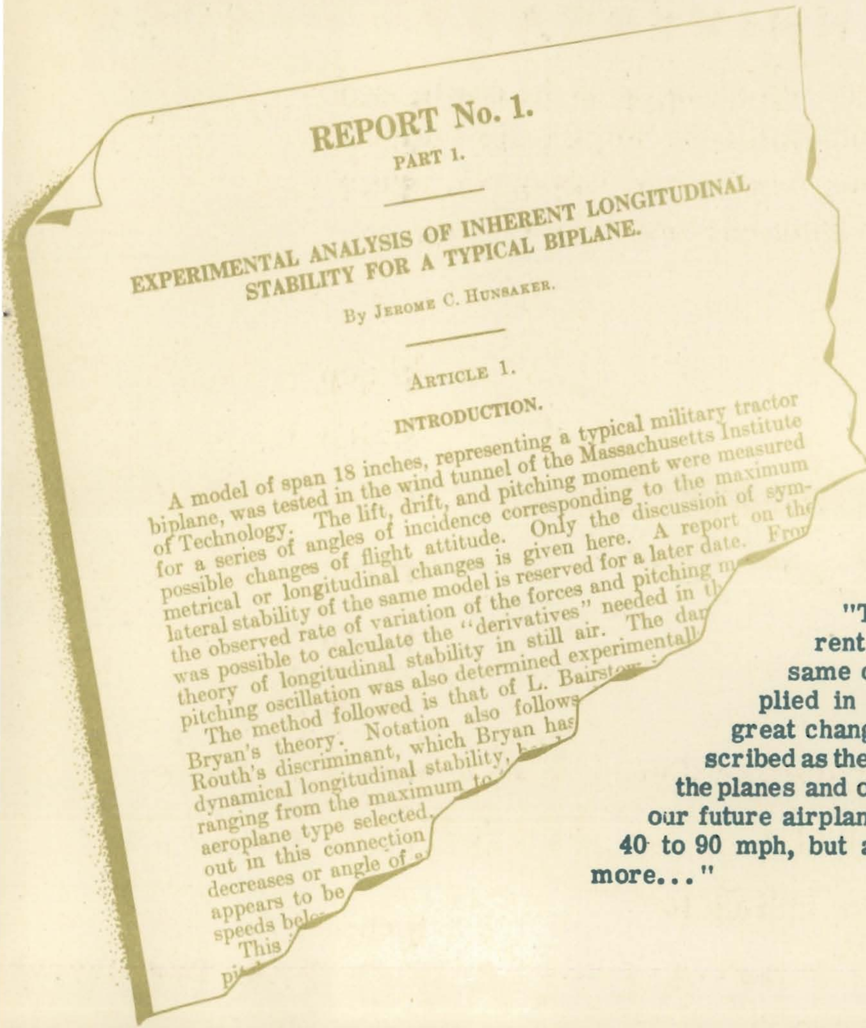
1915 ▪ ▪ ▪ 40th ANNIVERSARY ▪ ▪ ▪ 1955

NACA

1955 TRIENNIAL INSPECTION

AMES AERONAUTICAL LABORATORY


REPORT No. 1.

PART 1.

EXPERIMENTAL ANALYSIS OF INHERENT LONGITUDINAL STABILITY FOR A TYPICAL BIPLANE.

By JEROME C. HUNSAKER.

ARTICLE 1.

INTRODUCTION.

A model of span 18 inches, representing a typical military tractor
biplane, was tested in the wind tunnel of the Massachusetts Institute
of Technology. The lift, drift, and pitching moment were measured
for a series of angles of incidence corresponding to the maximum
possible changes of flight attitude. Only the discussion of sym-
metrical or longitudinal changes is given here. A report on the
lateral stability of the same model is reserved for a later date. From
the observed rate of variation of the forces and pitching m
was possible to calculate the "derivatives" needed in th
theory of longitudinal stability in still air. The dar
pitching oscillation was also determined experimentall
The method followed is that of L. Bairsto
Bryan's theory. Notation also follows
Routh's discriminant, which Bryan has
dynamical longitudinal stability,
ranging from the maximum to
aeroplane type selected.
out in this connection
decreases or angle of
appears to be
speeds bel
This
pi

THE COVER

"Many of the major problems of the aircraft of the future are old problems in new dress.

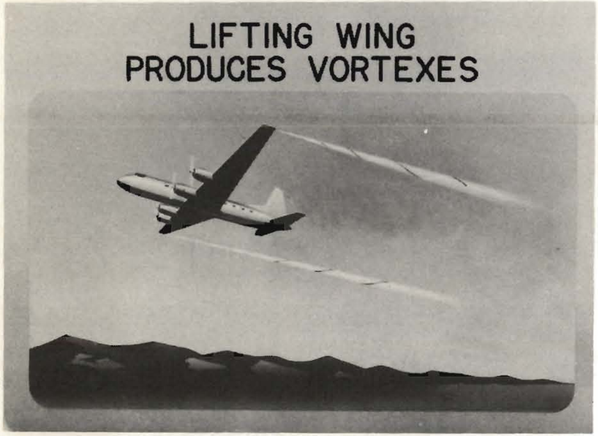
"The first technical report of the National Advisory Committee for Aeronautics, written in 1915 by Dr. J. C. Hunsaker, present NACA Chairman, dealt with the problem of the stability of an airplane in free flight.

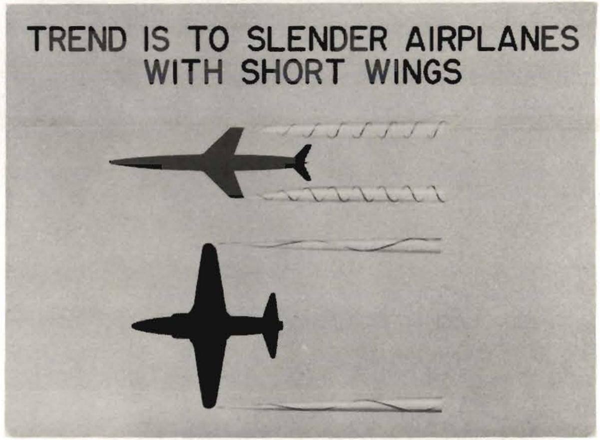
"The then current high-speed military airplane was the Curtiss J N2 with a maximum speed of about 85 mph and a minimum speed of about 43 mph.

"The problems of stability and control of current and future aircraft are describable in the same conceptual framework...which Hunsaker applied in NACA Report No. 1. There are, however, great changes in the superstructure, in what Bryan described as the approximations to the air pressures to which the planes and other parts of the machine are subjected. For our future airplanes we must assure stability not at speeds of 40 to 90 mph, but at speeds extending from 100 to 1000 mph or more..."

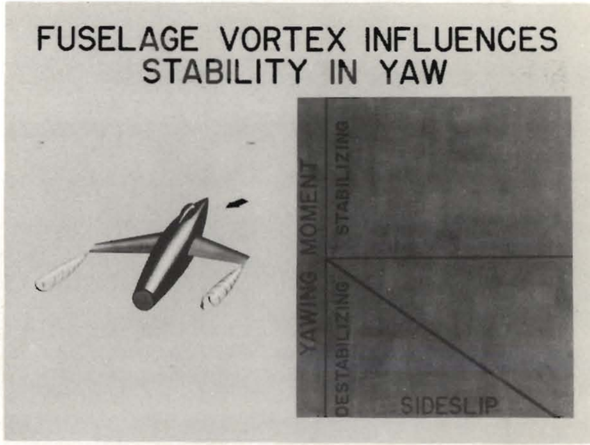
H. L. Dryden, January 7, 1955

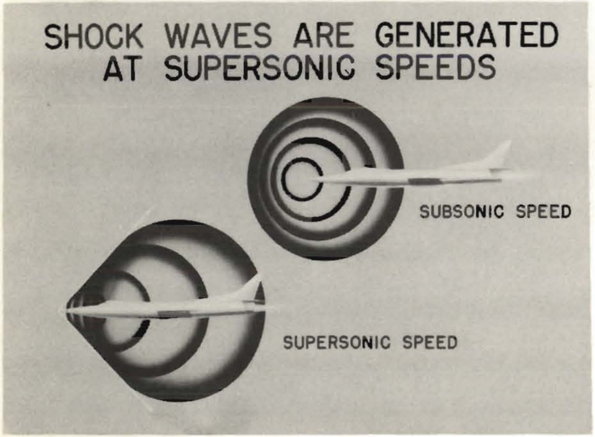
This booklet contains reproductions of the charts used to illustrate the presentations at the NACA'S 1955 Triennial Inspection at the Ames Aeronautical Laboratory. Space has been provided for those who wish to take notes.

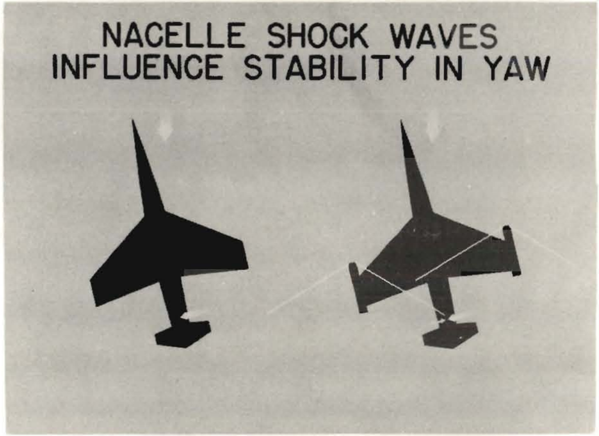

LIFTING WING
PRODUCES VORTEXES


TREND IS TO SLENDER AIRPLANES
WITH SHORT WINGS

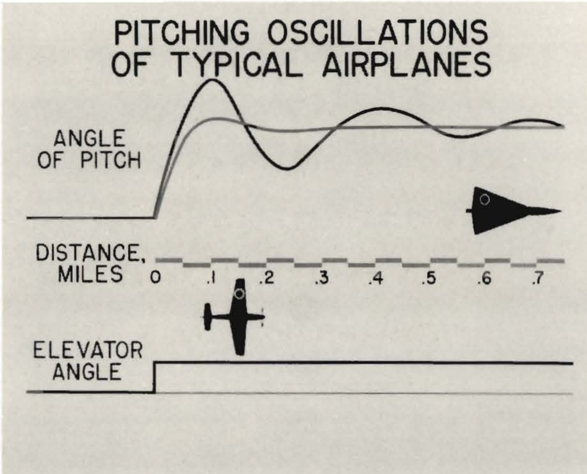

FUSELAGE
ALSO PRODUCES VORTEXES

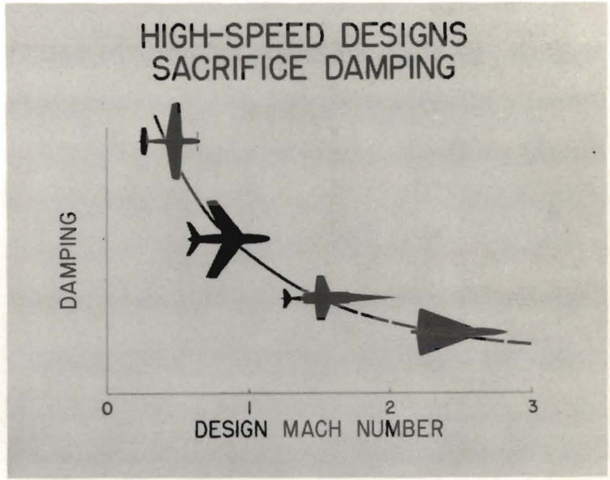

FUSELAGE VORTEX INFLUENCES
STABILITY IN YAW
YAWING MOMENT
STABILIZING
DESTABILIZING
SIDESLIP

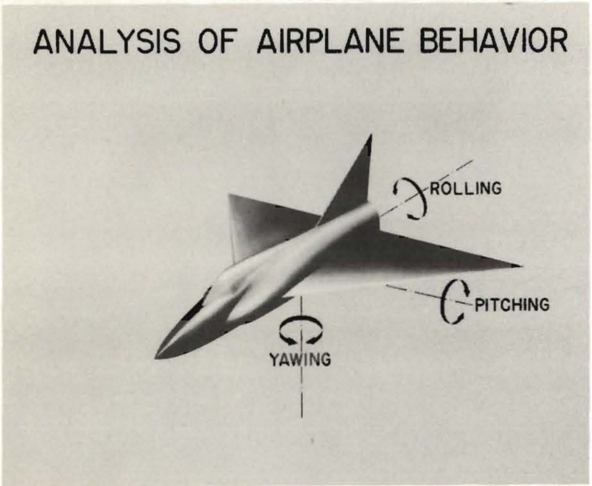

SHOCK WAVES ARE GENERATED
AT SUPERSONIC SPEEDS
SUBSONIC SPEED
SUPERSONIC SPEED

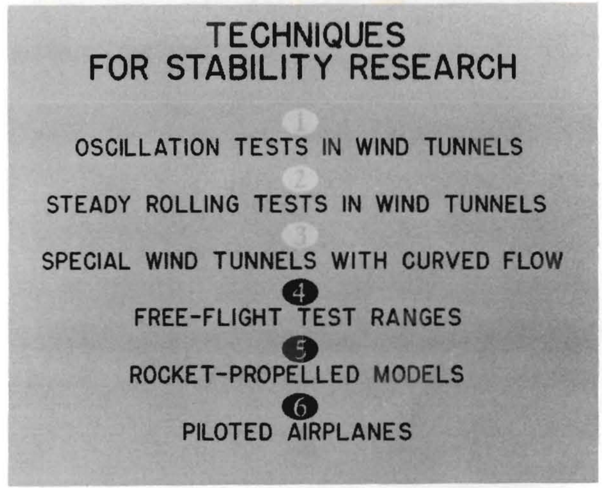

NACELLE SHOCK WAVES
INFLUENCE STABILITY IN YAW

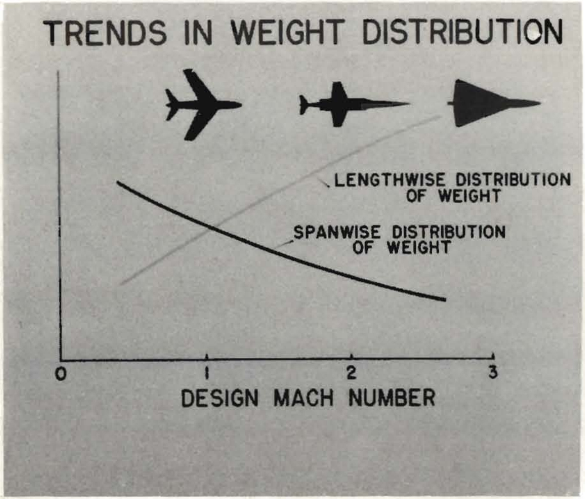
DYNAMIC STABILITY

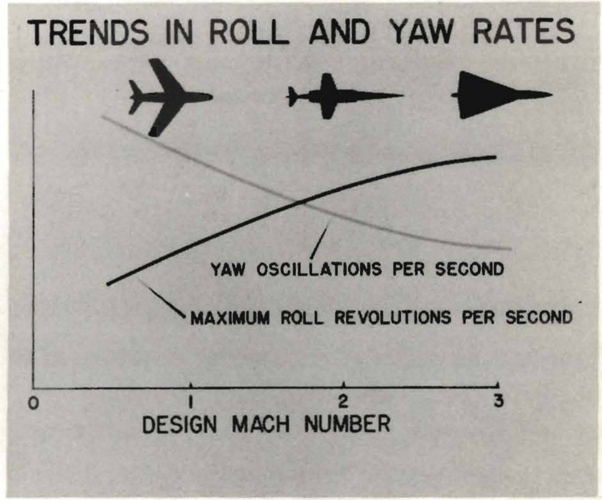




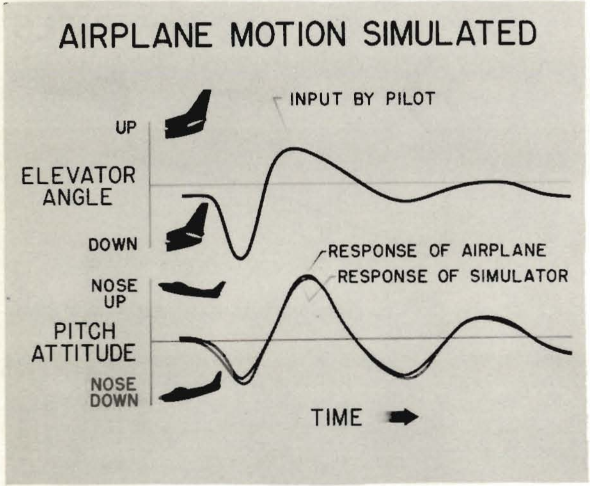

ANALYSIS OF AIRPLANE BEHAVIOR
ROLLING
PITCHING
YAWING

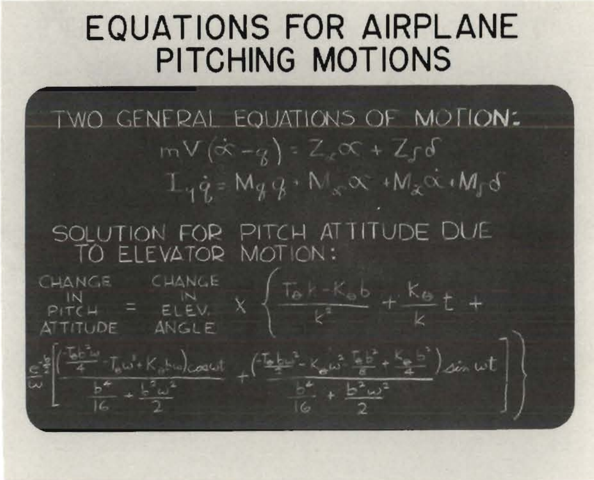

TECHNIQUES
FOR STABILITY RESEARCH
1
OSCILLATION TESTS IN WIND TUNNELS
2
STEADY ROLLING TESTS IN WIND TUNNELS
3
SPECIAL WIND TUNNELS WITH CURVED FLOW
4
FREE-FLIGHT TEST RANGES
5
ROCKET-PROPELLED MODELS
6
PILOTED AIRPLANES

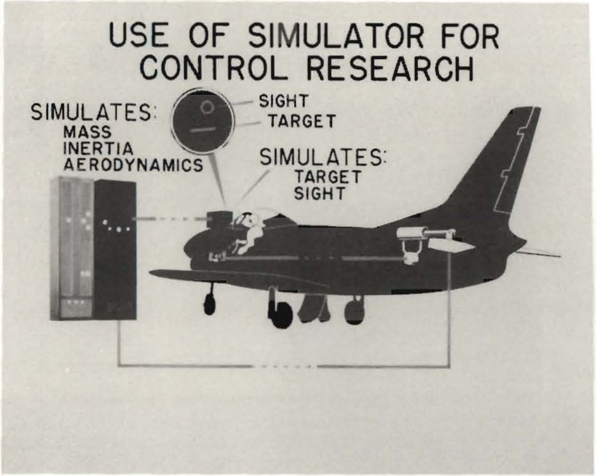

TRENDS IN WEIGHT DISTRIBUTION
LENGTHWISE DISTRIBUTION OF WEIGHT
SPANWISE DISTRIBUTION OF WEIGHT
0
1
2
3
DESIGN MACH NUMBER

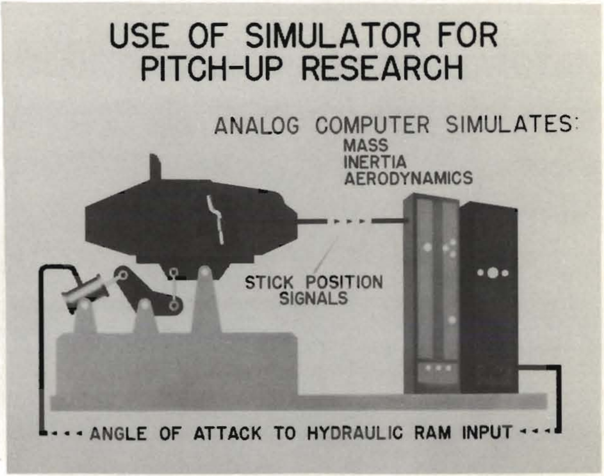

TRENDS IN ROLL AND YAW RATES
YAW OSCILLATIONS PER SECOND
MAXIMUM ROLL REVOLUTIONS PER SECOND
0
1
2
3
DESIGN MACH NUMBER

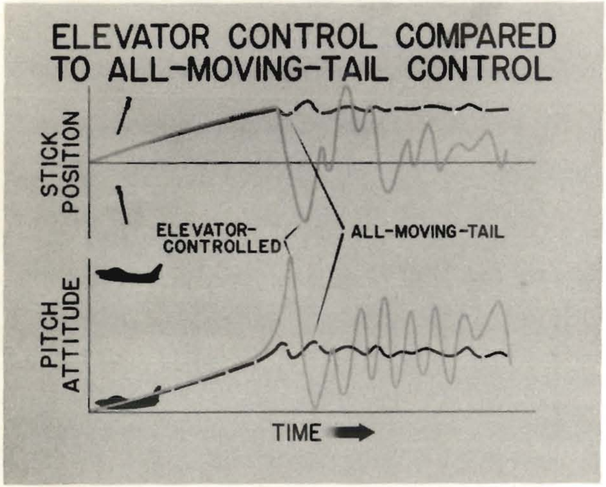
SIMULATORS AS AN AID TO FLIGHT RESEARCH



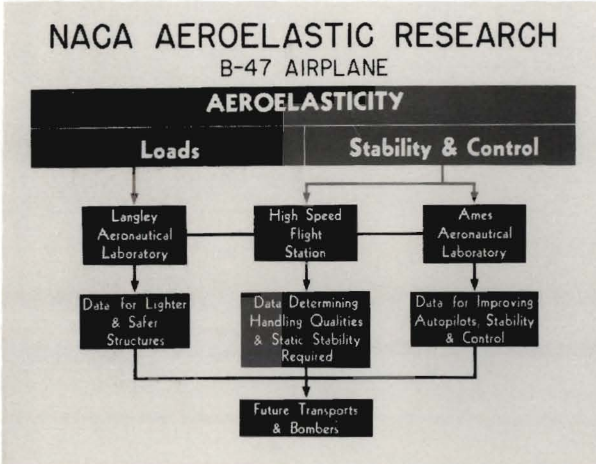


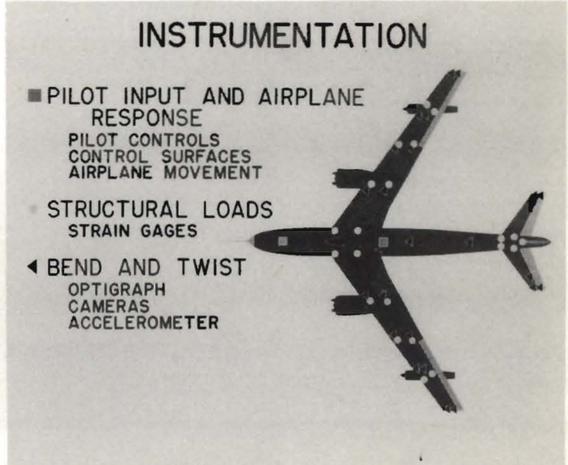

USE OF SIMULATOR FOR
CONTROL RESEARCH
SIMULATES:
MASS
INERTIA
AERODYNAMICS
SIGHT
TARGET
SIMULATES:
TARGET
SIGHT

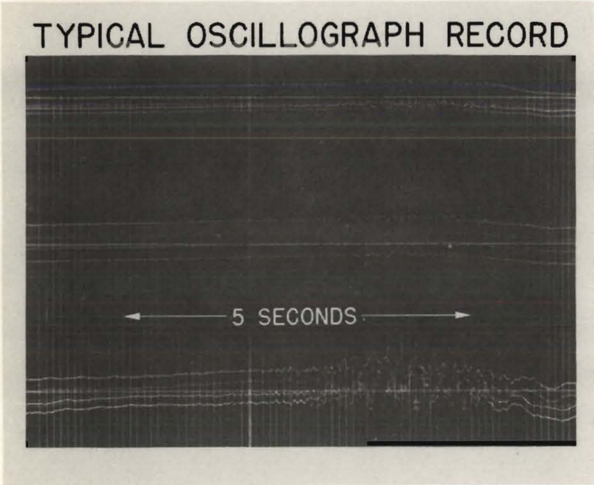

USE OF SIMULATOR FOR
PITCH-UP RESEARCH
ANALOG COMPUTER SIMULATES:
MASS
INERTIA
AERODYNAMICS
STICK POSITION
SIGNALS
ANGLE OF ATTACK TO HYDRAULIC RAM INPUT

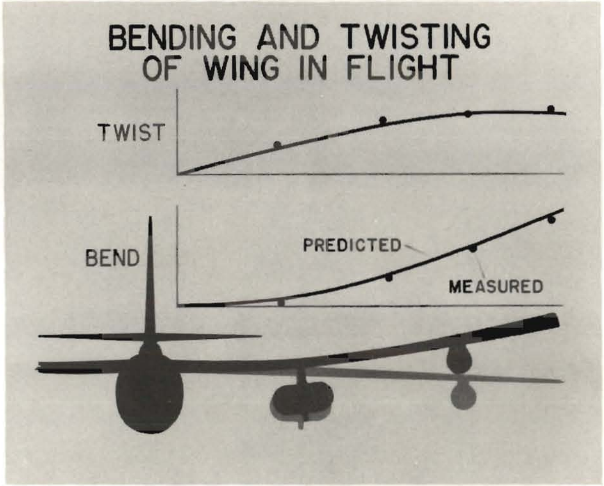

ELEVATOR CONTROL COMPARED TO ALL-MOVING-TAIL CONTROL
STICK POSITION
ELEVATOR-CONTROLLED
ALL-MOVING-TAIL
PITCH ATTITUDE
TIME

AIRPLANE FLEXIBILITY

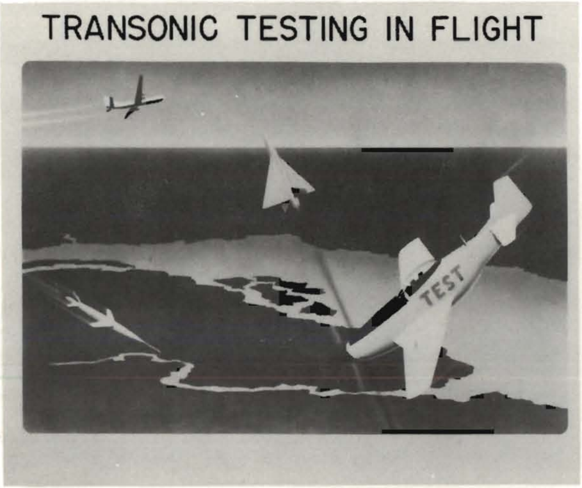


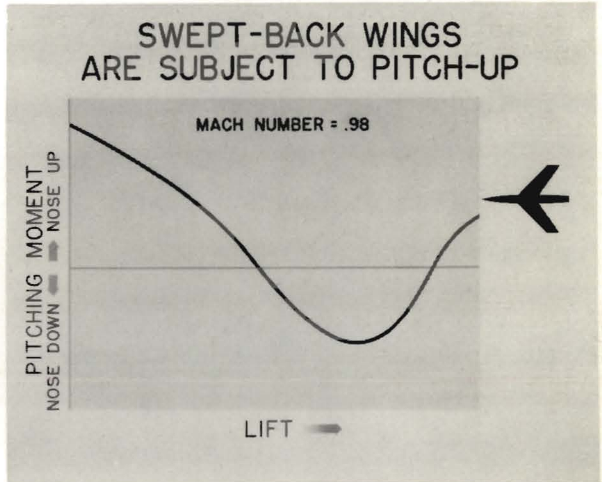


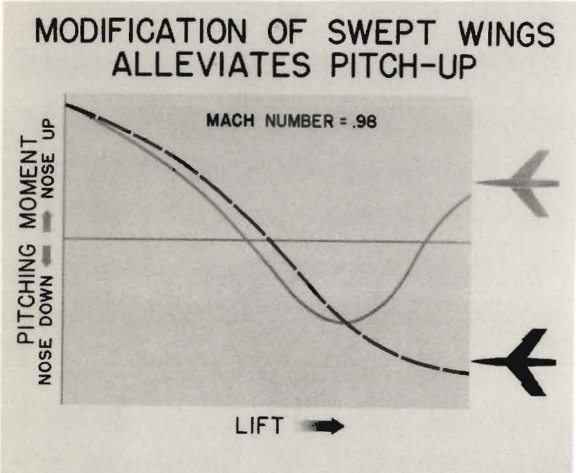

TYPICAL OSCILLOGRAPH RECORD
5 SECONDS

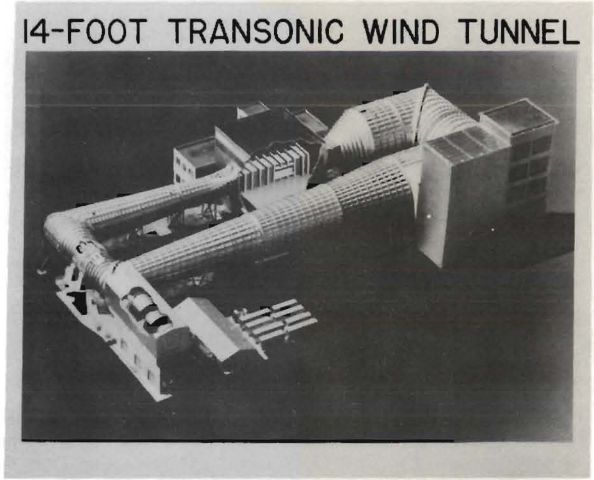

BENDING AND TWISTING
OF WING IN FLIGHT
TWIST
BEND
PREDICTED
MEASURED

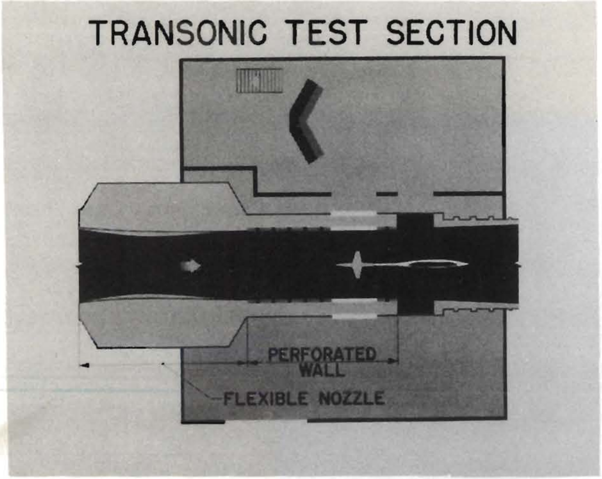
TRANSONIC RESEARCH



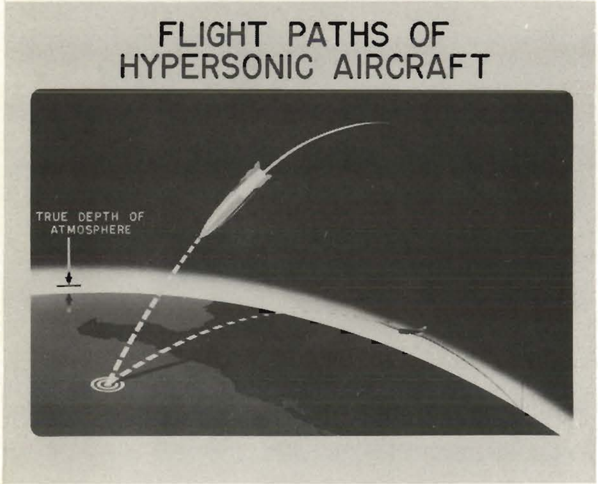


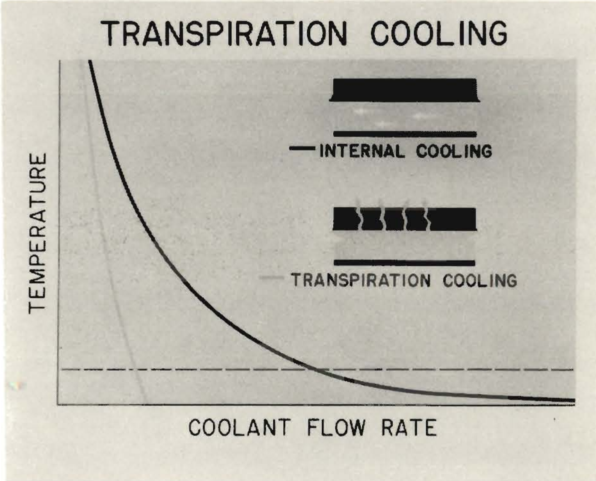

MODIFICATION OF SWEPT WINGS
ALLEVIATES PITCH-UP
MACH NUMBER = .98
PITCHING MOMENT
NOSE DOWN NOSE UP
LIFT

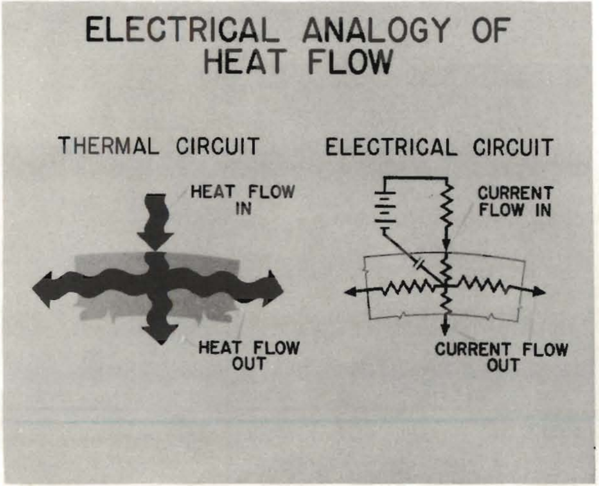

14-FOOT TRANSONIC WIND TUNNEL

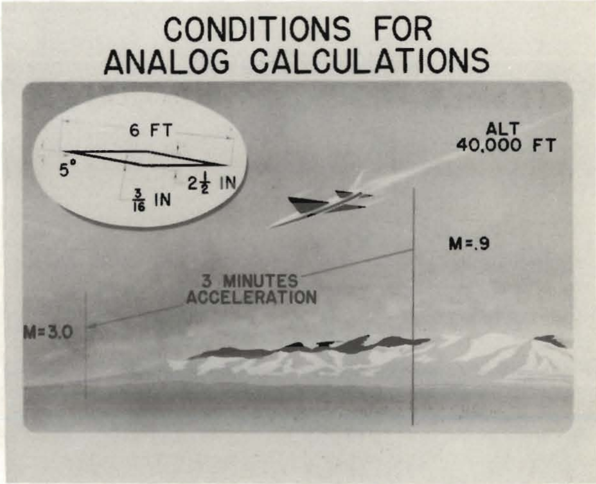

TRANSONIC TEST SECTION
PERFORATED WALL
FLEXIBLE NOZZLE

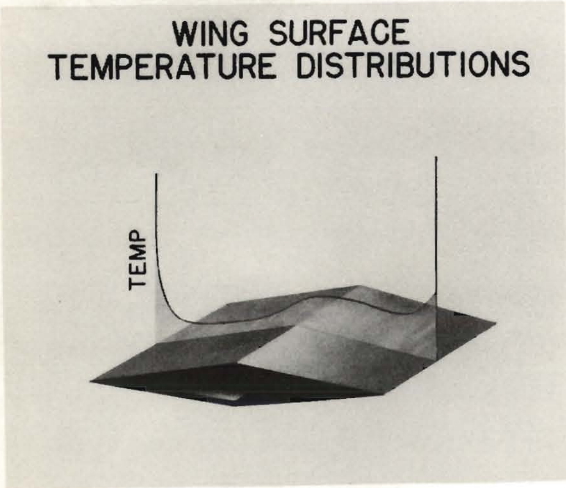
HYPERSONIC RESEARCH



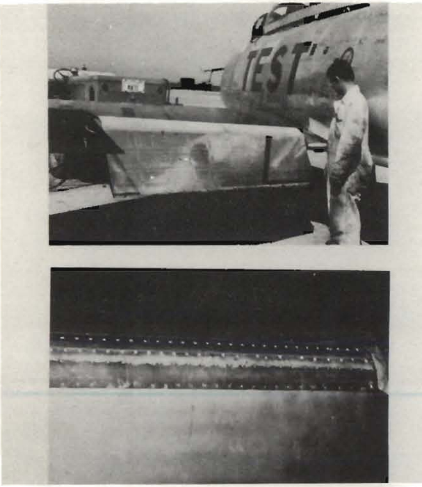


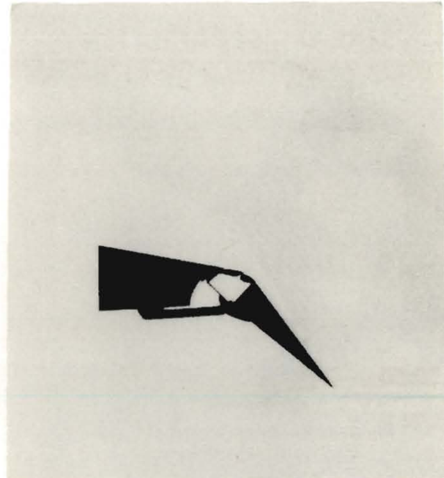

ELECTRICAL ANALOGY OF HEAT FLOW
THERMAL CIRCUIT
ELECTRICAL CIRCUIT
HEAT FLOW IN
HEAT FLOW OUT
CURRENT FLOW IN
CURRENT FLOW OUT

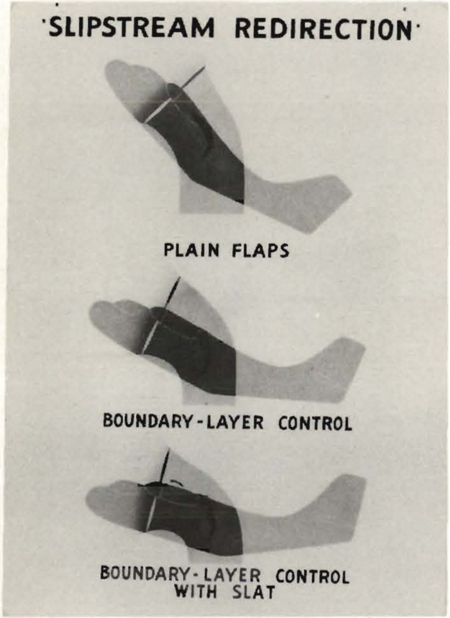

CONDITIONS FOR ANALOG CALCULATIONS
6 FT
5°
3/16 IN
2 1/2 IN
ALT 40,000 FT
M=.9
3 MINUTES ACCELERATION
M=3.0

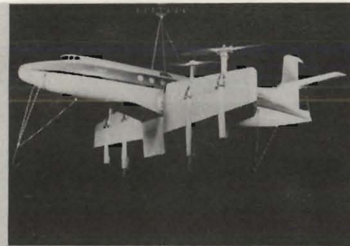

WING SURFACE
TEMPERATURE DISTRIBUTIONS
TEMP

RESEARCH ON TAKE-OFF AND LANDING

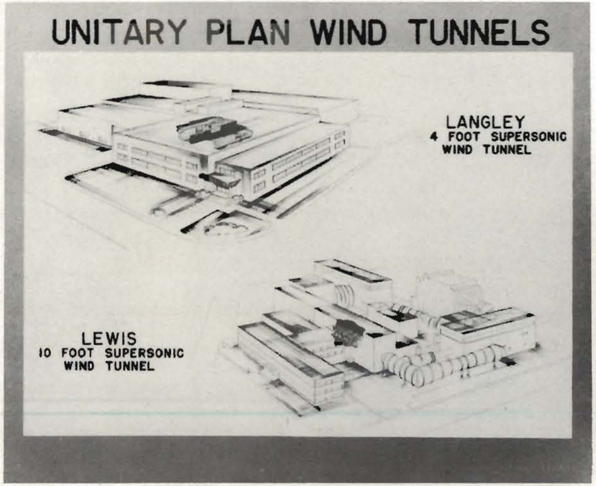


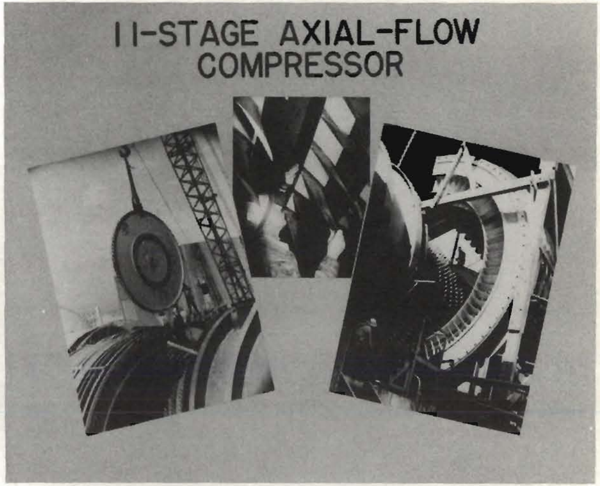


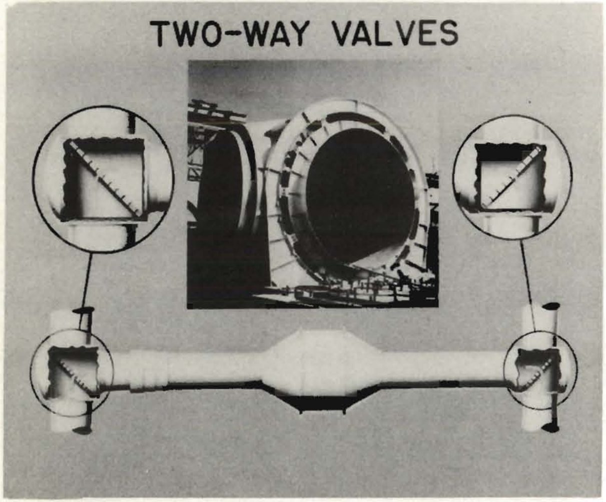

SLIPSTREAM REDIRECTION
PLAIN FLAPS
BOUNDARY-LAYER CONTROL
BOUNDARY-LAYER CONTROL WITH SLAT

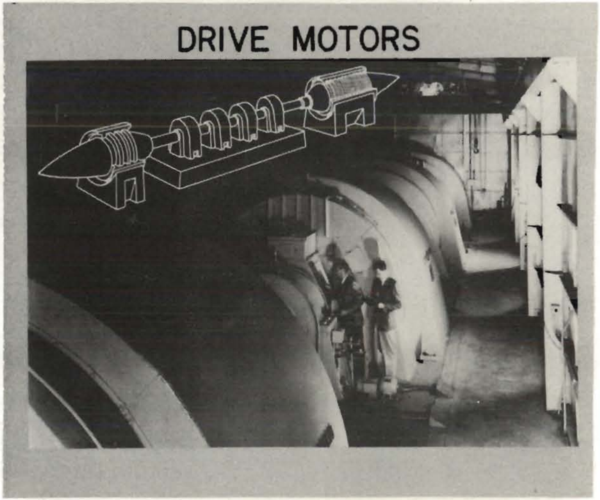


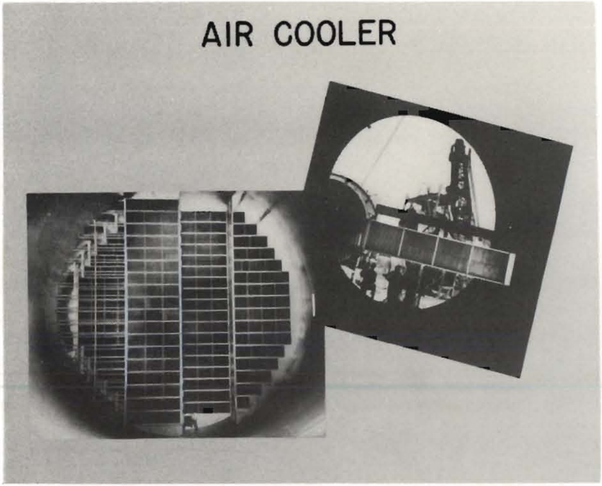
UNITARY PLAN WIND TUNNELS

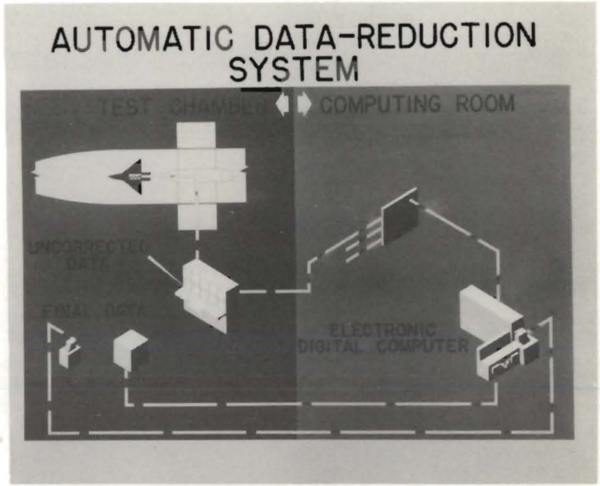




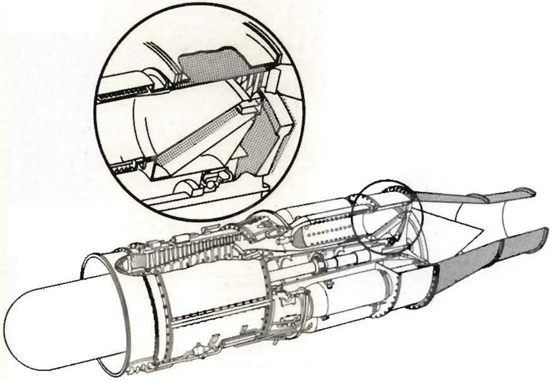

TWO-WAY VALVES


DRIVE MOTORS


AIR COOLER

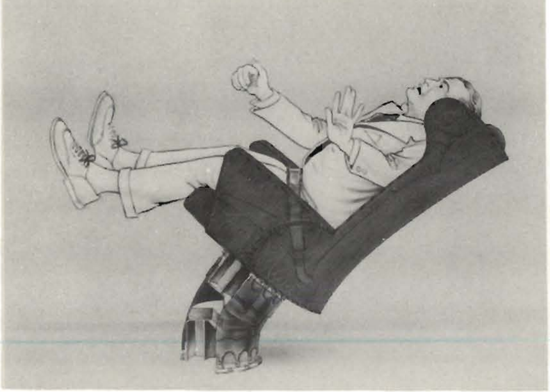

AUTOMATIC DATA-REDUCTION SYSTEM
TEST CHAMBER
COMPUTING ROOM
UNCORRECTED DATA
FINAL DATA
ELECTRONIC DIGITAL COMPUTER

TURBOJET CUT AWAY

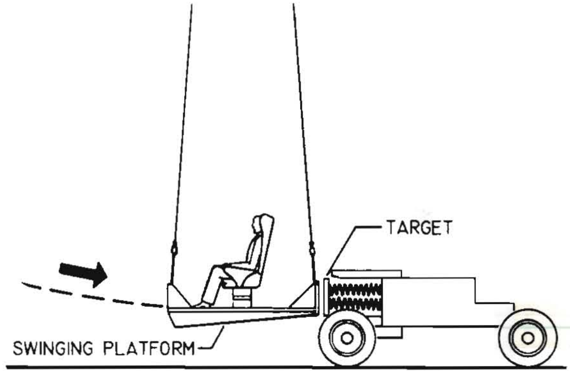


CRASH IMPACT SURVIVAL

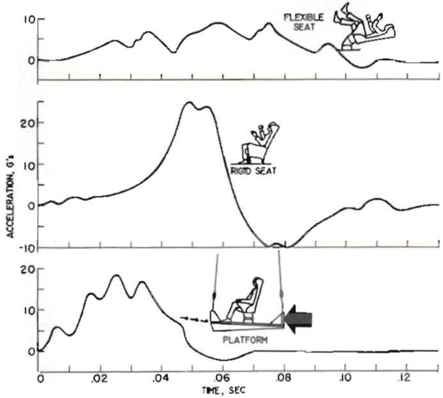
NACA EXPERIMENTAL FLEXIBLE SEAT
IMPACT FROM REAR



IMPACT SWING

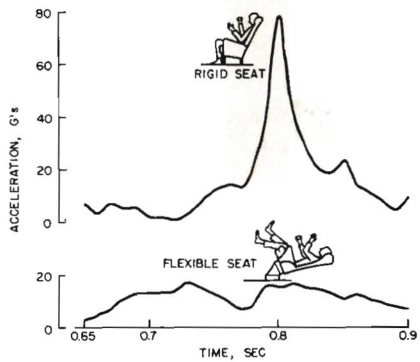


ATTENUATION OF CRASH LOAD BY FLEXIBLE SEAT



CHEST ACCELERATION

REAR FACING SEATS



NOTES:

NOTES: