

Aviation Safety Program



Synthetic Vision Systems

Dan Baize, Project Manager

SVS EGE Pre-Flight Briefing

August/September, 2001

**FINAL REPORT
TO
PRESIDENT CLINTON**

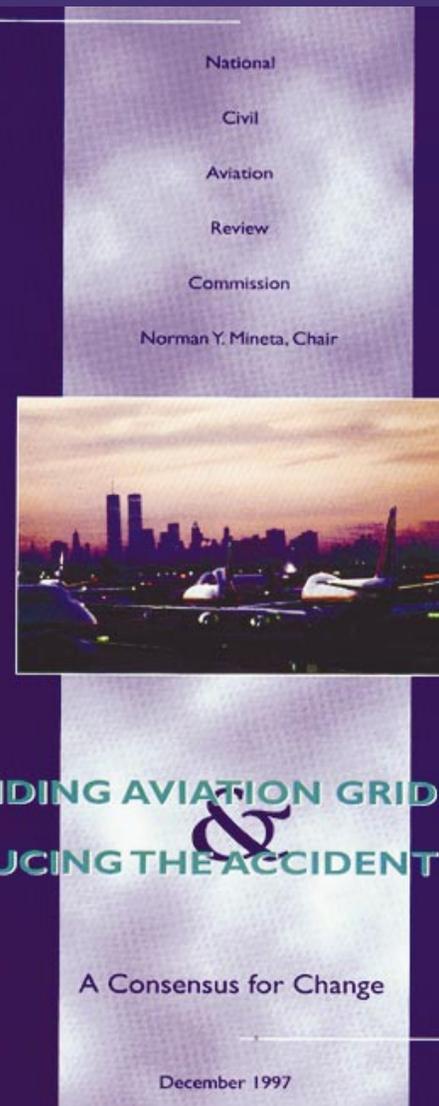


**White House Commission on
Aviation Safety and Security**



VICE PRESIDENT AL GORE, CHAIRMAN

FEBRUARY 12, 1997



“We will achieve a national goal of reducing the fatal aircraft accident rate by 80% within 10 years.”

President William J. Clinton, February 12, 1997



NASA Aviation Safety Program

Aviation Safety Program: Synthetic Vision Systems

Improving on Excellence - Enabling safer air travel throughout the world

Goal

Develop and demonstrate technologies that contribute to a reduction in the aviation fatal accident rate by a factor of 5 by year 2007 and by a factor of 10 by year 2022

Objectives

Eliminate Targeted Accident Categories

Strengthen Safety Technology Foundation

Increase Accident Survivability

Accelerate System Implementation to All Users & Vehicle Classes

Challenges

Determining Common "Addressable" Accident Precursors

Assuring Affordable & Implementable Solutions

Teaming with FAA Divisions/ Industry/Operators on Coordinated National & International Efforts

Approach

Teamed In-Depth Analysis of Safety Data

Systematically Formulate High-Payoff Interventions

Define Projects that Accelerate TRL/IRL

Forecast, Track, & Monitor System Impacts

Projects

Aviation System Monitoring & Modeling

System-Wide Accident Prevention

Single Aircraft Accident Prevention

Weather Accident Prevention

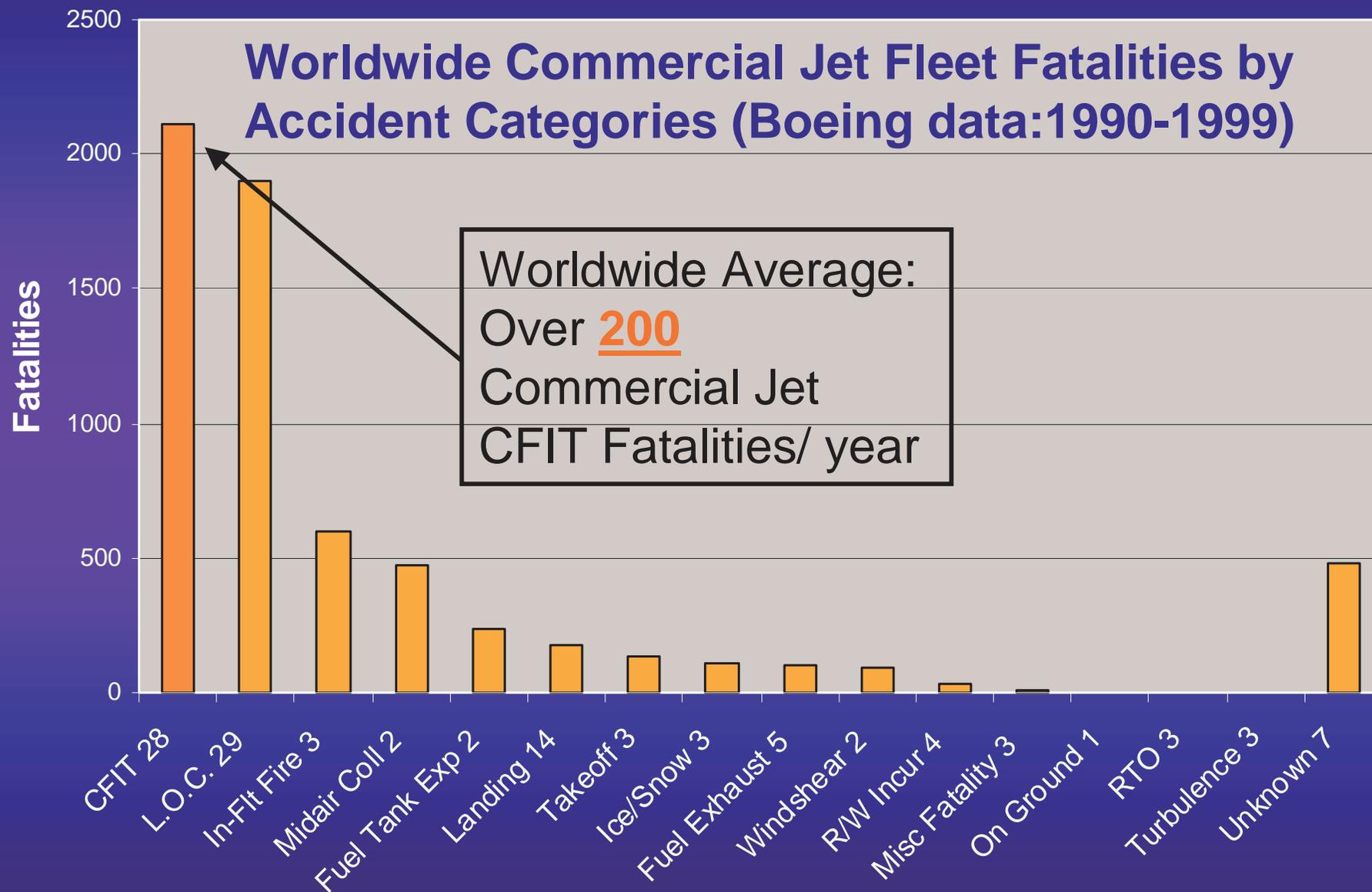
Synthetic Vision Systems

Accident Mitigation



CFIT- the #1 Killer in Commercial Aviation

Aviation Safety Program: Synthetic Vision Systems



Categories & Number of Fatal Accidents



CFIT – Recent Example

Aviation Safety Program: Synthetic Vision Systems



4/19/2000: The pilot of Air Philippines flight 541 reported **poor visibility** **minutes before the plane crashed**, killing all 131 people aboard.



CFIT, a Fatal Loss of Situation Awareness

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National Transportation Safety Board (NTSB) Update

3/29/01 crash of a chartered Gulfstream III (N303GA) @
Aspen Pitkin Airport, CO that killed all 18 aboard

- The crew of N303GA asked the tower if the lights were all the way up; the tower responded that they were, and on high
- When the tower asked N303GA if they had the runway in sight, the crew responded affirmatively
- At approximately twelve seconds prior to the end of the recording an electronic voice called "sink rate"
- Shortly after the 200-foot call out, there was an electronic voice call out of "bank angle" and the recording ended
- The recording did not appear to contain evidence of aircraft malfunction



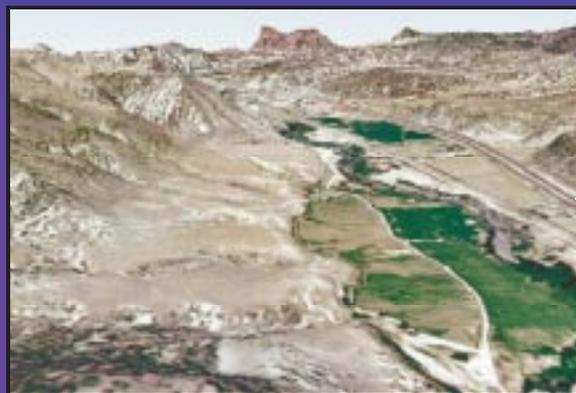
Visibility dropped from 10 miles to less than 2 miles in about 20 minutes just before the plane went down



The Complete Solution: Synthetic Vision

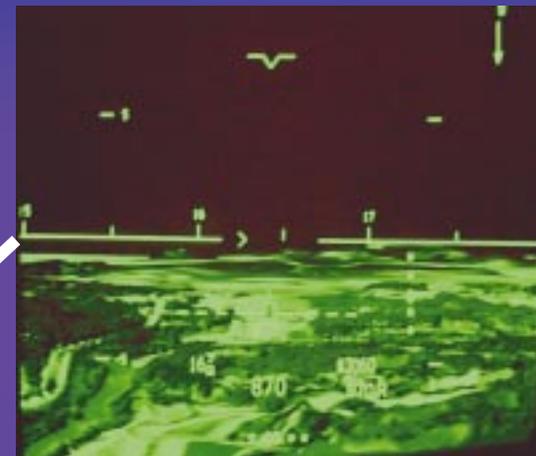
Aviation Safety Program: Synthetic Vision Systems

A database derived system utilizing precise GPS navigation & integrity-monitoring sensors (as required) to provide a unrestricted synthetic view of the aircraft's current external environment, regardless of weather or time of day



Worldwide Terrain, Obstacle & Airport Databases

INS / GPS
(LAAS/ WAAS)



Advanced Sensors for Database Integrity & Object Detection

Real-time tactical hazards (Weather, NOTAMS)



Real-time Synthetic Vision Display w/ Advanced Guidance

Relevant Traffic Information (ADS-B, TIS-B)



Synthetic Vision: A Technology Solution

Aviation Safety Program: Synthetic Vision Systems

Synthetic Vision Systems Goal: Eliminate Low-Visibility Induced Incidents and Accidents:

- **Controlled Flight Into Terrain (CFIT)**
- **Approach & Landing Errors**
- **GA Low-Visibility LOC**
- **Runway Incursions**



Through the introduction of advanced flight deck technologies which increase airborne & surface situation awareness:

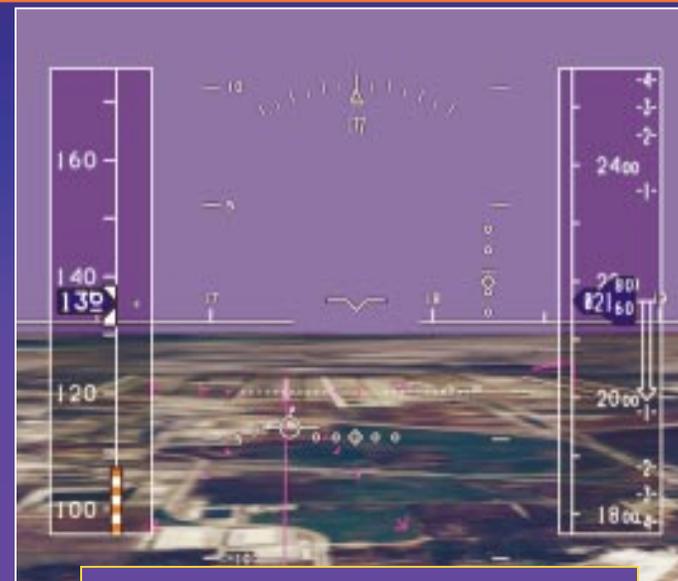
- **Vertical and Lateral Spatial Awareness** (know where you are)
- **Approved & Escape Path Awareness** (know where you need to go)
- **Terrain, Obstacle, Cooperative and Uncooperative Traffic, Weather Hazard Awareness** (know where the threats are)



Previous SVS Flight Test Findings (DFW)

Aviation Safety Program: Synthetic Vision Systems

- September/October 2000 @ DFW
 - 6 evaluation pilots
 - 76 approaches
 - 17.5 research flight hours
- Synthetic Vision appears to be viable & effective
 - All pilots acknowledged the enhanced situational awareness
- NASA opaque HUD concept appears feasible
 - Only night operations tested
 - Pilots liked the immersive feel of the HUD
- Rockwell-Collins (NASA cooperative research partner) concept effective, fairly mature



Size X HDD / Photo-Texturing



HUD / Generic-Texturing



Current Flight Test Purpose (EGE)

Aviation Safety Program: Synthetic Vision Systems

Evaluate Synthetic Vision display concepts in an operationally realistic, terrain-challenged environment

- 6 planned evaluation pilots
- Over 70 approaches expected
- Over 40 research flight hours planned

Runway 25



Runway 7



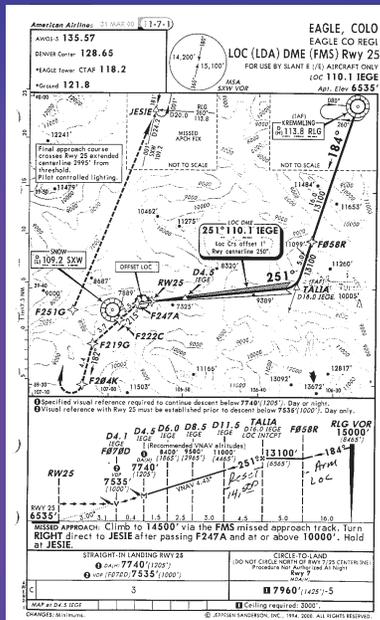
You are flying on a Research flight, not a dedicated Demo



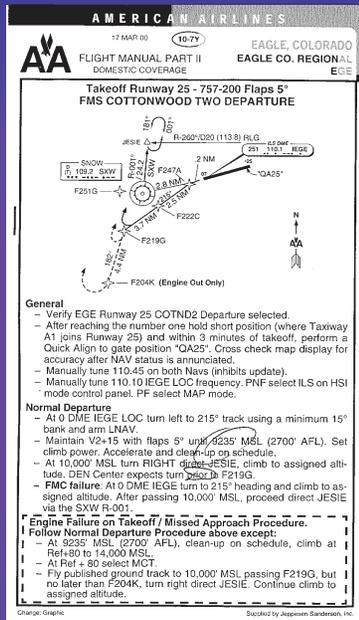
American Airlines App & Dep Procedures

Aviation Safety Program: Synthetic Vision Systems

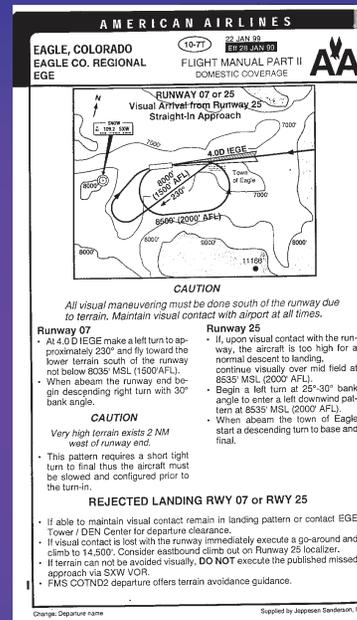
FMS 25 Approach (EGE LDA25)



Rnwy 25 Departure (EGE Cottonwood-2)



Circle-to-Land 7 (EGE Rnwy 7 Visual Landing)



Rnwy 07 Departure (EGE Kremm Departure)



Wx minimums for SVS-EGE: 6000 / 5
Wind restrictions will also apply



EGE Runway 25

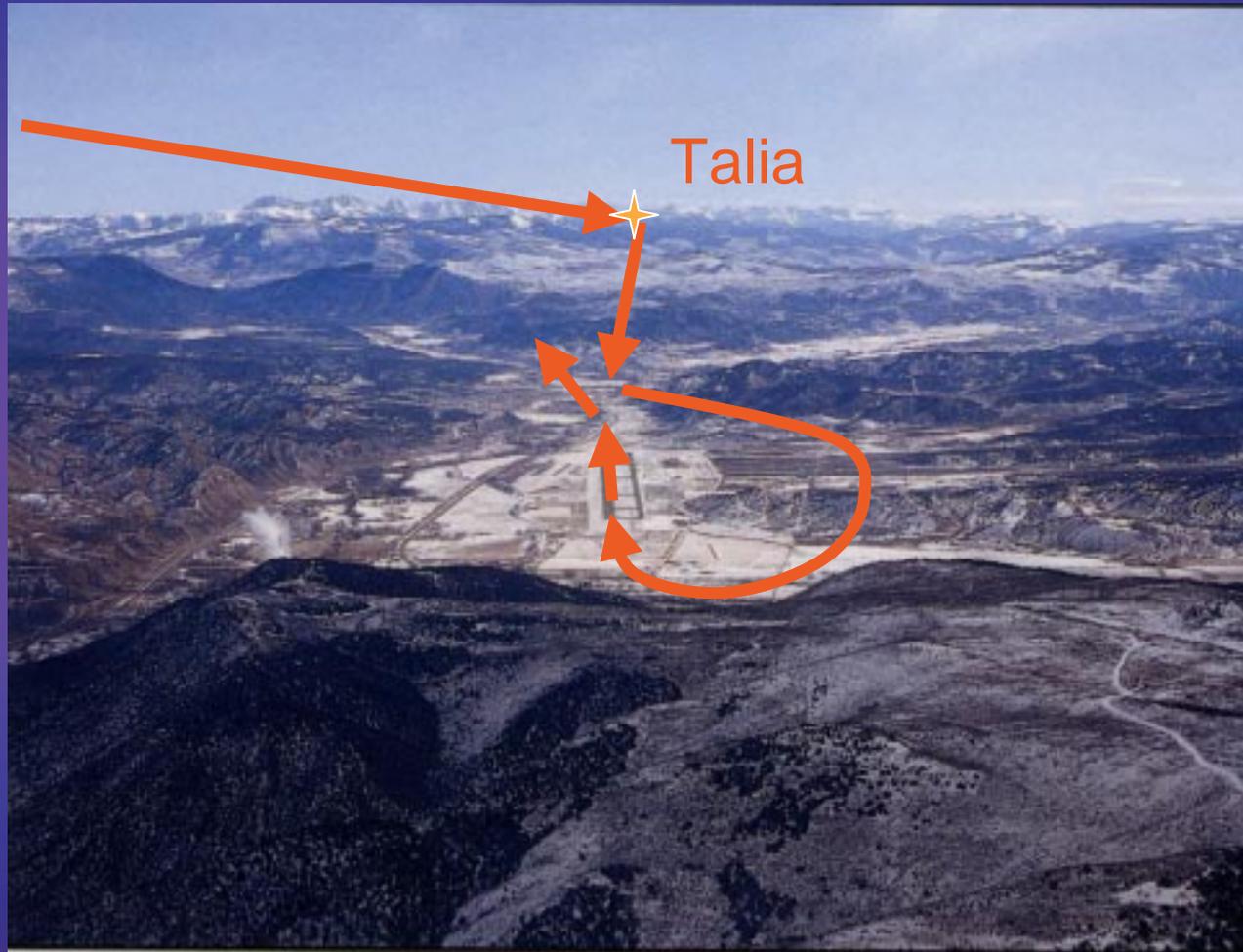
Aviation Safety Program: Synthetic Vision Systems





EGE Runway 7

Aviation Safety Program: Synthetic Vision Systems



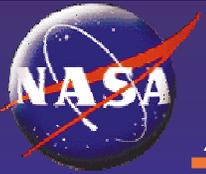


SVS Experimental Equipment on ARIES

Aviation Safety Program: Synthetic Vision Systems

- **Two Dedicated SVS Pallets**
 - NASA SVDC (Row 4)
 - Rockwell-Collins SVIS (Row 3)
- **HGS-4000 HUD**
 - Vision Restriction Capability for Simulated IMC
 - HUD Video Camera
- **SV Research Display**
 - 18.1 inch 1280x1024 Flat Panel
- **Subject Pilots**
 - Current 757 Captains from: American, United, Delta, FAA, Boeing, and NASA
 - EGE-Experience
 - HUD-Experience
 - Trained @ LaRC Simulators





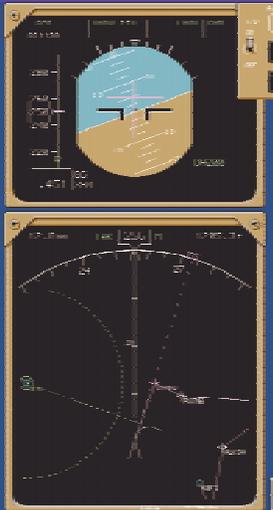
NASA Head-down SVS Concepts

Aviation Safety Program: Synthetic Vision Systems

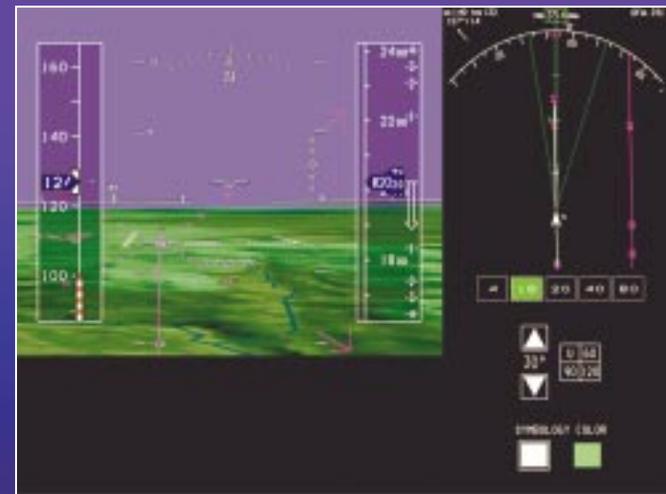
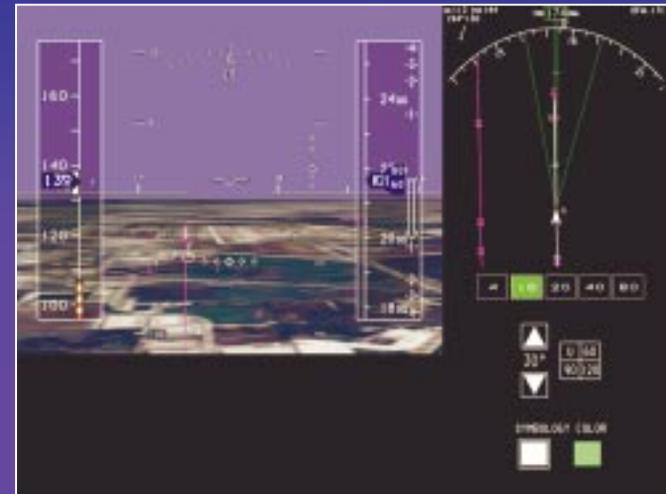
Size A/B

Size-X

Photo-realistic



Baseline



Generic Texturing

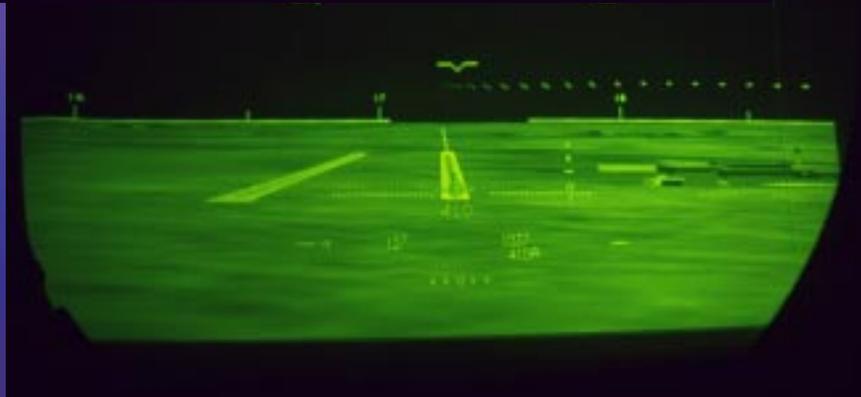
Pilot selectable field of view on all display sizes



NASA Head-up SVS Concepts

Aviation Safety Program: Synthetic Vision Systems

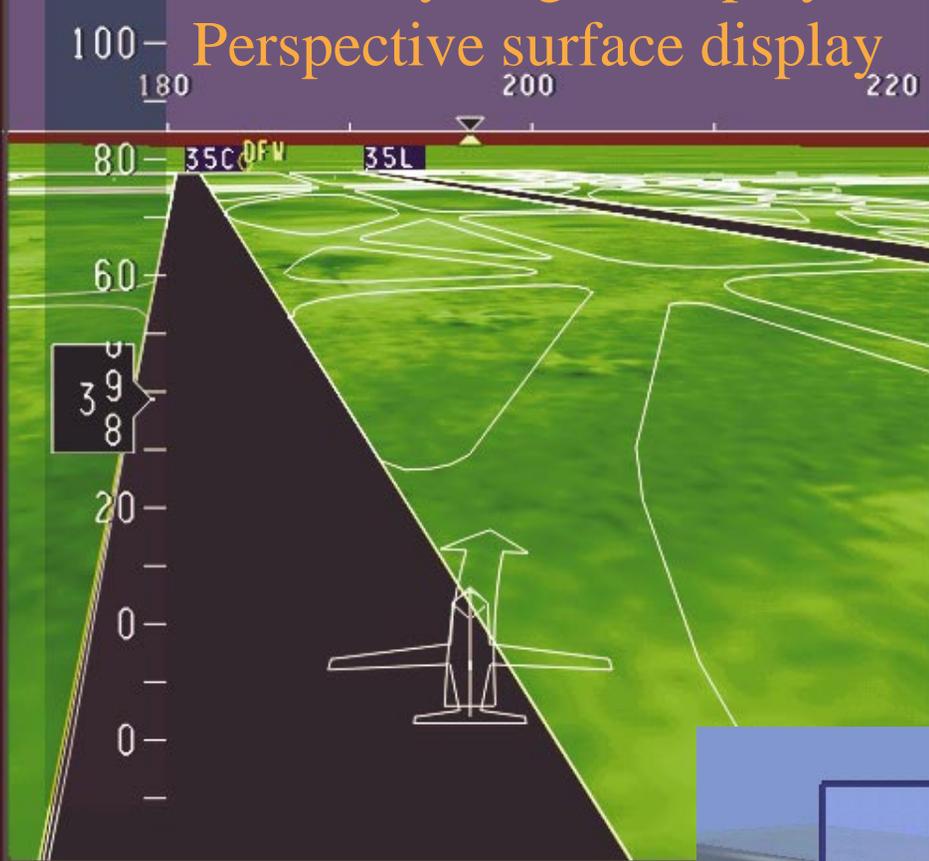
NASA Photo-Realistic HUD Concept



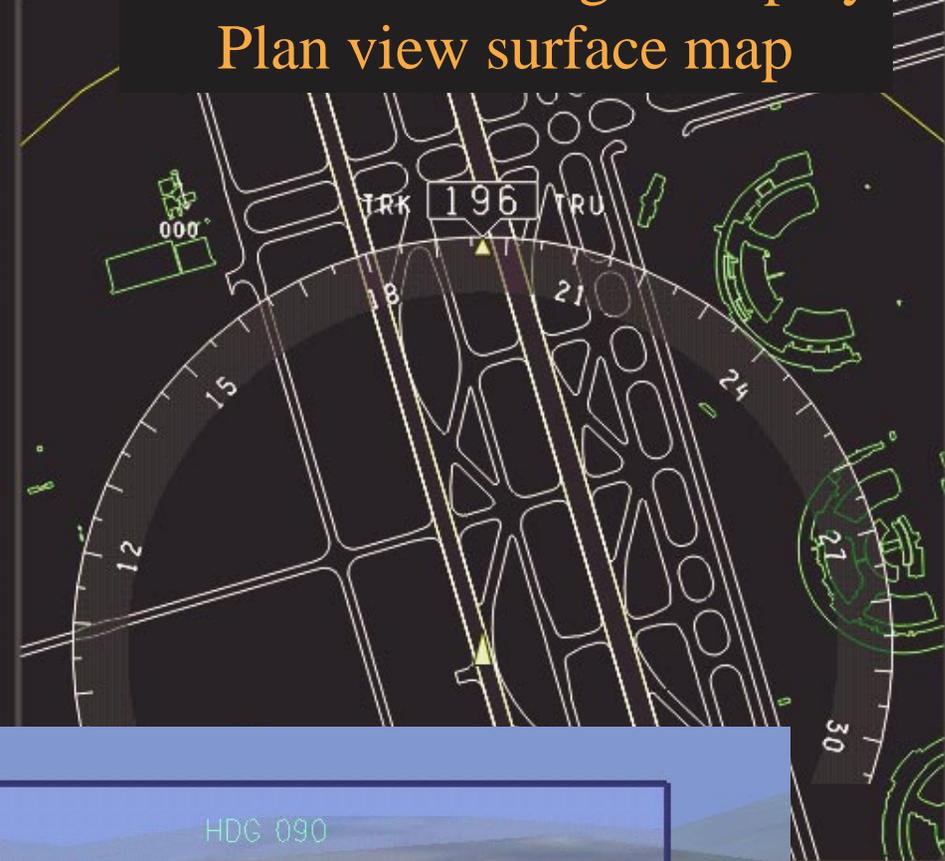
NASA Generic Texture HUD Concept

- **Unconventional HUD Concept**
 - Opaque, Computer-generated Terrain Scene With Symbology Overlay
 - Clear, See-Thru Sky
 - Declutter Switch Available to Remove Terrain Scene
 - Lowest cost analog-cockpit retrofit solution
- **Evaluating 2 Terrain Texturing Techniques**
 - Generic
 - Photo-Realistic

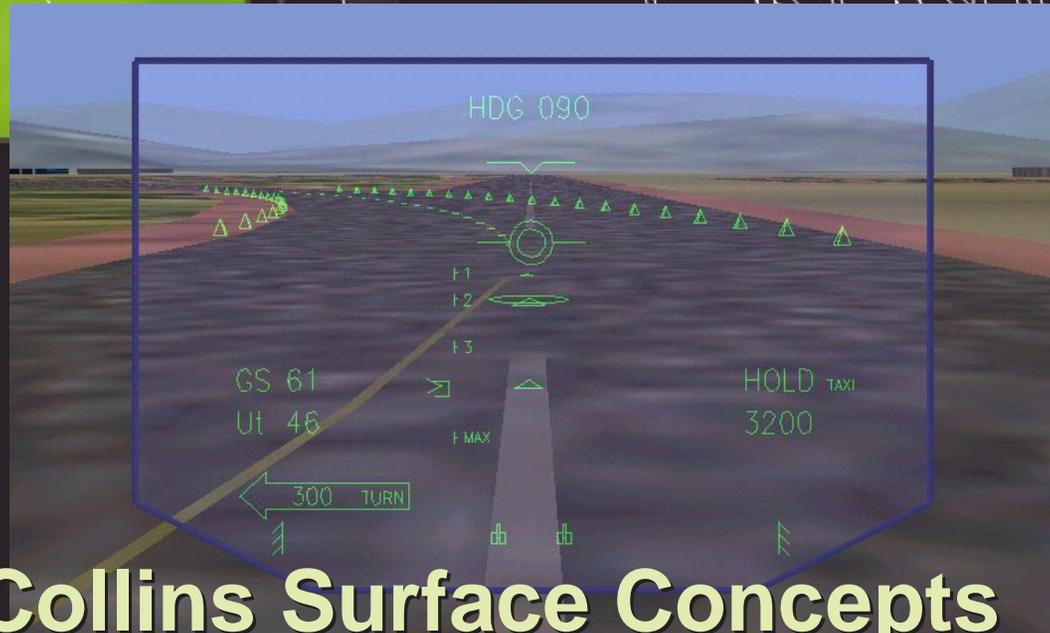
Primary Flight Display Perspective surface display



Multifunction Flight Display Plan view surface map



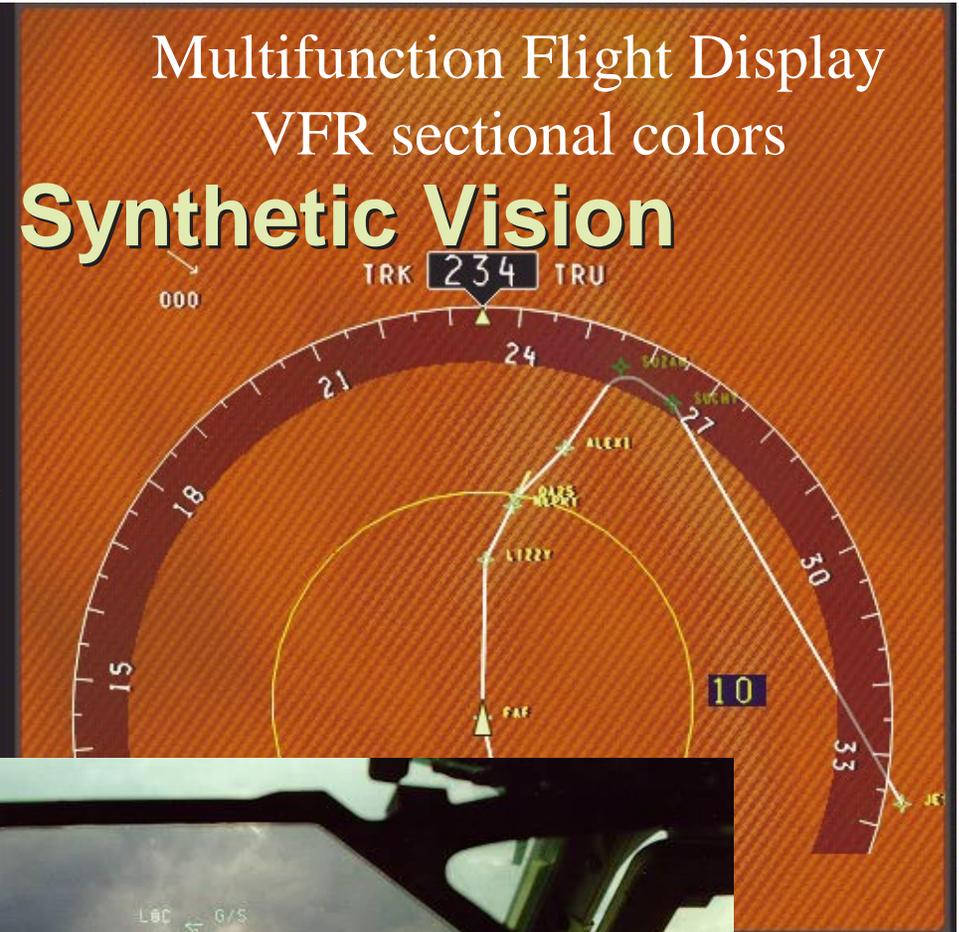
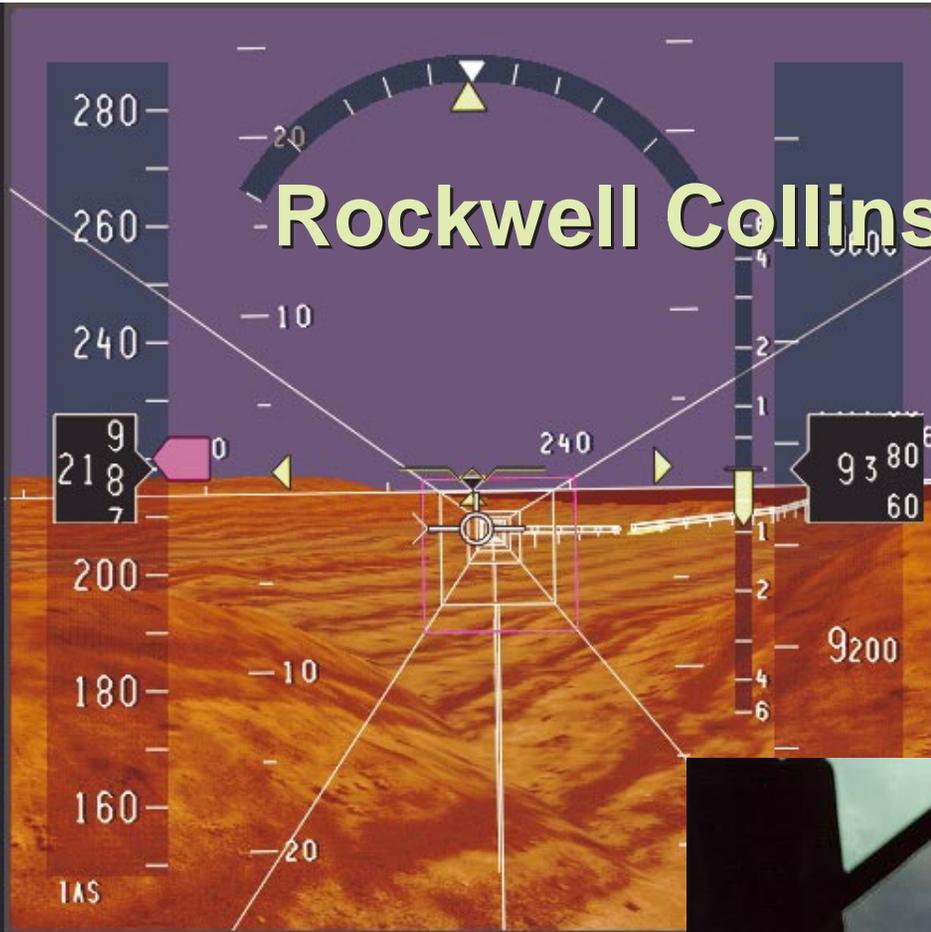
Head-up Display Surface Guidance Display



Rockwell Collins Surface Concepts

Multifunction Flight Display VFR sectional colors

Rockwell Collins Synthetic Vision



Primary Flight Display
approach to Eagle Valley

Head-up Display
wire-frame terrain





Active SVS Participants, a Partial List

Aviation Safety Program: Synthetic Vision Systems

Synthetic Vision

- Rockwell Collins
- BAE Systems
- Honeywell (Bendix/King Apex)
- Universal Avionics- Vision I
- Avrotec
- RTI/ Archangel
- Garmin
- Sierra Flight Systems
EFIS-2000
- BF Goodrich (SmartDeck)
- Avidyne
- Boeing MV-22 & Sonic Cruiser?
- Airbus A380
- Stanford
- FAA Capstone

Enhanced Vision

- Gulfstream
- Fed Ex
- RTI West
- Boeing C-17
- BAE Systems

Taxi Map/ RI Prevention

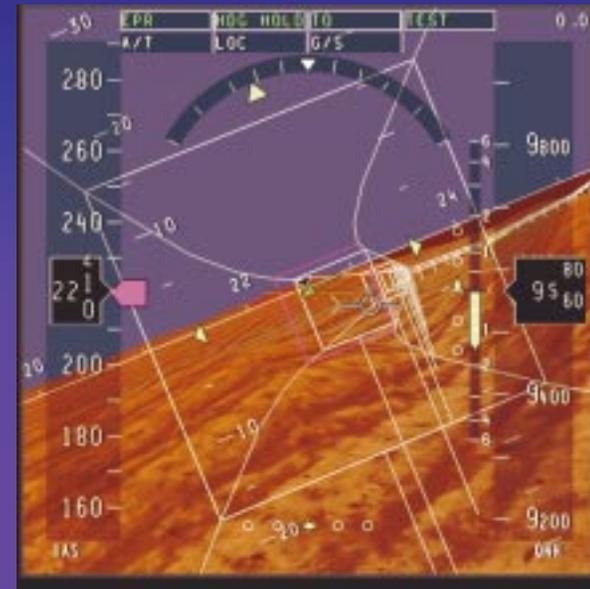
- FAA Safe Flight 21
- Rockwell Collins
- Flight Dynamics (SGS)
- UPS-AT (II Morrow)
- Rannoch



Synthetic Vision Systems Summary

Aviation Safety Program: Synthetic Vision Systems

- NASA's Aviation Safety Program targets and eliminates fatal accident precursors
- SVS eliminates the #1 NAS safety hazard & operational restriction --- limited visibility
- SVS utilizes integrated flight-critical databases & integrity monitoring sensors (radar/FLIR) as required by application
- 1st ever photo-realistic SVS concepts successfully flown at AVL, DFW, & EGE
- Expected Results:
 - Synthetic Vision provides improved path control and situation awareness in terrain-challenged airport operating areas
 - Retrofit of Synthetic Vision into glass and non-glass cockpits is viable and will provide safety and performance Benefits
 - SVS will fundamentally change the way the world flies





“Pilots take no special joy in walking.

Aviation Safety Program: Synthetic Vision Systems

Pilots like flying.” Neil Armstrong

- Obtain and don flight suit
- Meet outside the lobby at 7:00 am
- 4 ½ hour flight possible
 - 30 minute ferry time to and from EGE
 - 8 research approaches
- Turbulence is very likely
- Questions are encouraged
- Have a great, safe flight