maneuverability

1
00:00:00,000 --> 00:00:03,436
>>Flashing across California desert skies, the airplanes you see

2
00:00:03,436 --> 00:00:07,540
here are writing new chapters in the story
of man made flight....there she goes!

3
00:00:07,540 --> 00:00:12,078
>>This is my first opportunity
to greet you as deputy administrator

4
00:00:12,078 --> 00:00:15,749
of the National Aeronautics
and Space Administration.

5
00:00:16,082 --> 00:00:18,718
>>Together, you and I must make our new agency

6
00:00:18,718 --> 00:00:20,053
>>A most unusual place

7
00:00:20,086 --> 00:00:22,922
>>An organization that can challenge
conventional wisdom.

8
00:00:22,922 --> 00:00:26,526
>>We can engineer anything we can write the requirements for.

9
00:00:26,526 --> 00:00:27,927
>>We're going to make your idea work.

10
00:00:27,927 --> 00:00:30,497
This particular idea is quite disruptive.

11
00:00:31,164 --> 00:00:35,435
>>A typical flight, of course, starts
under the wing of the B-52 mothership.

12

00:00:35,602 --> 00:00:41,041
>>This sleek, high speed machine
would have made Rube Goldberg proud.

13
00:00:41,174 --> 00:00:44,044
>>The manner in which we fly
reentry from space,

14
00:00:44,044 --> 00:00:48,048
on the space shuttle was
pioneered on the X-15.

15
00:00:48,048 --> 00:00:53,653
>>The X-31 pretty much wrote the book on thurst vectoring, along with its sister program, the F-18 HARV.

16
00:00:53,653 --> 00:00:55,822
>>An observation of an occulation is

17
00:00:55,822 --> 00:00:58,792
one of the more challenging
missions that SOFIA can do.

18
00:00:59,592 --> 00:01:18,778
[Music/Background sound]

19
00:01:19,612 --> 00:01:23,983
>>Right now, we are looking
at the dawn of a new era of aviation.

20
00:01:27,020 --> 00:01:31,357
[Music/Background sound]

21
00:01:37,931 --> 00:01:40,900
[Music/Radio Chatter]

22
00:01:41,234 --> 00:01:43,736
>>...this is gonna be a wild one!

23
00:01:44,771 --> 00:01:48,608

[Jets flying/Radio Chatter]

24
00:01:50,009 --> 00:01:52,412
>>Our pilots are constantly faced

25
00:01:52,412 --> 00:01:55,982
in flying into North Vietnam with missile
firings...

26
00:01:56,082 --> 00:01:58,318
>>...we've got MiGs right under us!

27
00:01:58,751 --> 00:02:01,721
[Radio Chatter/Explosion]

28
00:02:02,188 --> 00:02:05,492
>>For a long time.,
speed was the military aircraft designers'

29
00:02:05,492 --> 00:02:10,163
main objective, but in a dogfight,
maneuverability is as important as speed.

30
00:02:10,697 --> 00:02:13,399
The fly-by-wire system
and its computers provided

31
00:02:13,399 --> 00:02:16,136
a way to build potentially more
maneuverable aircraft.

32
00:02:16,436 --> 00:02:19,239
>>...an urgent requirement
to dramatically enhance

33
00:02:19,239 --> 00:02:23,243
air to air combat maneuverability,
the program is called HiMat.

34

00:02:23,610 --> 00:02:27,514
The main emphasis of the flight test
program is high-g maneuvering

35
00:02:27,514 --> 00:02:32,285
in the transonic flight regime, where most
fighter versus fighter combat occurs.

36
00:02:32,285 --> 00:02:36,422
Composite material makes it possible
to aeroelastically tailor

37
00:02:36,422 --> 00:02:41,094
the wings and canards; they bend and twist
in flight to the most favorable shape

38
00:02:41,194 --> 00:02:45,165
to give the aircraft increased
transonic maneuverability and performance.

39
00:02:46,166 --> 00:02:49,903
>>The Advanced Fighter Technology
Integration F-16 program;

40
00:02:50,270 --> 00:02:53,573
the unconventional maneuvers of de-coupled
flight were evaluated:

41
00:02:53,573 --> 00:02:57,477
vertical translation,
lateral translation, pitch pointing,

42
00:02:57,744 --> 00:03:02,715
yaw pointing, and the maneuver that proved
most effective for combat, flat turn.

43
00:03:02,715 --> 00:03:06,019
>>...United States Department of Defense wanted to create a fighter plane
that would be more agile.

44

00:03:07,453 --> 00:03:10,123
Stable design gave way to maneuverability.

45
00:03:10,456 --> 00:03:13,993
>>This latest X program explores
several different

46
00:03:13,993 --> 00:03:17,630
yet integrated technologies
in one demonstrator aircraft.

47
00:03:17,764 --> 00:03:19,432
>>Slow speed High-Alpha maneuvering is where

48
00:03:19,432 --> 00:03:22,368
the X-29 will most probably outperform
current frontline fighters.

49
00:03:22,468 --> 00:03:25,438
>>Literally hundreds of feet is the
radius of turn, which is very impressive

50
00:03:26,039 --> 00:03:27,774
[Beeping]

51
00:03:27,774 --> 00:03:29,842
[Tone]

52
00:03:29,842 --> 00:03:32,979
>>A certain barrier exists
for every flying vehicle.

53
00:03:33,646 --> 00:03:37,884
It is a barrier that has taken more lives
than the erroneously named sound barrier.

54
00:03:38,151 --> 00:03:40,887
It is the stall, or high
angle of attack, barrier.

55
00:03:41,321 --> 00:03:45,258
>>The tendency of an aircraft to stall
and become uncontrollable at slow speeds

56
00:03:45,558 --> 00:03:48,995
was the greatest limiting factor
in an airplane's maneuverability.

57
00:03:49,762 --> 00:03:53,666
>>High-alpha, or high angle of attack,
is the position of the aircraft's

58
00:03:53,666 --> 00:03:57,503
body and wings in relation
to its actual flight path.

59
00:03:57,503 --> 00:03:59,505
>>The benefit of fighter airplanes

60
00:03:59,505 --> 00:04:03,243
being able to maneuver
at high angles of attack is that it

61
00:04:03,243 --> 00:04:07,280
has the ability to put its weapons
on a target; point and shoot.

62
00:04:07,580 --> 00:04:11,150
>>The trouble has been that with the plane's
nose pitched up at these high

63
00:04:11,150 --> 00:04:14,754
angles, it continues to fly
in its original direction.

64
00:04:15,054 --> 00:04:18,625
This reduces lift, and when there's
no lift, there's no control.

65

00:04:20,560 --> 00:04:23,529
[Background sound]

66
00:04:25,365 --> 00:04:26,366
>>Engineers placed

67
00:04:26,366 --> 00:04:30,036
special movable paddle-like
vanes near the engine's exhaust.

68
00:04:30,203 --> 00:04:31,638
These can be deflected

69
00:04:31,638 --> 00:04:35,708
into the exhaust flow to produce
both pitch and yaw movements.

70
00:04:35,842 --> 00:04:39,612
>>Nobody had flown and thrust vectoring
airplane closed-loop control yet.

71
00:04:39,646 --> 00:04:42,749
We flew the airplane to 117 degrees
angle of attack.

72
00:04:42,749 --> 00:04:47,787
>>The nose strakes allow selective
triggering of the two hidden vortices

73
00:04:47,787 --> 00:04:51,391
which come off the nose; we can interrupt
the flow of one and let the other one

74
00:04:51,391 --> 00:04:55,928
be still, generating more lift on one side
and allowing us to turn the airplane.

75
00:04:56,095 --> 00:04:59,198
>>I believe it will be married
with micro-machine technology and smart

76
00:04:59,198 --> 00:05:03,202
skin someday to control an airplane
in more bird-like flight.

77
00:05:03,369 --> 00:05:06,806
Major leap in understanding and design;

78
00:05:07,006 --> 00:05:11,311
really set the stage
to assist in F-22, F-35.

79
00:05:11,611 --> 00:05:14,147
[Music]

80
00:05:14,147 --> 00:05:16,582
>>To maintain the advantage
in the air, close-in

81
00:05:16,582 --> 00:05:19,719
aerial combat beyond the normal flight
envelope parameters

82
00:05:19,719 --> 00:05:20,553
is necessary

83
00:05:20,553 --> 00:05:24,123
>>...the capabilities
of this aircraft to decelerate

84
00:05:24,123 --> 00:05:27,960
in high angles of attack
and to roll its nose around the velocity

85
00:05:28,661 --> 00:05:31,898
vector and flight path
for pointing and weapons deployment.

86
00:05:32,031 --> 00:05:35,301

>>If, in fact we succeed, we will have
demonstrated a new way to fly.

87
00:05:35,601 --> 00:05:39,072
>>Simply put, the X-31
allows the pilot to fly controllably

88
00:05:39,372 --> 00:05:42,642
well beyond that point where normal
airplanes have their wings stall out.

89
00:05:42,675 --> 00:05:47,013
>>The X-31s are conducting air-to-air
engagements against a conventional jet

90
00:05:47,013 --> 00:05:47,780
fighter.

91
00:05:47,780 --> 00:05:50,350
>>What you will see
is the decoupling of the aircraft

92
00:05:50,350 --> 00:05:54,120
longitudinal axis from the velocity vector
at high angles of attack.

93
00:05:54,120 --> 00:05:58,858
>>This maneuver results in a very high turn
rate and a very low turn radius

94
00:05:59,092 --> 00:06:02,762
and is one of the fundamental advantages
of post-stall maneuvering.

95
00:06:03,062 --> 00:06:06,366
>>Seeing it was jaw dropping.

96
00:06:06,532 --> 00:06:11,537
>>An airplane is not supposed to do
what the X-31 did. It's awesome.

97
00:06:12,472 --> 00:06:14,374
It was literally awesome.

98
00:06:15,375 --> 00:06:18,444
>>The ACTIVE program began to achieve
flight research milestones

99
00:06:18,745 --> 00:06:21,881
with the first ever supersonic pitch
and yaw vectoring flights.

100
00:06:22,415 --> 00:06:25,718
>>The nozzles themselves
will vector the thrust

101
00:06:25,718 --> 00:06:29,422
plus or minus 20 degrees,
about 4,000 pounds of load

102
00:06:29,689 --> 00:06:33,893
each, in any direction at a high rate,
about 80 degrees per second.

103
00:06:34,127 --> 00:06:37,163
The X-36 is a remotely piloted
research aircraft

104
00:06:37,563 --> 00:06:41,033
developed to demonstrate the maneuvering
capability of a tailless fighter.

105
00:06:41,434 --> 00:06:45,538
>>The maneuver capabilities
of conventional aircraft are also limited

106
00:06:45,738 --> 00:06:50,877
by the pilot's physiological tolerances,
such as the ability to withstand G forces.

107
00:06:50,977 --> 00:06:52,812
[Music]

108
00:06:52,812 --> 00:06:57,083
>>Pilotless aircraft could be smaller,
lighter, and more agile.

109
00:06:57,617 --> 00:06:59,886
With over a mile of lateral separation,

110
00:07:00,286 --> 00:07:03,489
they autonomously maneuver
to preserve their configuration.

111
00:07:04,657 --> 00:07:07,360
>>...down about ten degrees
relative to the rest of the wing,

112
00:07:07,360 --> 00:07:08,761
but it allowed the airplane

113
00:07:08,761 --> 00:07:12,398
to be maneuvered quite aggressively
compared to the way it was before.

114
00:07:13,166 --> 00:07:16,369
>>What is it that gives birds
their dexterity in the air?

115
00:07:16,636 --> 00:07:20,139
The best minds in aerospace
have long dreamed of an airplane that can

116
00:07:20,139 --> 00:07:23,209
change its features and its structures
and can soar like an eagle.

117
00:07:23,242 --> 00:07:24,377
[Jet taking off]

118
00:07:24,377 --> 00:07:28,114
>>At high speeds on high-performance
aircraft, all wings bend and twist.

119
00:07:28,381 --> 00:07:32,618
What we're trying to do is essentially
control that wing aeroelastic twist,

120
00:07:33,019 --> 00:07:36,355
and by doing so, we're able to improve
the maneuverability of the airplane.

121
00:07:36,889 --> 00:07:40,193
>>Nobody has figured out
how to make flying wings work.

122
00:07:40,426 --> 00:07:43,296
I mean, we see them
every day, right? Birds!

123
00:07:43,296 --> 00:07:47,099
So now when you roll, you get yaw

124
00:07:47,133 --> 00:07:50,770
in the correct direction
in the same direction that you're rolling.