00:34:57,128 --> 00:35:00,532
as you looked down
the row of chalets,

627
00:35:00,532 --> 00:35:03,468
you see all the people coming
out of the chalets,

628
00:35:03,468 --> 00:35:06,705
out against the railing
to watch the flight.

629
00:35:06,705 --> 00:35:10,241
If the events leading up
to the X-31's mishap

630
00:35:10,241 --> 00:35:13,078
are a reminder of how much
vigilance is required in order

631
00:35:13,078 --> 00:35:17,515
to mitigate the risks
inherent in a flight test
program,

632
00:35:17,515 --> 00:35:21,252
the X-31's Paris Air Show
performance was a reminder

633
00:35:21,252 --> 00:35:25,857
of why those risks
are still worth undertaking.

634
00:35:25,857 --> 00:35:29,160
(Smith) Flight test of all kinds
is inherently dangerous.

635
00:35:29,160 --> 00:35:31,363

There are risks involved in it.

636
00:35:31,363 --> 00:35:34,666
Never can you or anybody else
bring it to zero.

637
00:35:34,666 --> 00:35:37,335
Well, you can, and that's keep
the airplane in the hangar.

638
00:35:37,335 --> 00:35:38,903
Don't fly.

639
00:35:38,903 --> 00:35:41,906
But if you don't fly, you
don't move forward,

640
00:35:41,906 --> 00:35:43,441
you don't discover,

641
00:35:43,441 --> 00:35:46,144
you don't prove things.

642
00:35:46,144 --> 00:35:50,982
So you need to take some
risks but you need to do it in a

643
00:35:50,982 --> 00:35:53,018
controlled fashion.

644
00:35:53,018 --> 00:35:55,820
(Szalai) The reason we spend
time on looking

645
00:35:55,820 --> 00:35:58,590
at these accidents is that there
aren't many accidents.

646
00:35:58,590 --> 00:36:02,193

We don't lose many airplanes
in flight research activities

647
00:36:02,193 --> 00:36:03,695
at Dryden.

648
00:36:03,695 --> 00:36:06,131
We haven't over the years. And
so when you do have one,

649
00:36:06,131 --> 00:36:08,400
you better learn everything
about it. In fact,

650
00:36:08,400 --> 00:36:10,702
you should do the same thing for
close calls.

651
00:36:10,702 --> 00:36:13,505
The lessons to be learned.

652
00:36:13,505 --> 00:36:15,440
Don't assume that they've been
learned.

653
00:36:15,440 --> 00:36:20,378
We can always, with every
new group have to learn

654
00:36:20,378 --> 00:36:24,015
the same lessons and you don't
want to do it the hard way

655
00:36:24,015 --> 00:36:27,352
with an accident. Safety is
everybody's business.

656
00:36:27,352 --> 00:36:29,654
Flight test safety is
everybody's business

657
00:36:29,654 --> 00:36:33,491
on the team. And, there
are no processes...

658
00:36:33,491 --> 00:36:36,928
you have to have processes...
but there are no perfect

659
00:36:36,928 --> 00:36:42,200
processes that will not require
good judgement

660
00:36:42,200 --> 00:36:45,837
from all levels of the program.

661
00:36:45,837 --> 00:36:48,306
If you're a program that has
been operating for a long time,

662
00:36:48,306 --> 00:36:50,842
potentially, and you've got a
lot of turnover,

663
00:36:50,842 --> 00:36:52,510
you're in your mature years,

664
00:36:52,510 --> 00:36:55,780
all your documentation is
years old.

665
00:36:55,780 --> 00:36:59,317
Maybe you better make sure that
all your new people are as good

666
00:36:59,317 --> 00:37:00,985
as your old people.

667
00:37:00,985 --> 00:37:03,488

That you've reviewed your documentation and it's still

668
00:37:03,488 --> 00:37:05,390
correct and that you all understand it.

669
00:37:05,390 --> 00:37:07,659
And that what you're doing today still makes sense

670
00:37:07,659 --> 00:37:09,260
from how you started.

671
00:37:09,260 --> 00:37:13,765
Maybe if you're in that area you ought to take a look at yourself.

672
00:37:13,765 --> 00:37:18,636
It always is clear what you should do after the fact

673
00:37:18,636 --> 00:37:20,271
or should have done rather.

674
00:37:20,271 --> 00:37:23,241
And nobody thinks it's ever going to happen to them,

675
00:37:23,241 --> 00:37:27,045
to lose judgement, to lose this communication link,

676
00:37:27,045 --> 00:37:30,949
to not do the right things.

677
00:37:30,949 --> 00:37:33,551
So what is the message?

678
00:37:33,551 --> 00:37:36,321
What is the message for
the team? It may mean that

679
00:37:36,321 --> 00:37:42,694
"I" am a part of the chain and
that if I don't catch this

680
00:37:42,694 --> 00:37:46,297
and if other people don't catch
their mistakes,

681
00:37:46,297 --> 00:37:49,901
we will run through the entire
chain and lead to a mishap.

682
00:37:49,901 --> 00:37:52,737
So it means that every
individual on the program,

683
00:37:52,737 --> 00:37:55,607
from beginning to end, no matter
what the job is,

684
00:37:55,607 --> 00:37:59,377
from the highest-level job to
the lowest-level job,

685
00:37:59,377 --> 00:38:03,214
in terms of detail, they have to
take it very seriously.

686
00:38:03,214 --> 00:38:05,984
And, that's the
message that you have to keep

687
00:38:05,984 --> 00:38:09,787
promoting, pronouncing, and
explaining.

688
00:38:09,787 --> 00:38:13,725
It sounds trite but everybody is
responsible for safety.

689
00:38:13,725 --> 00:38:16,928
If you think some safety office
analysis is going to find

690
00:38:16,928 --> 00:38:19,464
these things, they won't.

691
00:38:19,464 --> 00:38:22,600
Mishaps can occur everywhere.

692
00:38:22,600 --> 00:38:28,006
But, the point is, you have
to fly, safely...