

safety

1

00:00:00,734 --> 00:00:04,170

>>Flashing across California desert skies, the airplanes you see

2

00:00:04,170 --> 00:00:08,274

here are writing new chapters in the story
of man made flight....there she goes!

3

00:00:08,274 --> 00:00:12,812

>>This is my first opportunity
to greet you as deputy administrator

4

00:00:12,812 --> 00:00:16,483

of the National Aeronautics
and Space Administration.

5

00:00:16,816 --> 00:00:19,452

>>Together, you and I must make our new agency

6

00:00:19,452 --> 00:00:20,787

>>A most unusual place

7

00:00:20,820 --> 00:00:23,656

>>An organization that can challenge
conventional wisdom.

8

00:00:23,656 --> 00:00:27,260

>>We can engineer anything we can write the requirements for.

9

00:00:27,260 --> 00:00:28,661

>>We're going to make your idea work.

10

00:00:28,661 --> 00:00:31,231

This particular idea is quite disruptive.

11

00:00:31,898 --> 00:00:36,169

>>A typical flight, of course, starts
under the wing of the B-52 mothership.

12

00:00:36,336 --> 00:00:41,775

>>This sleek, high speed machine
would have made Rube Goldberg proud.

13

00:00:41,908 --> 00:00:44,778

>>The manner in which we fly
reentry from space,

14

00:00:44,778 --> 00:00:48,782

on the space shuttle was
pioneered on the X-15.

15

00:00:48,782 --> 00:00:54,387

>>The X-31 pretty much wrote the book on thrust vectoring, along with its sister program, the F-18 HARV.

16

00:00:54,387 --> 00:00:56,556

>>An observation of an occultation is

17

00:00:56,556 --> 00:00:59,526

one of the more challenging
missions that SOFIA can do.

18

00:01:00,326 --> 00:01:19,512

[Music/Background sound]

19

00:01:20,346 --> 00:01:24,717

>>Right now, we are looking
at the dawn of a new era of aviation.

20

00:01:27,754 --> 00:01:32,092

[Music/Background sound]

21

00:01:38,364 --> 00:01:44,471

[Music]

22

00:01:45,839 --> 00:01:46,873

>>Pull up!

23

00:01:46,873 --> 00:01:48,942

>>K, we finished our climb check-

24

00:01:48,942 --> 00:01:51,044

Now it's time for a Chesterfield!

25

00:01:53,613 --> 00:01:58,084

>>Small general purpose planes outnumber the world's transports by a hundred to one...

26

00:01:58,084 --> 00:02:01,988

>>and there are thousands of privately owned airplanes all over America...

27

00:02:01,988 --> 00:02:05,058

>>the number of mistakes I've seen private pilots make over

28

00:02:05,058 --> 00:02:06,559

the years is astonishing...

29

00:02:06,559 --> 00:02:08,895

>>A man must know the limits of his machine...

30

00:02:09,429 --> 00:02:14,167

>>Engineers continually assess the technological limits of safety

31

00:02:14,767 --> 00:02:17,570

and aggressively seek out those advancements,

32

00:02:17,737 --> 00:02:20,373

which offer a significant promise.

33

00:02:20,406 --> 00:02:22,075

>>The built-in dangers of flight testing

34

00:02:22,075 --> 00:02:25,645

showed up during this evaluation
of the PA-30 Twin Comanche.

35

00:02:25,945 --> 00:02:30,517

>>The plane had a serious flutter problem,
which appeared unexpectedly

36

00:02:30,517 --> 00:02:33,820

>>As speeds and performance of light aircraft
increase,

37

00:02:34,320 --> 00:02:36,556

much more attention must be given

38

00:02:36,823 --> 00:02:39,559

to flutter and aero-elastic behavior.

39

00:02:40,393 --> 00:02:43,463

>>The introduction of wide-body
airplanes in the 70s

40

00:02:43,463 --> 00:02:46,699

was instrumental in satisfying
the public's desire for traveling.

41

00:02:47,267 --> 00:02:48,635

Along with this increased

42

00:02:48,635 --> 00:02:52,539

mix of aircraft comes an increased concern
about wake turbulence.

43

00:02:52,572 --> 00:02:57,043

>>Wake vortex is a turbulent
air condition that forms at an airplane's

44

00:02:57,043 --> 00:02:57,977

wingtip.

45

00:02:57,977 --> 00:03:00,713

>>Violent whirlpools of air called vortices...

46

00:03:00,847 --> 00:03:04,584

...one of these disturbances could last
for as much as several minutes in the air-

47

00:03:04,584 --> 00:03:06,252

-an invisible hazard.

48

00:03:06,252 --> 00:03:09,689

>>The wake vortex from a large transport
can throw a smaller plane

49

00:03:09,689 --> 00:03:10,757

out of control,

50

00:03:10,757 --> 00:03:14,460

an effort to reduce its hazards
became a matter of national priority.

51

00:03:15,028 --> 00:03:18,398

By comparing upsets of probe aircraft flying in the wake,

52

00:03:19,165 --> 00:03:22,502

they proved that using selected
combinations of wing flap,

53

00:03:22,936 --> 00:03:25,004

spoiler and landing gear positions,

54

00:03:25,705 --> 00:03:28,441

they could effectively reduce
the strength of the vortex.

55

00:03:29,342 --> 00:03:32,579

>>Separation standards were developed
that established aircraft

56

00:03:32,579 --> 00:03:34,514
weight categories and distances.

57

00:03:37,217 --> 00:03:38,284
>>Escape technology

58

00:03:38,284 --> 00:03:39,319
is having a hard time

59

00:03:39,319 --> 00:03:43,389
keeping pace with the demands placed
upon it by improved aircraft performance,

60

00:03:43,923 --> 00:03:47,894
more complex missions and more low level
flying now required in the current

61

00:03:47,894 --> 00:03:48,928
training environment.

62

00:03:48,928 --> 00:03:51,898
>>Today, man's life more than ever before depends

63

00:03:52,398 --> 00:03:55,735
on complex man machine inter-communication;

64

00:03:56,236 --> 00:03:58,338
he must be aware of the soft-spots.

65

00:03:58,338 --> 00:04:02,408
>>When the Enterprise performed
its approach and landing tests at Dryden,

66

00:04:02,408 --> 00:04:06,546
it discovered a problem in
maneuvering of all fly-by-wire airplanes.

67

00:04:06,746 --> 00:04:09,582
It happens when the aircraft's controls

don't respond

68

00:04:09,582 --> 00:04:12,118

to the pilot's
commands as fast as he expects.

69

00:04:12,852 --> 00:04:15,221

The pilot
automatically assumes the controls

70

00:04:15,221 --> 00:04:18,291

didn't get the message,
so he repeats his commands.

71

00:04:19,192 --> 00:04:22,028

Meanwhile, the computer is executing
the first command,

72

00:04:22,729 --> 00:04:25,265

so the pilot reacts
by trying to compensate

73

00:04:25,265 --> 00:04:29,135

for the extra command. To solve the pilot
induced oscillation problem.

74

00:04:29,202 --> 00:04:33,006

Engineers programmed
the F-8's computers to make the plane

75

00:04:33,006 --> 00:04:35,541

particularly susceptible to PIOs.

76

00:04:36,476 --> 00:04:39,646

The pilot flew the plane
in the oscillation vulnerable mode

77

00:04:40,146 --> 00:04:44,984

and tried a series of PIO suppression
filters to find which one worked best.

78

00:04:46,386 --> 00:04:47,754

>>It would be a fighter pilot's

79

00:04:47,754 --> 00:04:51,791

ultimate dream to be able to maneuver
care-free at extremely high alpha.

80

00:04:51,891 --> 00:04:55,161

>>But what happens to the total
aerodynamics when we increase

81

00:04:55,161 --> 00:04:57,063

alpha beyond that recommended?

82

00:04:57,063 --> 00:04:58,231

Stall.

83

00:04:58,231 --> 00:05:01,868

The result of an alpha so great
that the air can no longer flow

84

00:05:01,868 --> 00:05:03,236

smoothly over the curved

85

00:05:03,236 --> 00:05:04,504

top surface of the wing.

86

00:05:04,504 --> 00:05:10,443

>>Air is not moving over the control surfaces as it should, which renders
the plane's controls virtually useless.

87

00:05:12,045 --> 00:05:15,014

>>Ok, spinning one half mile
northeast of the spin point, Bill.

88

00:05:15,815 --> 00:05:16,883

>>Thanks, Gary.

89

00:05:17,283 --> 00:05:20,286

[Music/Background noise]

90

00:05:20,920 --> 00:05:23,423

>>The F-14 is a Navy high-

91

00:05:23,423 --> 00:05:27,026

performance fighter. While performing
certain extreme maneuvers,

92

00:05:27,627 --> 00:05:31,064

pilots have had problems
with spin and loss of control.

93

00:05:32,165 --> 00:05:33,566

>>Stall on the right-

94

00:05:33,566 --> 00:05:35,568

>>-it shut down-

95

00:05:35,601 --> 00:05:38,004

>>-and I've got recovery!

96

00:05:38,004 --> 00:05:42,475

>>Control modifications done here
have made the F-14 easier to fly.

97

00:05:44,310 --> 00:05:44,711

>>We were

98

00:05:44,711 --> 00:05:50,083

able to assist the Federal Aviation
Administration in testing a new aviation

99

00:05:50,083 --> 00:05:54,120

fuel, which was not supposed to burn
if the aircraft crashed.

100

00:05:54,654 --> 00:05:57,890

Unfortunately,
the tests showed that the fuel did burn.

101

00:05:58,558 --> 00:06:01,361

>>Two of the technologies
of the second half of this century.

102

00:06:01,828 --> 00:06:05,431

That affected major changes in aerospace
are the jet engine

103

00:06:05,765 --> 00:06:08,234

and the digital computer.

104

00:06:09,302 --> 00:06:14,107

[Music/Background noise]

105

00:06:15,708 --> 00:06:18,411

>>We had no ailerons to bank the airplane.

106

00:06:18,411 --> 00:06:20,413

We had no rudders to turn it.

107

00:06:20,413 --> 00:06:22,849

No elevators to control the pitch.

108

00:06:22,849 --> 00:06:25,385

We had no leading edge slats
for slowing the airplane down.

109

00:06:25,485 --> 00:06:27,520

No trailing edge flaps for landing.

110

00:06:27,520 --> 00:06:31,491

>>NASA's Dryden Flight Research Center
began to investigate ways to safely land

111

00:06:31,491 --> 00:06:34,627

crippled airplanes,
using only throttle controls.

112

00:06:34,627 --> 00:06:36,629

>>To see what we could do
with just the engines

113

00:06:36,629 --> 00:06:38,297

if all the flight controls were gone.

114

00:06:38,297 --> 00:06:41,267

>>Things you do here
may prevent a lot of disasters.

115

00:06:41,968 --> 00:06:44,170

>>Central hydraulics systems
tend to be very vulnerable.

116

00:06:44,237 --> 00:06:47,206

These power
by wire systems aren't as vulnerable.

117

00:06:47,440 --> 00:06:51,010

>>These experimental actuators operate
independently of the F-18's

118

00:06:51,010 --> 00:06:52,779

hydraulic system.

119

00:06:52,779 --> 00:06:56,949

They could greatly reduce the costs,
weight and maintenance of future aircraft.

120

00:06:56,983 --> 00:07:01,721

The real time flush air data sensing
system used a group of eleven tiny

121

00:07:01,721 --> 00:07:04,690

pressure orifices
arranged on the nose of the F-18.

122

00:07:04,957 --> 00:07:09,195

The system eliminates the need for external air data probes or booms,

123

00:07:09,295 --> 00:07:13,699

which are sensitive to vibration and alignment errors and can be easily damaged.

124

00:07:14,500 --> 00:07:19,372

Another experiment will evaluate a newly developed air mass flux sensor device.

125

00:07:19,572 --> 00:07:23,075

The sensor may enhance safety by rapid detection of hazardous

126

00:07:23,075 --> 00:07:26,245

airflow conditions, which could lead to in-flight engine stalls.

127

00:07:27,647 --> 00:07:30,183

[Radio chatter]

128

00:07:30,183 --> 00:07:32,752

>>Fly up! Fly up!

129

00:07:33,052 --> 00:07:35,221

[Radio chatter]

130

00:07:35,855 --> 00:07:38,724

>>The HISTEC program evaluated a computerized system

131

00:07:38,891 --> 00:07:43,229

that can sense and respond to high levels of engine inlet air flow turbulence.

132

00:07:43,896 --> 00:07:48,501

This system could successfully prevent sudden in-flight engine compressor stalls

133

00:07:48,768 --> 00:07:53,105

and potential engine failures,
and thereby increase aircraft safety.

134

00:07:53,739 --> 00:07:58,010

>>Clear-air turbulence is turbulence that give no indication of their presence...

135

00:07:58,144 --> 00:08:01,914

...can be very dangerous to fly through
because it moves the aircraft around

136

00:08:01,914 --> 00:08:04,884

and damages
the aircraft and the people inside.

137

00:08:05,885 --> 00:08:09,489

And even the most conscientious pilot
has really no warning that it's present.

138

00:08:10,122 --> 00:08:13,726

>>The garment I'm currently wearing
protect me against both partial pressure

139

00:08:13,726 --> 00:08:17,497

and high G-force, and as you can see,
the coverage is pretty extensive.

140

00:08:17,597 --> 00:08:18,898

In modern aircraft,

141

00:08:18,898 --> 00:08:21,067

heat stress becomes a very big problem.

142

00:08:21,434 --> 00:08:24,203

APECS is a prototype cooling

143

00:08:24,203 --> 00:08:24,971
garment.

144

00:08:24,971 --> 00:08:27,540

>>The next generation in microclimate cooling.

145

00:08:28,608 --> 00:08:32,745

[Music/jet taking off]

146

00:08:33,880 --> 00:08:35,147

>>The Intelligent Flight Control

147

00:08:35,147 --> 00:08:39,719

Project is a project where we take
a highly advanced F-15 aircraft

148

00:08:40,253 --> 00:08:43,923

and we add another computer to it
that has a neural network in it,

149

00:08:43,923 --> 00:08:48,494

that neural network
will actually take the errors to control

150

00:08:48,494 --> 00:08:53,099

surface failures and aerodynamic failures
and augment those failures

151

00:08:53,299 --> 00:08:57,103

with self-learning neural network software.
We don't tell the neural networks

152

00:08:57,103 --> 00:08:58,504

what actually failed.

153

00:08:58,504 --> 00:09:01,274

It just knows that
there's an error in the system

154

00:09:01,507 --> 00:09:05,845
and it sends pitch, roll, and yaw commands
to the flight computer and

155
00:09:06,212 --> 00:09:08,014
commands the aircraft properly.

156
00:09:08,014 --> 00:09:09,982
>>If the research that we do right now results

157
00:09:09,982 --> 00:09:12,985
in just one saved aircraft, I think it's
well worth the effort that we spent.

158
00:09:13,152 --> 00:09:15,988
>>This research makes aircraft
more safe because what it does is it

159
00:09:15,988 --> 00:09:19,292
makes the aircraft more smart, able
to adapt to failures.

160
00:09:19,559 --> 00:09:21,928
This computer
would be able to take over the airplane

161
00:09:21,928 --> 00:09:24,130
and be able land it safely
and stabilize it.

162
00:09:24,530 --> 00:09:27,233
>>This research has a lot of applications. Using the flight

163
00:09:27,233 --> 00:09:30,636
controls to help
reduce the stresses on the structure,

164
00:09:30,636 --> 00:09:35,274
we could use it for active load
alleviation or possibly active flutter

165

00:09:35,308 --> 00:09:37,143
or LCO suppression.

166

00:09:37,143 --> 00:09:38,911
>>With lightweight wings,

167

00:09:38,911 --> 00:09:43,249
they are prone to flutter,
which is a phenomenon where you go

168

00:09:43,249 --> 00:09:44,383
too fast,

169

00:09:44,383 --> 00:09:47,320
and then the wing just falls apart.

170

00:09:47,553 --> 00:09:53,025
The X-56A project is intended, by
development of flight control technologies,

171

00:09:53,593 --> 00:09:55,695
to suppress flutter,

172

00:09:56,062 --> 00:10:00,266
to use other control
surfaces to counteract that vibration.

173

00:10:01,000 --> 00:10:03,102
[Music/Background noise]

174

00:10:04,136 --> 00:10:06,405
>>Since the dawn of aircraft,

175

00:10:06,405 --> 00:10:09,842
the ground has been an enemy of the pilot.

176

00:10:10,042 --> 00:10:13,179

>>ACAT is the autonomous collision avoidance technology program,

177

00:10:13,179 --> 00:10:16,482

ground collision avoidance and air to air collision avoidance.

178

00:10:16,582 --> 00:10:21,420

>>We decided let's see how we can adapt this technology to other platforms.

179

00:10:21,454 --> 00:10:26,258

We moved the software from high dollar fighter hardware processors

180

00:10:26,659 --> 00:10:28,661

to cell phone.

181

00:10:28,661 --> 00:10:31,631

>>Two recover! Two recover!!

182

00:10:31,631 --> 00:10:34,433

>>From general aviation to airlines to military aviation,

183

00:10:34,433 --> 00:10:36,469

we can make it safer.

The technology's there.

184

00:10:36,469 --> 00:10:38,938

We just need to put it all together and make it happen.

185

00:10:40,840 --> 00:10:43,643

>>We're trying to correlate our radar readings

186

00:10:44,010 --> 00:10:45,378

with the actual readings

187

00:10:45,378 --> 00:10:49,215

that we're getting from in-situ
measurements to see if we can figure out

188

00:10:49,215 --> 00:10:52,251

if you can predict this high ice water
content.

189

00:10:52,251 --> 00:10:53,853

>>Right now, our flight tracks

190

00:10:53,853 --> 00:10:57,089

are overflying the coldest temperatures
that we can find,

191

00:10:57,623 --> 00:11:00,559

which correlates
to the deepest convection going on.

192

00:11:02,261 --> 00:11:04,630

>>Basically,
what the scientists are trying to do

193

00:11:04,630 --> 00:11:09,268

is get a baseline of how pilots
breathe in tactical airplanes.

194

00:11:09,268 --> 00:11:13,406

>>This program is going to help develop
new equipment, new systems and expand