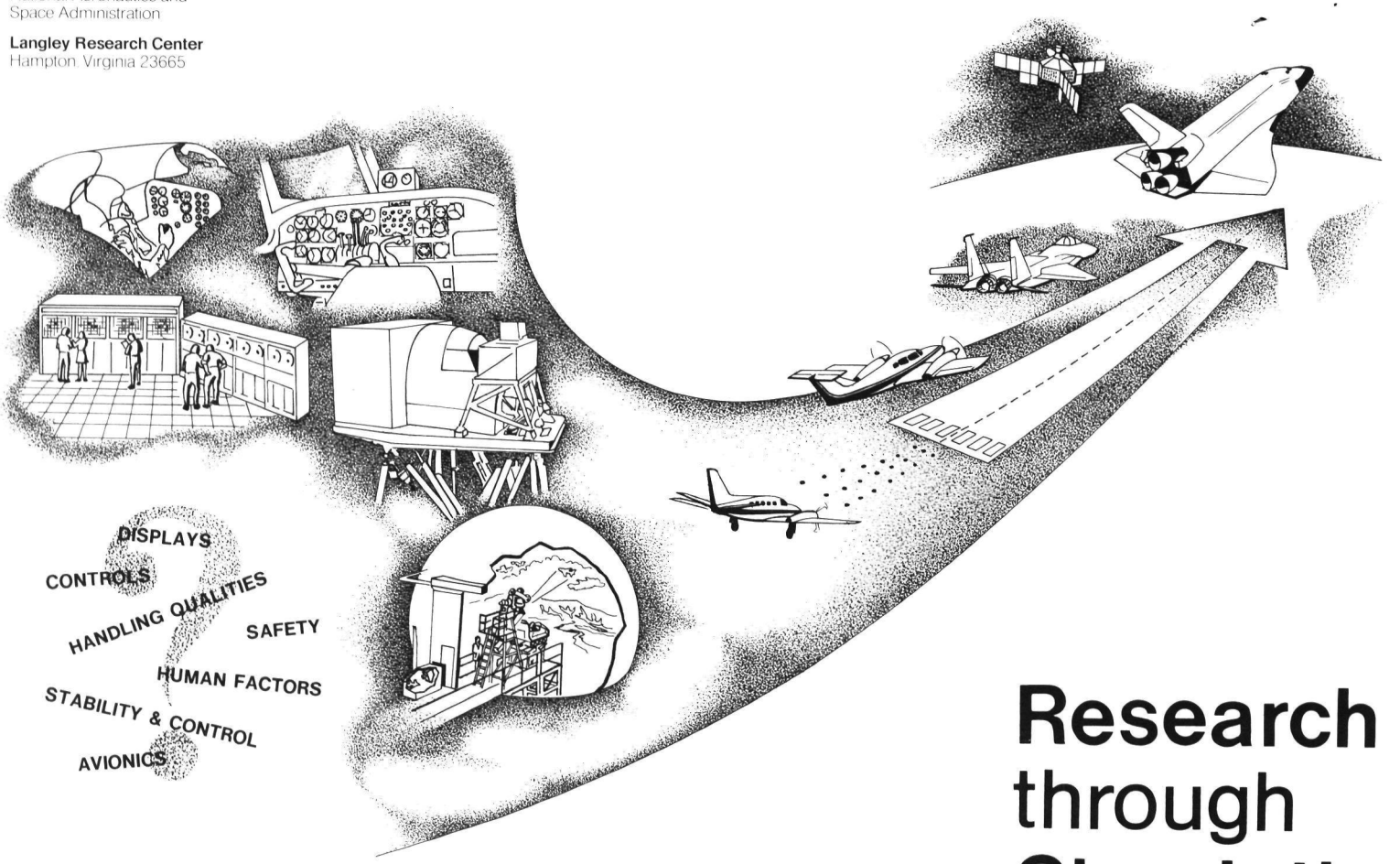
NF-125

NASA
National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23665



Research through Simulation

LANGLEY RESEARCH CENTER

Research through Simulation

Analysis and Computation Division

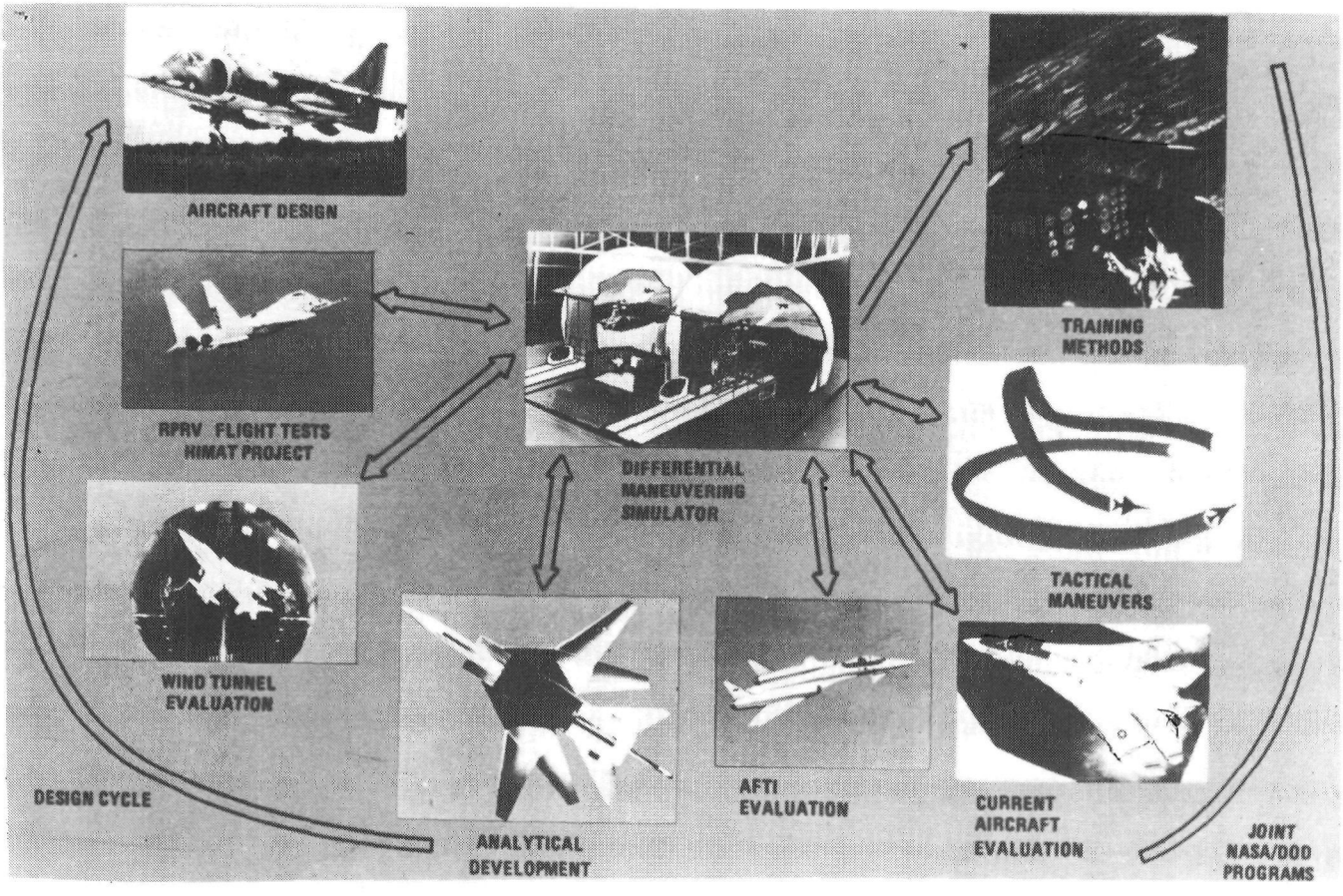
Compiled and Edited by

James L. Copeland

ENGINEERING FLIGHT SIMULATION

Since its meager beginning during World War II, flight simulation has evolved to satisfy ever increasing demands in engineering and flight training associated with aerospace vehicles. Today, many training tasks which until recently were conducted in the sky are now being simulated on the ground with increased safety, cost savings, and reduced energy consumption. While NASA has made extensive use of flight simulators to train astronauts, there has also been wide acceptance and use of flight simulators to solve engineering problems. Engineering flight simulators, used in conjunction with wind tunnels and flight testing, add another dimension in the cost effective development of new aeronautical, control and operational concepts for aerospace vehicles. Such simulation is achieved by mathematically modeling a vehicle's aerodynamics, controls, propulsion system, structures, avionics, and environmental characteristics and using computer controlled displays and a control feel system to give the pilot the illusion of actual flight. Many simulation studies are conducted in support of Langley's research efforts. To carry out these simulations requires large high-speed computers. LaRC's unique configuration which allows using the central computer complex for simulation applications supports very sophisticated and realistic simulations. The computer complex can be tied to any LaRC simulator through an elaborate signal distribution system. Today's simulators give the engineer a tool to evaluate new concepts and establish the effects of system parameters on performance both from the pilot's subjective view and objective measurements obtained by the computer. All this is accomplished under controlled conditions in the safety of the laboratory and at much lower costs than flight testing. LaRC's roles and missions in aeronautics and avionics require diverse simulator systems to study the many problems in these areas.

SIMULATORS IN RESEARCH AND DEVELOPMENT

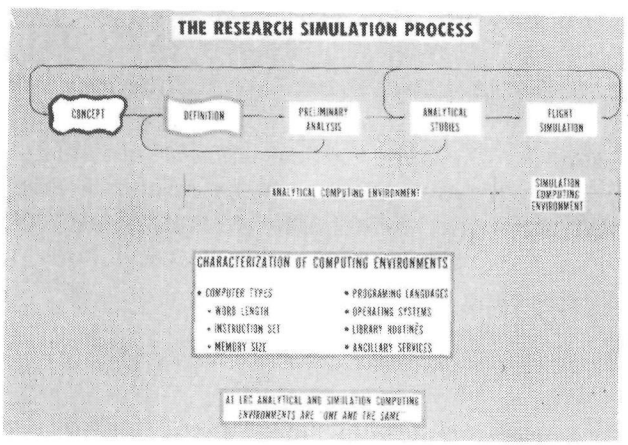


CENTRAL COMPUTER COMPLEX

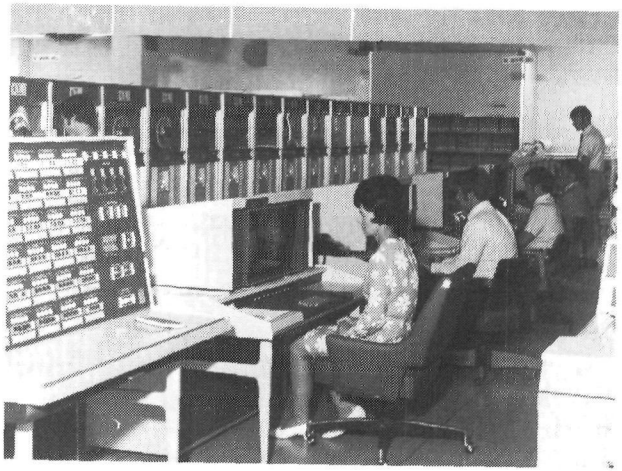
The research simulation process requires several steps from concept to proven design and in many cases requires recycling of a given concept between analytical studies and simulation verification. In this situation, transition between analytical and simulation studies can be time consuming because of reprogramming and because of requirements to reevaluate algorithms if different computers are involved. For example, effects of truncation and rounding errors may be trivial on the computer used in the analytical work but may have a destructive effect if the simulation is supported by a computer with different word lengths and instruction sets.

These concerns are eliminated in the approach taken at Langley Research Center since the same large scale computers are used to support both analytical and simulation phases in a centralized complex with specialized subsystems to support the time critical applications such as real-time simulation. The centralized approach allows the allocation of computer resources among real-time simulation, analytical and engineering studies, and experimental data reduction according to needs as they vary from day to day. The design of the computer operating system allows for concurrent support of time-critical simulations and background analytical computing on the same machine. The multifunction non-dedicated support of the Center's research makes the use of the large computer for simulation affordable.

The present complement of computers in the central complex includes three Control Data Series 6000 Computers, two Control Data CYBER 175's, two Control Data CYBER 173's, and a Star 100 Vector Processing Computer. Normally, the two CYBER 175's are assigned the time-critical simulation computing function with the other programming and math model development aspects supported by other computers in the complex in a "non-real-time" mode. Each of the two real-time computer interface subsystems has three real-time operator consoles associated with it, allowing up to six simulations to be conducted simultaneously.



CENTRAL COMPUTER OPERATIONS



REAL-TIME OPERATOR CONSOLES

SIGNAL DISTRIBUTION SYSTEM

The Langley Simulation Facility Signal Distribution System provides the following:

A. Signal path interconnections between computing hardware and flight simulation hardware is provided to allow up to six simultaneous simulation programs to be in operation at one time. Several simulator hardware facilities exist both locally within the same facility as the computer hardware and at four remote buildings which are linked with the computer building via long line underground cables. Signal distribution is accomplished by a system of patch boards that allows connecting any computer facility with any configured simulation hardware facility. The system provides the following standard signal complement for each of seven signal sub-groups (six from the digital computing complex and one from the analog computing complex):

96 Analog from computer

40 Analog to computer

60 Discrete from computer

60 Discrete to computer

A reconfiguration capability is provided to allow convenient expansion of any sub-group with additional analog or discrete signal paths.

B. Voice communications between the computer operator, the simulator pilot, and the simulator operator are provided by a telephone conferencing system. Reconfiguration is accomplished at a conference bussing station with patch cords.

C. A Video Distribution System provides the linkage of any of the Adage Graphics Video Converters, the Visual Landing Display System, or the General Purpose Target Image Generator to any of the simulator hardware facilities or any Out-The-Window display provided at the various cockpit stations. The system allows straight patching of video signals to a cockpit or patching through video mixing and insertion equipment to a cockpit.

CHARACTERISTICS

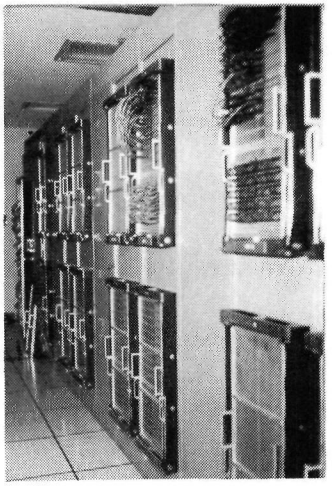
TWO ANALOG-DIGITAL SUBSYSTEMS
- 240 DAC's
- 80 ADC's
- 1000 DISCRETES IN
- 1000 DISCRETES OUT

PATCH BOARD CONNECTION TO SIXTEEN SIMULATOR SITES

VIDEO PATCHING WITH MIXING-INSERTION TO ALL SITES

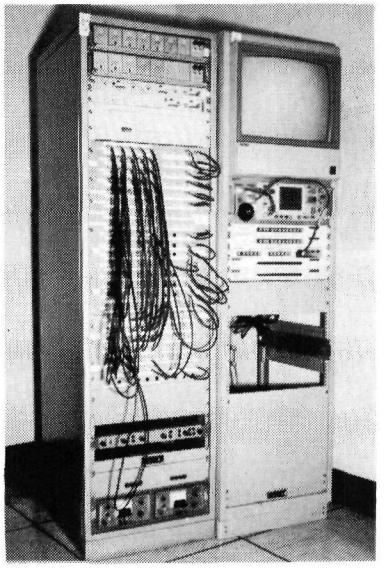
FLEXIBLE-PATCHABLE INTERCOM SYSTEM

CENTRAL REFERENCE VOLTAGES

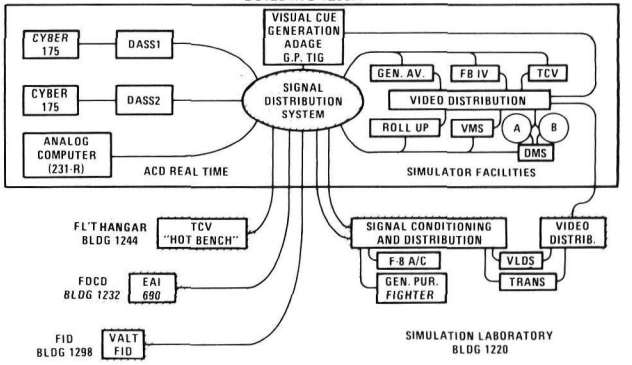


SIMULATOR SITE DISTRIBUTION

CENTRAL VIDEO DISTRIBUTION



SIMULATION SIGNAL DISTRIBUTION SYSTEM
BUILDING 1268A



DIFFERENTIAL MANEUVERING SIMULATOR

The Langley Differential Maneuvering Simulator (DMS) provides a means of simulating two piloted aircraft operating in a differential mode with a realistic cockpit environment and a wide angle external visual scene for each of the two pilots. The system consists of two identical fixed-base cockpits and projection systems, each based in a 12.2 m (40 ft.) diameter projection sphere. Each projection system consists of a sky-Earth projector to provide a horizon reference and a system for target-image generation and projection. The internal sky-Earth scene provides reference in all three rotational degrees of freedom in a manner which allows unrestricted aircraft motions. The sky-Earth scene has no translational motion. The internal visual scene also provides continuous rotational and bounded (300 ft. – 45,000 ft.) translational reference to a second (target) vehicle in six degrees of freedom. The target image presented to each pilot represents the aircraft being flown by the other pilot in this dual simulator. Each cockpit provides essential instruments and displays along with a wide angle heads-up-display. Kinesthetic cues in the form of a G-suit pressurization system, G-seat system, cockpit buffet and programmable control forces are provided to each pilot consistent with his aircraft's motions.

RESEARCH APPLICATIONS

SIMULATOR VALIDATION – Actual flight runs involving high performance maneuvers in an F-4 aircraft were repeated in the simulator.

NAVY FIGHTER STUDY – F-4, F-14, and other aircraft were compared in the one-on-one Air-Combat Maneuvering (ACM) mode.

PARAMETRIC STUDY – Evaluation has been made of the relative effect of parameter changes on the performance of several baseline aircraft.

VECTORED THRUST STUDY – A joint program involving both simulator and actual flight was conducted to evaluate the effect of high-speed thrust vectoring on one-on-one ACM.

ROTORCRAFT/AIRCRAFT TACTICS DEVELOPMENT – A program was carried out to evaluate and develop rescue helicopter evasive manuevers for a one-on-one engagement for both a high speed fighter aircraft and an attack helicopter.

HIGH ANGLE OF ATTACK, SPIN SUSCEPTIBILITY – Studies to evaluate the high angle of attack spin susceptibility of several aircraft have been made.

CHARACTERISTICS

2 PILOTS/AIRCRAFT INTERACTING

270° H FIELD OF VIEW, 60° DOWN, 90° UP

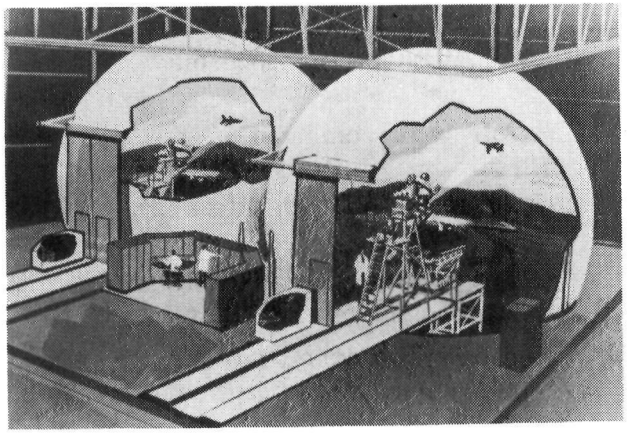
SYNCHRONIZED VISUAL DISPLAY, TARGET TO HORIZON MOTIONS

FIXED BASE W/BUFFET, G-SUIT, G-SEAT SCENE BRIGHTNESS DIMMING/G

H.U.D.S. (ADAGE DRIVEN)

CAPABLE OF BETTER THAN 8 G MANEUVERS

AUDIO CUES



DIFFERENTIAL MANUVERING SIMULATOR

INTERIOR VIEW

RESEARCH APPLICATIONS

A/C PERF. COMPARISONS

HIGH AOA HANDLING QUALITY

SPIN ENTRY

AIRCRAFT VS. ROTORCRAFT TACTICS

ROTORCRAFT VS. ROTORCRAFT TACTICS

AIR TO AIR MISSILES

PILOT TRAINING

VISUAL MOTION SIMULATOR

The Langley Visual Motion Simulator (VMS) is a general purpose simulator consisting of a two-man cockpit mounted on a six-degree-of-freedom synergistic motion base. A collimated visual display provides a 60° out-the-window color display for both the left seat and the right seat. The visual display can accept inputs from several sources of image generation presently. A programmable hydraulic control loading system is provided for the column, wheel and rudder in the left side. A mechanical spring-viscous damper type cyclic controller is presently provided for the right seat. Instruments and displays on the left side are typical of transport aircraft (CTOL) while those on the right side are typical of helicopters (VTOL). A friction-type collective control is provided for both the left and right seats. Motion cues are provided to the simulator by the relative extension or retraction of the six hydraulic cylinders of the motion base. Washout techniques are used to return the motion base to the neutral point once the onset motion cues have been commanded.

RESEARCH APPLICATIONS

737 MB – Study for the evaluation of combined visual/motion cues for non-linear washout for CTOL aircraft.

S61 MB – Study of visual/motion requirements for non-linear washout for VTOL aircraft.

RIDE QUALITY – Human factors study on pleasantness or unpleasantness of motion sensed by the riding public on commercial airliners.

ALTRACK – Study of pilot work loads in tracking a target aircraft with time delays.

OTTER II – Study of turbulence models for light wing loaded aircraft in landing approaches.

ABC SIMULATOR – Study of the performance characteristics of the Advancing Blade Concept Helicopter.

REAL WORLD DISPLAY – Study of a heads-up landing approach display for helicopters.

F-16 MB – Study of visual/motion requirements including optimizing non-linear washout for fighter aircraft.

CHARACTERISTICS

SIX-DEGREE-OF-FREEDOM MOTION

LEFT AND RIGHT COLLIMATING DISPLAYS

LEFT SIDE INSTRUMENTS – TRANSPORT

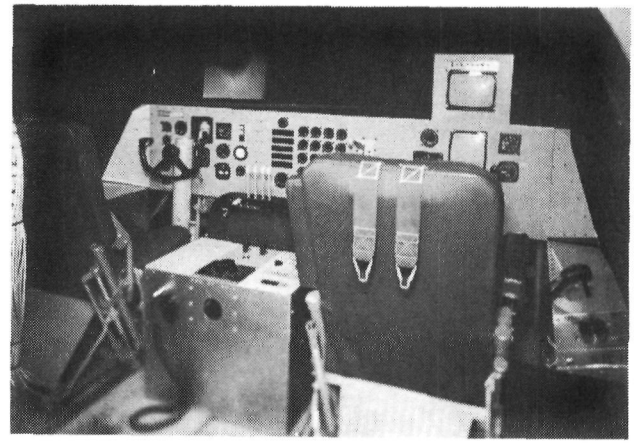
RIGHT SIDE INSTRUMENTS – HELICOPTER

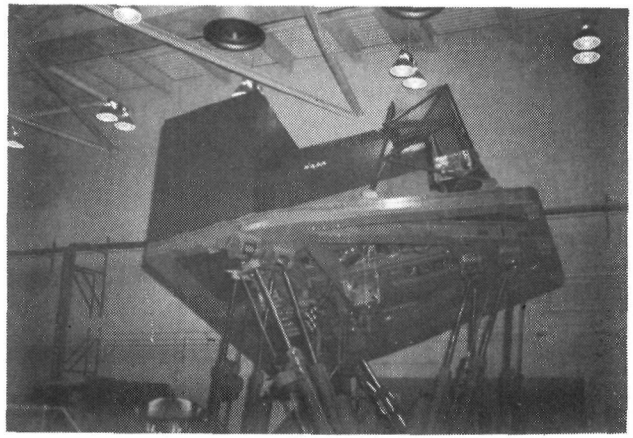
LEFT SIDE – PROGRAMMABLE HYDRAULIC WHEEL, COLUMN AND RUDDER

RIGHT SIDE – MECH. CYCLIC CONTROLLER

AUDIO CUES

INTERIOR VIEW





VISUAL MOTION SIMULATOR

RESEARCH APPLICATIONS

LANDING APPROACH STUDIES

AIRCRAFT STABILITY AND CONTROL STUDIES

EFFECT OF VISION AND/OR MOTION ON HUMAN PERFORMANCE

SUPPORT OF FLIGHT TESTS

PILOT TRAINING

TERMINAL CONFIGURED VEHICLE SIMULATOR

The Terminal Configured Vehicle Simulator (TCV) is a duplicate of the aft deck cockpit in the Boeing 737 – 100 aircraft. The simulator provides the means of ground-base simulation in support of the TCV research program. The cockpit contains duplicate flight instruments, interchangeable CRT's for the electronic attitude indicator and multiple function indicator, computer driven throttles and flaps, a simulated navigation control display unit and a simulated control mode panel. The Simulator allows proposed control laws or display techniques to be verified and validated prior to testing in the aircraft.

RESEARCH APPLICATIONS

DIRECT LIFT – Investigations into the use of flight spoilers as direct lift control devices.

CONTROL/DISPLAY IN WIND SHEAR – Evaluation of acceleration information in a display when encountering wind shears.

VELOCITY CONTROL WHEEL STEERING/DISPLAY – Investigation of reduced pilot workload and improved precision of path control through improved controls and displays.

R-NAV CAPTURE – Correction and improvement of R-NAV control algorithm for the 737 aircraft system.

OCULOMETER – Investigation of pilot lookpoints in an advanced display environment.

CHARACTERISTICS

SINGLE OR DUAL CREW OPERATIONS

MULTI-LEVEL AUTOMATIC OR MANUAL FLIGHT CONTROL

ELECTRONIC OR ELECTRO-MECHANICAL INSTRUMENTS.

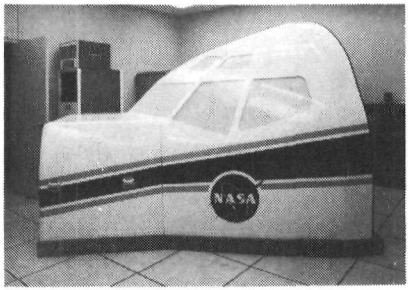
OUT-THE-WINDOW COLOR DISPLAY

PROGRAMMABLE PILOT/COMPUTER INTERFACE

CONTROL/DISPLAY FEATURES
- FLIGHT PATH ANGLE
- POTENTIAL FLIGHT PATH
- ALTITUDE INTERCEPT PREDICTION
- TRACK ANGLE SELECT
- TIME BOX (4-D NAV)
- COMPUTER CONTROLLED THROTTLES
- COMPUTER CONTROLLED FLAPS

AUDIO CUES

INTERIOR VIEW



TERMINAL CONFIGURED VEHICLE SIMULATOR

RESEARCH APPLICATIONS

DIRECT LIFT

CONTROL/DISPLAY IN WIND SHEAR

VELOCITY CONTROL WHEEL STEERING/DISPLAY

R-NAV CAPTURE

OCULOMETER

GENERAL AVIATION AIRCRAFT SIMULATOR

The General Aviation Aircraft Simulator (GAAS) consists of a flight quality general aviation aircraft cockpit mounted on a two-degree-of-freedom motion platform. The cockpit is a reproduction of a twin-engine propellor driven general aviation aircraft with programmable control loading for the wheel and "thru-the-panel" column, and spring loaded rudder pedals as well as a full complement of instruments, controls and switches including radio/navigation equipment. A collimated image visual system provides a 60° field-of-view out the window color display. The visual system can accept inputs from a model board system, computer generated graphics and a target aircraft/horizon scene.

RESEARCH APPLICATIONS

The simulator has research applications in a variety of general aviation aircraft areas. Although the simulator is new, programs are being accomplished in the following areas:

LIGHT AIRCRAFT HANDLING QUALITIES – Evaluation of stick pusher system to reduce stalls. Light aircraft heads-up-display (HUD) study using a simplified and inexpensive heads-up-display for approach and landing.

FREE WING AIRCRAFT – Evaluation of the stability and control of a free wing aircraft.

MOTION WASHOUT STUDIES – Development of nonlinear motion washout techniques for a two-degree-of-freedom motion platform.

GENERAL AVIATION INSTRUMENT LANDING SYSTEM – Development of simplified R-NAV System applicable to general aviation.

SINGLE PILOT IFR – Development of techniques to accomplish single pilot operation under Instrument Flight Rules.

GUST ALLEVIATION – Evaluation control techniques of mechanically providing gust control.

CHARACTERISTICS

TWIN ENGINE INSTRUMENTS AND CONTROLS

60^{O} FIELD OF VIEW COLOR OUT THE WINDOW DISPLAY

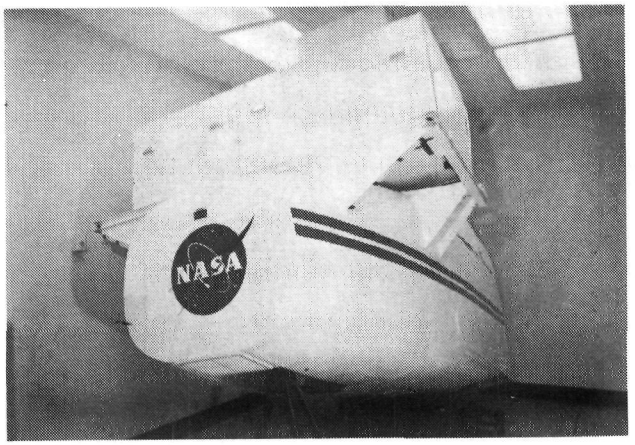
TWO DEGREE OF FREEDOM MOTION

CONTROL LOADING

SOUND SYSTEM

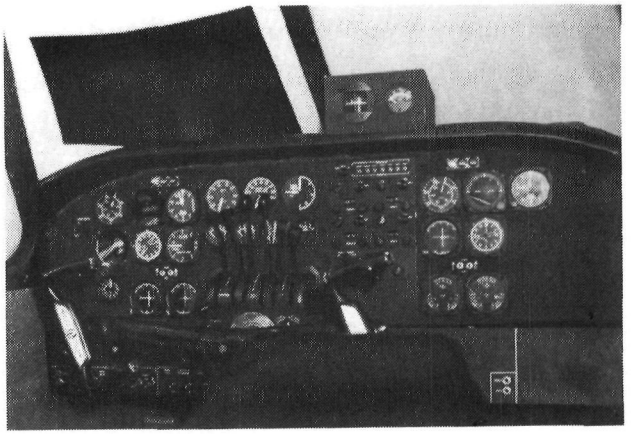
RADIO/NAV. EQUIPMENT

AUDIO CUES



EXTERIOR VIEW

INTERIOR VIEW



RESEARCH APPLICATIONS

HANDLING QUALITIES

GUST ALLEVIATION DEVICES

SIMULATOR REQUIREMENTS FOR PILOT TRAINING

R/NAV STUDIES

LANDING AIDS STUDIES

SPIN ALLEVIATION STUDIES

SINGLE PILOT IFR STUDIES

DECOUPLED CONTROL

GENERAL PURPOSE FIXED BASE SIMULATOR

The General Purpose Fixed Base Simulator is a multipurpose fixed-base cockpit providing a two-man side-by-side control station or either side alone to provide a one-man control station. Flight control responses for the control stick (pitch and roll) and rudder pedals are simulated by forces from hydraulic servo systems. A collective pitch controller is provided for each control station. Throttle controls can be provided on the side or as a center quadrant. A virtual image color visual display is provided for the left-side control station. The Adage Graphics Display is available as separate displays for both stations or the left-side out-the-window display using a video mix capability. A sound system is available to provide cues relative to engine rpm, airspeed, gear retraction and touchdown/rollout. In addition, kinesthetic cues are available by use of a "seat-shaker" on the left-side station.

RESEARCH APPLICATIONS

The simulator has been utilized to simulate various types of aircraft from general aviation class to helicopter. Programs are being accomplished in the following areas:

VTOL (CH-47) – Study to evaluate the performance of a CRT displayed three-axis flight director using an electromechanical three-axis flight director as a baseline.

CH-54 SLING LOAD – Study to compare and evaluate various methods for stabilizing sling loads, including pilot ratings and safety aspects.

RSRA – Study to evaluate control systems and handling qualities of the three configurations of the Rotor Systems Research Aircraft (Fixed Wing, Rotary Wing, and Compound).

CHARACTERISTICS

STICK (CYCLIC) AND COLLECTIVE AT BOTH STATIONS

60^{O} FIELD OF VIEW COLOR OUT THE WINDOW DISPLAY

CRT COCKPIT DISPLAYS

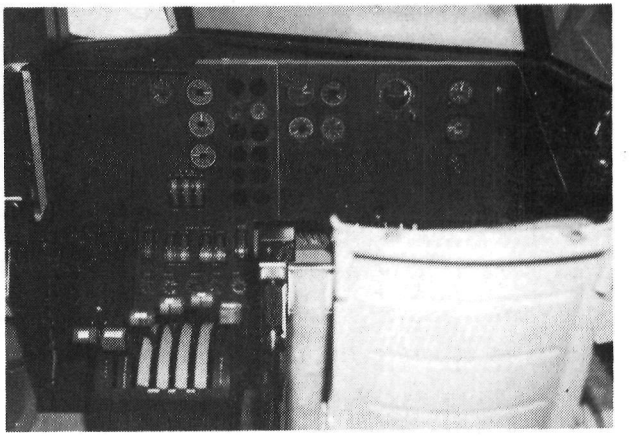
FIXED BASE W/CONTROL LOADING, BUFFET

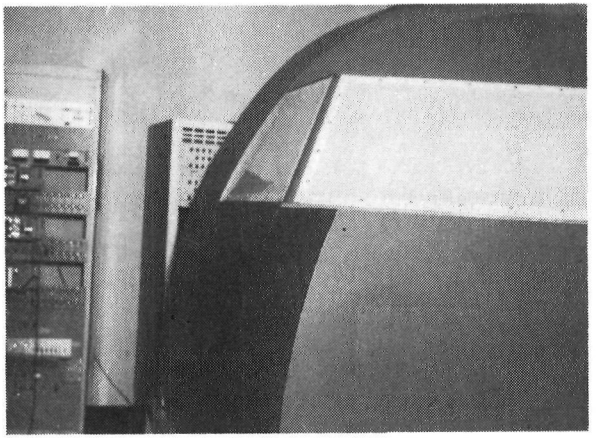
PLUG-IN INSTRUMENT PANELS

PLUG-IN SIDE AND CENTER CONSOLES

AUDIO CUES

INTERIOR VIEW





EXTERIOR VIEW

RESEARCH APPLICATIONS

HELICOPTER AUTOMATIC LANDINGS (VALT) STUDIES

HELICOPTER SLING LOAD STUDIES

RSRA HANDLING QUALITIES AND CONTROL STUDIES

GENERAL AVIATION LANDING AID STUDIES

TRANSPORT SIMULATOR

The Transport Simulator located in B-1220 consists of a fixed-base DC-8 cockpit, signal distribution console, two X-Y plotters, and electronic cabinets. Three stations are available in the cockpit for a Captain, First Officer, and a Flight Engineer. Flight control responses for elevator, aileron, and rudder are simulated by forces from hydraulic servo systems. Throttle controls for four engines are provided on the center console. Two high frequency and two very high frequency communication receivers and six stations for V.O.R./I.L.S. navigation are provided. A collimated color visual out-the-window display is provided at the Captain's station. The Adage Graphics Display can be made available via closed circuit television. Area navigation system is available to provide horizontal and vertical steering signals to simulate an aircraft following a predetermined, three-dimensional flight path.

RESEARCH APPLICATIONS

The simulator has research applications in simulating large multi-engine jet aircraft. Programs have been accomplished:

SUPERSONIC TRANSPORT-AIR-TRAFFIC CONTROL – The simulator was tied into the FAA Air Traffic Control Simulator at NAFEC, Atlantic City, New Jersey for extensive study of the SST in the air traffic environment.

HANDLING QUALITY STUDIES – Studies have been made of the handling qualities in the approach configuration and the stall susceptability of such aircraft as the DC-9 and B-727.

STOL TERMINAL AREA OPERATIONS – Techniques for operations into unaided airports using on-board R-NAV capabilities have been studied.

BLOWN FLAP SIMULATIONS STUDIES – Studies were carried out in conjunction with flight tests of a modified B-707 in the evaluation of blown flaps.

ADVANCED SUPERSONIC TRANSPORT – A program to determine the handling characteristics and stability augmentation requirements for both baseline and powered-lift advanced supersonic transport configurations have been made in conjunction with flight tests using a variable stability aircraft.

CHARACTERISTICS

60° FIELD OF VIEW COLOR DISPLAY

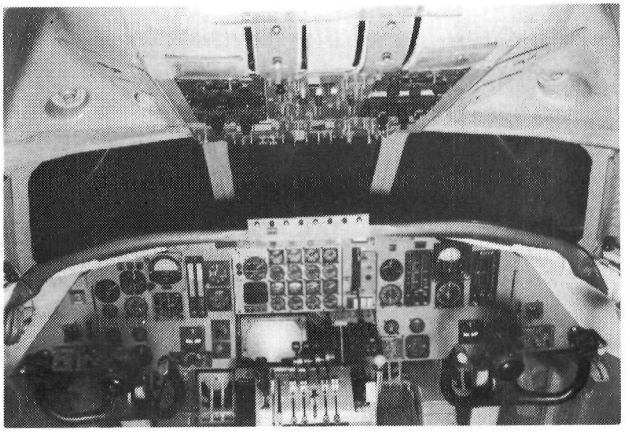
C.R.T. COCKPIT DISPLAYS

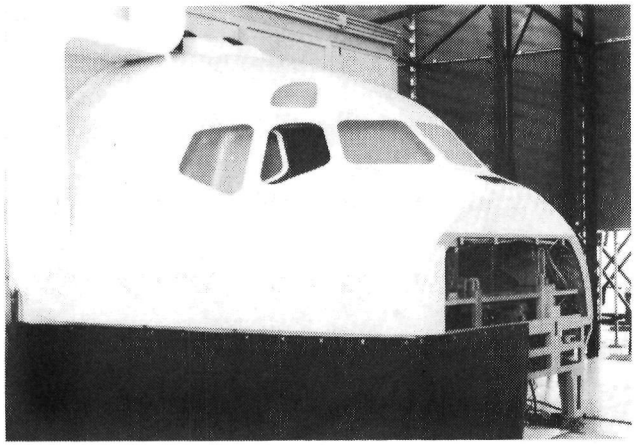
RADIO/NAV. EQUIPMENT

FIXED BASE W/CONTROL LOADING

PILOT, CO-PILOT AND ENGINEER STATIONS

INTERIOR VIEW





EXTERIOR VIEW

RESEARCH APPLICATIONS

MULTI-ENGINE JET

ATC STUDIES

STOL TERMINAL AREA

NOISE ABATEMENT STUDIES

CURVED TRAJECTORIES

HANDLING QUALITIES

DIGITAL FLY-BY-WIRE SIMULATOR

The Digital Fly-By-Wire Simulator consists of a modified surplus F-8 aircraft which has been used for advanced control law research for the F-8 Digital Fly-By-Wire program. The simulator provides a pilot station with controls and instruments which can be monitored at a remote station by closed circuit television. Other key elements of the system are an AP 101 digital flight computer, interface equipment, and fully powered aircraft control surfaces which can be driven either by the flight computer or the central computers.

RESEARCH APPLICATIONS

ADVANCED CONTROL LAW DEVELOPMENT – Studies of several advanced concepts such as control configured vehicles, adaptive control and learning controls have been carried out.

DIGITAL FLIGHT CONTROL SYSTEM – Evaluation of digital system parameters such as speed, word length, step size have been conducted.

REDUNDANCY MANAGEMENT STUDIES – Evaluation of redundancy requirements and concepts for digital control systems have been made.

CHARACTERISTICS

TYPICAL INSTRUMENT PANEL

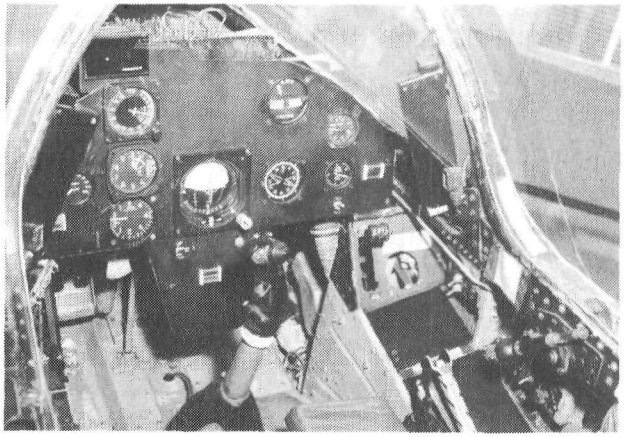
STANDARD PILOT CONTROLS/SIDEARM CONTROLLER

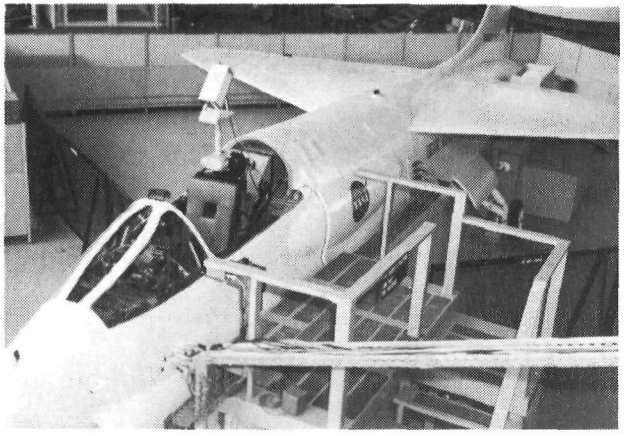
CONTROL SURFACES DRIVEN FROM CENTRAL COMPUTERS OR CANDIDATE FLIGHT COMPUTER

COCKPIT VIDEO MONITORED

AP101 DIGITAL FLIGHT COMPUTER

INTERIOR VIEW





DIGITAL FLY-BY-WIRE SIMULATOR

RESEARCH APPLICATIONS

ADVANCED CONTROL LAW DEVELOPMENT

DIGITAL FLIGHT CONTROL SYSTEMS

REDUNDANCY MANAGEMENT STUDIES

GENERAL PURPOSE FIGHTER SIMULATOR

The General Purpose Fighter Simulator located in Building 1220 is a fixed-base cockpit providing a one-man control station for fighter simulators. Flight control responses for the control stick (pitch and roll) and rudder pedals are simulated by forces from hydraulic servo systems. A throttle quadrant is provided for single or dual throttle operation. The simulator is located in a spherical projection screen capability for adding an external visual display system for 270° field of view terrain and target scenes or 60° field of view area-of-interest landing scene.

RESEARCH APPLICATIONS

The simulator has research applications as a general purpose fighter cockpit simulator, simulating either single or dual engine aircraft. A program is being accomplished to simulate the F5-A radio-controlled airplane model at high angles of attack.

CHARACTERISTICS

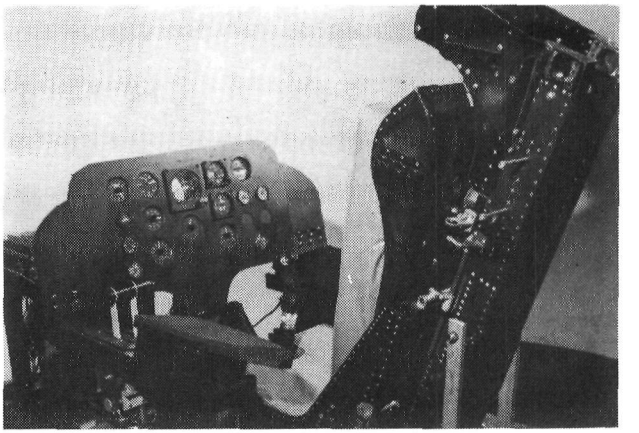
ONE-MAN FIGHTER COCKPIT

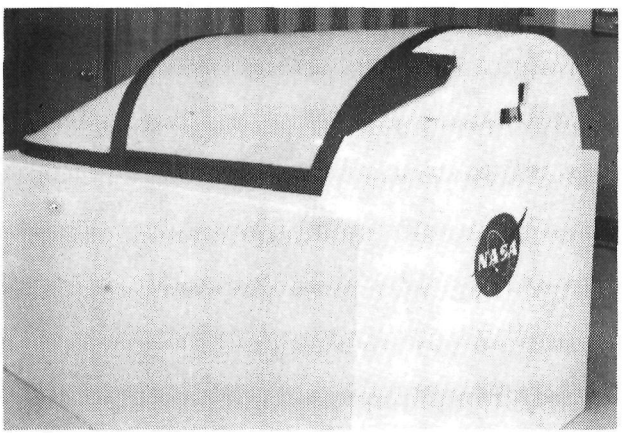
STANDARD INSTRUMENTATION

FIXED BASE WITH THREE AXIS CONTROL LOADING

HOUSED IN A 20 FT. DIAMETER PROJECTION SPHERE

INTERIOR VIEW





EXTERIOR VIEW

RESEARCH APPLICATIONS

HIGH AOA INSTRUMENT TRAINING

RPV CONTROL

HANDLING QUALITIES STUDIES

PILOT TRAINING OF SPECIFIC CONTROL TASKS

ROLL-UP COCKPIT

The Roll-Up Cockpit is a portable simulator that was designed to operate in the real-time control area to allow a researcher to develop control laws or displays without having to compete for the major simulator facilities. The cockpit is easily reconfigured to accommodate a variety of research. Its main feature is that it can be rolled up to the Real-Time Control Consoles to take advantage of the Real-Time CRT displays or general purpose CRT's are easily added to the cockpit for use with the Adage Graphics Terminal.

RESEARCH APPLICATIONS

F-8 FLY-BY-WIRE – Research in the Fly-By-Wire control of the F-8 aircraft to develop and validate control laws in conjunction with the F-8 Ironbird Simulator and the AP101 flight control computer.

REDUNDANCY MANAGEMENT – Evaluation of redundancy concepts as applied to Fly-By-Wire control was conveniently carried out using this simulator.

SHUTTLE REENTRY – Evaluations of the shuttle control system in both the manual and automatic modes including the transport lags introduced by the flight computers have been carried out.

CHARACTERISTICS

SIMPLIFIED INSTRUMENT PANEL EASILY RECONFIGURED

TWO ENGINE THROTTLES

TWO-AXIS SIDE ARM CONTROLLER

RUDDER PEDALS

PORTABLE

CONVENIENT TO REAL-TIME CONTROL AND REAL-TIME CRT DISPLAYS

EXTERIOR VIEW WITH SIMULATED HEADS-UP DISPLAY

INTERIOR VIEW WITH CRT DISPLAYS

RESEARCH APPLICATIONS

F-8 FLY-BY-WIRE

REDUNDANCY MANAGEMENT FOR FLY-BY-WIRE SYSTEMS

SHUTTLE MANUAL REENTRY

SHUTTLE AUTOMATIC REENTRY

VISUAL LANDING DISPLAY SYSTEM

The Langley Visual Landing Display System (VLDS) is a camera/model board system for generating a visual out-the-window scene for the pilot of a simulated aircraft. The system consists of a 60 foot by 24 foot dual scaled terrain model, a lampbank to illuminate the model, a three-degree-of-freedom translation system to position the camera, and a three-degree-of-freedom optical/rotational system mated to a color television camera. The VLDS provides non-composite RGB television signals to an external simulator cockpit window display device to give a field of view of 48 degrees horizontally by 36 degrees vertically. The optical/rotational system also employs a "sky plate" optical device to create the sky above the terrain scene and to provide for limited visibility conditions. The system is designed to accommodate a wide range of simulation studies.

SIMULATOR SUPPORT APPLICATIONS

The VLDS can generate out-the-window displays for these simulators located at the Langley Research Center.

VISUAL MOTION SIMULATOR – The VLDS can be displayed to the pilots in both the left and right seats through two reflective virtual image color display systems.

GENERAL AVIATION AIRCRAFT SIMULATOR – The VLDS can be displayed to the pilot in the left seat through a reflective virtual image color display system.

GENERAL PURPOSE FIXED BASE SIMULATOR – The VLDS can be displayed in color to the pilot in the left seat through a refractive virtual image color display device.

TRANSPORT SIMULATOR – The VLDS can be displayed in color to the pilot in the left seat through a refractive virtual image color display device.

DIFFERENTIAL MANEUVERING SIMULATOR – The VLDS can be displayed in monochrome to the pilot in either sphere A or sphere B by means of the heads up display device.

TERMINAL CONFIGURED VEHICLE SIMULATOR – The VLDS can be displayed to the pilot in the left seat through a reflective virtual image color display system.

CHARACTERISTICS

TERRAIN MODEL 60 FT. x 24 FT.

DUAL SCALED 1500/1 AND 750/1

SIX DEGREES OF FREEDOM

RGB COLOR CAMERA

FIELD OF VIEW 48^{O} H BY 36^{O} V

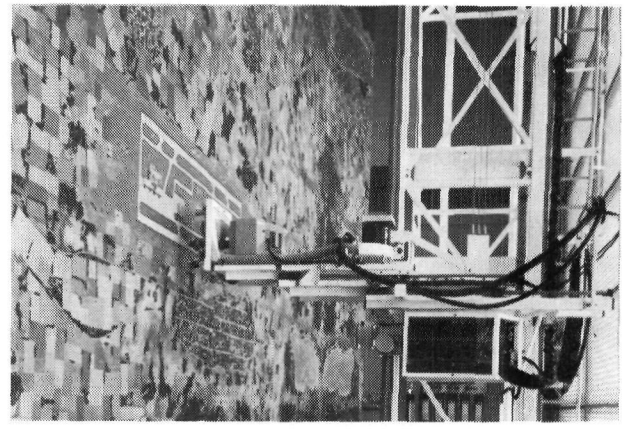
CTOL, STOL AND VTOL LANDING AREAS

BOTH VFR AND IFR SIMULATION

DAYLIGHT,DUSK, DARK DISPLAYS

VISUAL LANDING DISPLAY SYSTEM

1500:1 AIRPORT



SIMULATION SUPPORT CAPABILITIES

VISUAL MOTION SIMULATOR

GENERAL AVIATION AIRCRAFT SIMULATOR

G.P. FIXED BASE SIMULATOR

TRANSPORT SIMULATOR

DIFFERENTIAL MANEUVERING SIMULATOR

TERMINAL CONFIGURED VEHICLE SIMULATOR

GRAPHICS DISPLAY SYSTEM

The Graphics Display System at Langley Research Center consists of two identical Adage Graphics Terminals (AGT). Each terminal has four display CRT's. Three of the four scopes are interfaced with television cameras to provide simulation cockpit displays via a television distribution system. The fourth CRT is used as a monitor at the AGT control console.

Each terminal is also connected to a CDC CYBER 175 Computer through a digital interface providing the capability of driving displays with variables from a digital simulation. The systems were designed to operate in real-time, non-real-time (batch), and a stand-alone mode. In the real-time mode, the AGT receives data in time synchronization with the real-time simulation program being run on the CYBER 175 Computer. A maximum of 512 words each iteration (or frame time) can be transferred to the AGT from the CDC CYBER 175.

In the non-real-time mode, files can be transferred in either direction, but not at the same time, i.e., the interface is half-duplex. Files can vary from a short message (a few words) to very large files.

SIMULATOR APPLICATIONS

The Graphics Display System can be superimposed on the VLDS or GPTIG scenes or displayed alone on any of the cockpit visual displays as well as any CRT display. Applications to date have been:

VISUAL MOTION SIMULATOR – Can be displayed as either a heads-up or heads-down display mixed with other video sources.

GENERAL AVIATION AIRCRAFT SIMULATOR – A simplified heads-up display superimposed on the VLDS display.

DIFFERENTIAL MANEUVERING SIMULATOR – An electronic ADI on the heads-up display with tracers for gun fire.

GENERAL PURPOSE FIXED BASE SIMULATOR – An electronic flight director cockpit display as well as cargo/cable configuration superimposed on the VLDS scene.

T.C.V. SIMULATOR – An electronic ADI as well as moving map displays, flight paths, and terminal area traffic pattern displayed on cockpit CRT's.

CHARACTERISTICS

512 WORDS/ITERATION TRANSFER FROM CENTRAL COMPUTER IN REAL-TIME

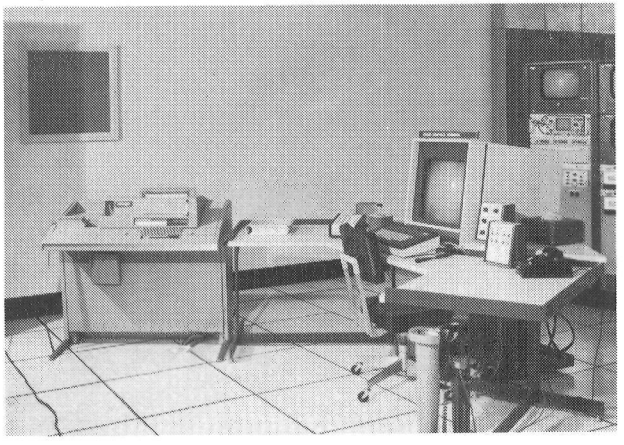
MONOCHROME DISPLAY FOR OPERATOR

3 GRAPHIC-TO-VIDEO CONVERTERS PER SYSTEM

COLOR CAPABILITY FOR COCKPIT DISPLAYS

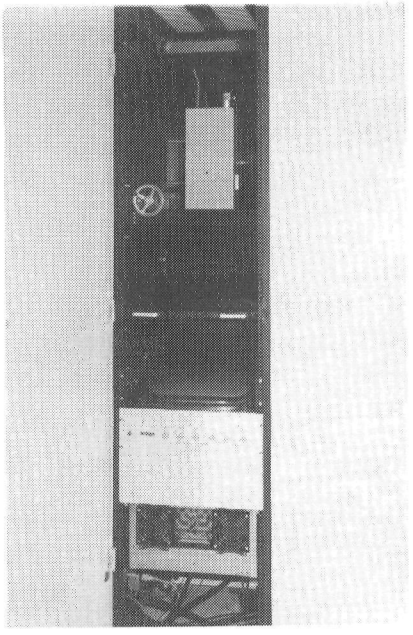
REAL-TIME OR NON-REAL TIME OPERATION

VIDEO MIXING OF DISPLAY SOURCES



ADAGE GRAPHICS TERMINAL

GRAPHICS TO VIDEO CONVERTER



SIMULATOR SUPPORT CAPABILITIES

TERMINAL CONFIGURED VEHICLE

DIFFERENTIAL MANUEVERING SIMULATOR

GENERAL AVIATION SIMULATOR

TRANSPORT SIMULATOR

VISUAL MOTION SIMULATOR

GENERAL PURPOSE FIXED BASE