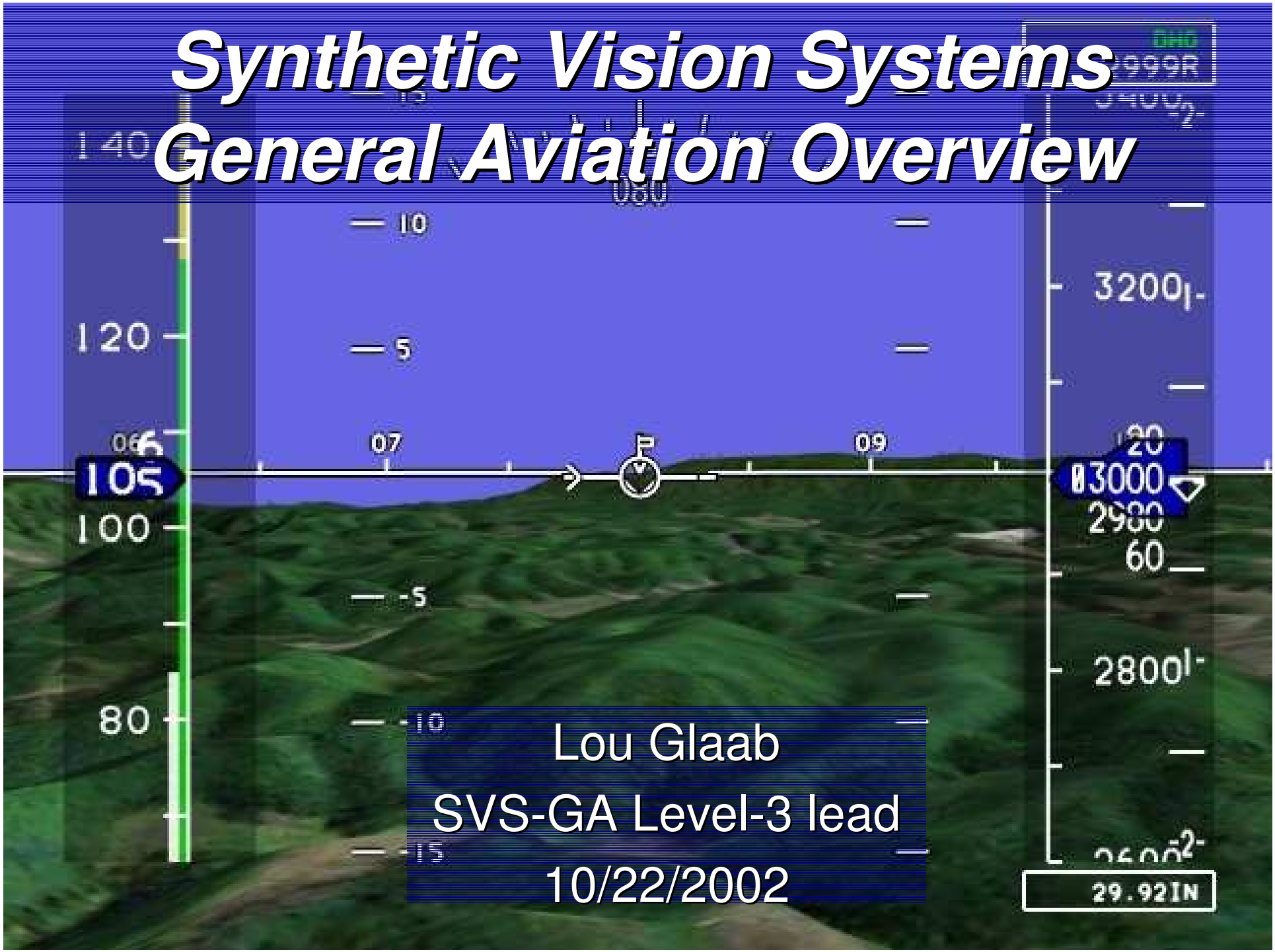
Synthetic Vision Systems
General Aviation Overview



Lou Glaab
SVS-GA Level-3 lead
10/22/2002

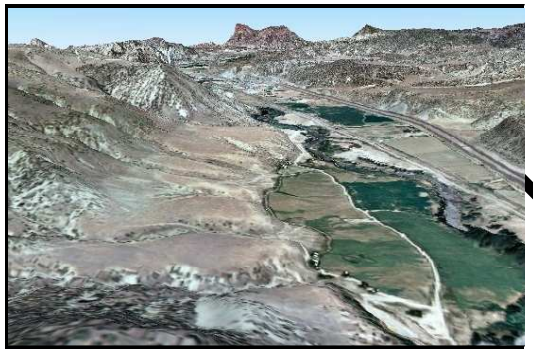
Outline

- AvSP/SVS-GA Goals and Objectives
- Synthetic Vision Systems definition
- SVS project overview
- General Aviation focus
- Major NASA LaRC SVS-GA experiments
- Facilities
- Outside involvements
  - Cooperative Research Agreements (CRAs)
  - FAA Capstone-II
  - University grants
- Summary

AvSP/SVS-GA Goals and Objectives

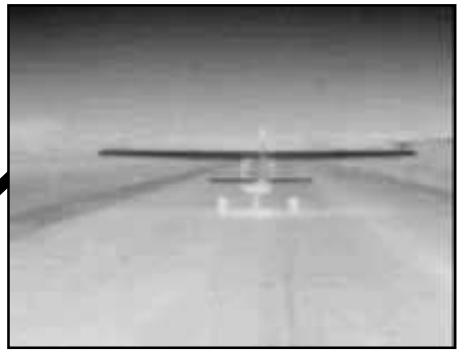
- The Aviation Safety Program (AvSP) is striving to reduce frequency of fatal accidents
- In support of this, SVS-GA is developing technology to:
    1. Provide the pilot an unobstructed view of terrain, regardless of weather and/or time of day
        - Enhance pilot's situation awareness
        - Reduce Controlled Flight Into Terrain (CFIT) occurrences
        - Reduce low visibility loss of control (LVLOC) events
    2. Integrate advanced symbology
        - Dramatically increase pilot performance
        - Maintain or decrease pilot workload

Synthetic Vision *System*



Worldwide Terrain, Obstacle & Airport Databases

Accurate Position and Orientation



Advanced Sensors for Database Integrity & Object Detection

Real-time Synthetic Vision Display w/ Advanced Guidance

Real-time tactical hazards (Weather, NOTAMS)

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

SVS Project Overview

- SVS Project is composed of 3 elements
  - Commercial and Business Aircraft (SVS-CaB)
  - Enabling Technologies (SVS-ET)
  - General Aviation (SVS-GA)
- SVS-CAB
  - Focuses on issues particular to large jet transport aircraft
  - More expensive sensor augmented systems
- SVS-ET
  - Focuses on supporting technologies for SVS
  - Terrain and obstacle database development
  - Terrain database verification and monitoring
- SVS-GA
  - Focuses on the particular needs and applications to GA aircraft
  - SVS core technology development

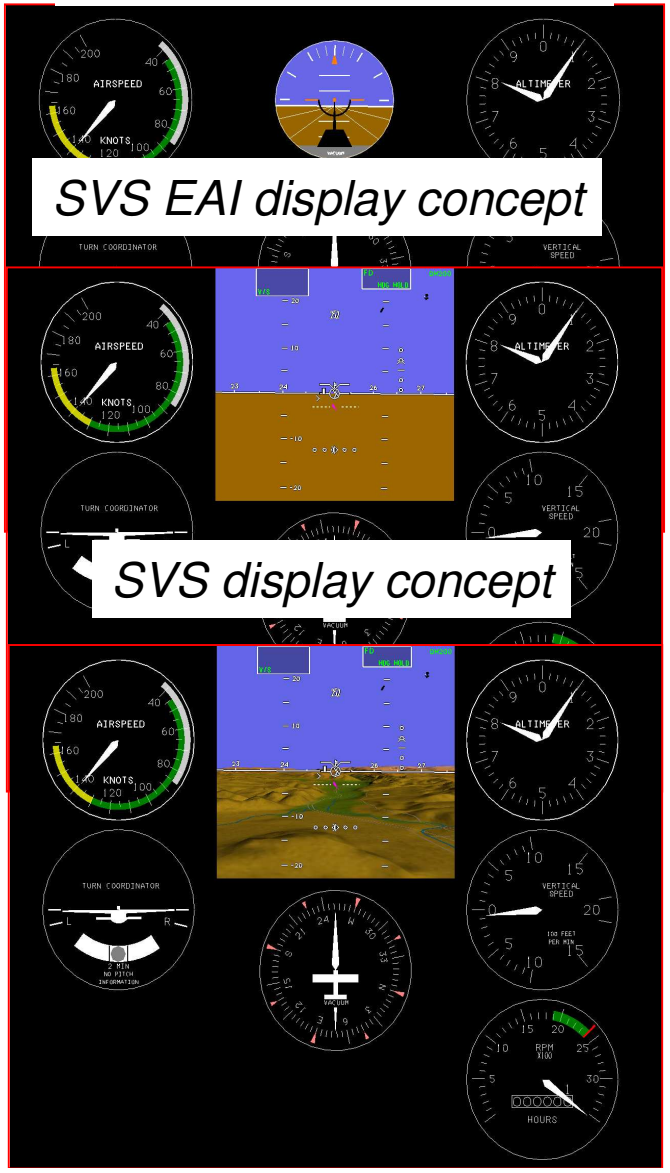
SVS-GA Focus

- Low Cost
  - Potentially no Sensors (outside of ADAHRS)
  - Potentially no HUD applications
- Variable pilot background and capabilities
- Employ existing strategic terrain displays primarily
- CFIT and LVLOC prevention
- Inadvertent IMC operations
- Different buyer motivations
  - General appeal
  - Concerned with personal safety

Low Visibility Loss of Control experiment

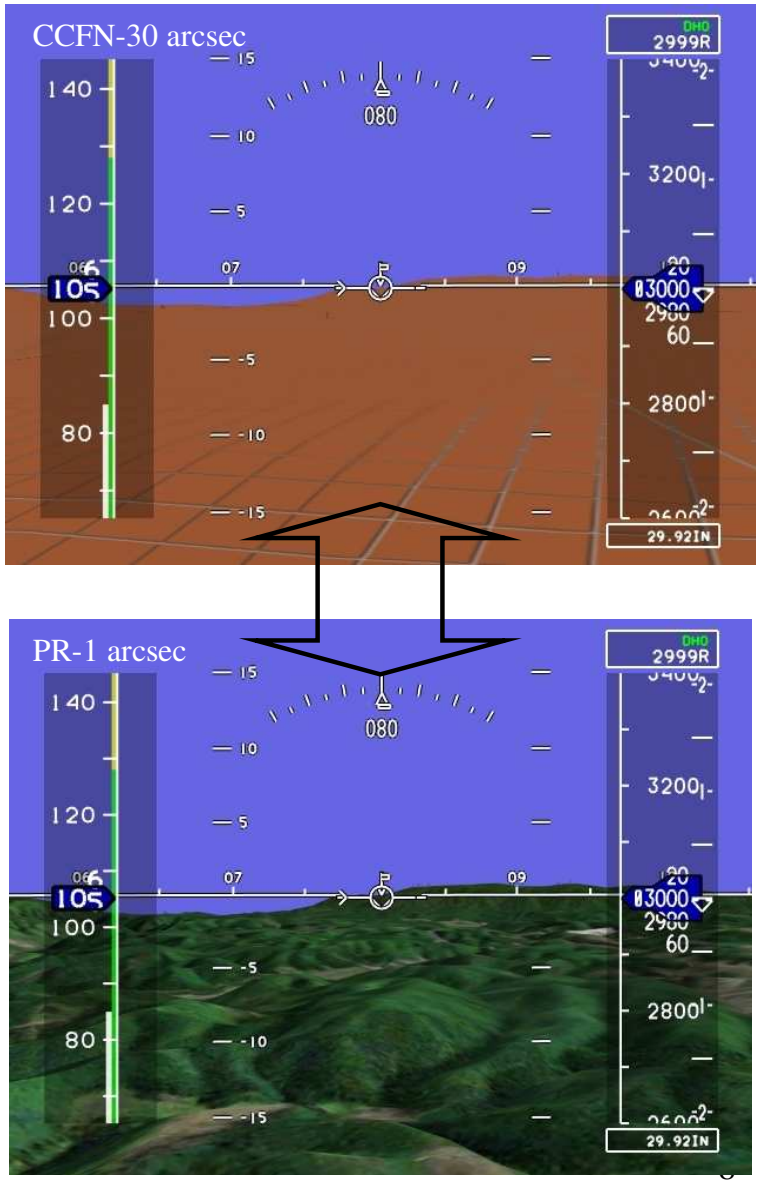
- Provided
  - Initial estimate of LVLOC prevention
  - Categorized other dangerous events as "massive loss of SA"
  - First look at situation awareness (SA) improvements and pilot performance
  - Included physiological measures
- 18 Low-time GA pilots in NASA LaRC GA Work Station (GAWS)
- General en-route maneuvers
- Employed elevation-based generically textured terrain database
- Preliminary results: SAE 2002-01-1550
- Demonstrated enhanced pilot performance and SA for SVS displays

Standard Flight Displays



Terrain Portrayal for Head Down Displays

- Establish relationship between terrain portrayal fidelity and pilot performance and SA
- TP-HDD sim (GAWS)
  - 27 pilots for the formal evaluation
  - Included 10 SVS concepts and two baseline concepts
  - En Route, approach, and rare event maneuvers
  - Advanced symbology
- TP-HDD flight (Cessna 206)
  - Was an extensive flight test
    - 15 pilots
    - 2 sites (ROA and PHF)
    - Approximately 100 hours of checkout and flight testing
  - Complemented and extended ground based testing
  - Included 7 SVS concepts and a Blue-sky/Brown-ground baseline



Subsequent Studies

- Symbology Development for Head-Down Displays (SD-HDD)
  - What is the appropriate symbology for SVS-GA?
    - Specific terrain databases
    - Various guidance symbology
  - Obstacle presentations
  - Simulation (GAWS)+Flight testing (Lancair)
  - Combined with Small Aircraft Transportation System (SATS) program
- Advanced Media/Portable Media (AM/PM)
  - What displays can be used to implement SVS in GA aircraft?
  - Displays envisioned are: Hand-held, Head-worn, Low-cost HUDs, expensive, tethered displays, cheap?
  - GAWS+Flight testing
- Strategic Display Enhancement and Integration (SD&EI)
  - Integrate traffic, weather and terrain on the strategic display
  - Incorporate updates to the baseline strategic display (MX-20) based on previous research (TP-HDD, SD-HDD)
  - Develop integrated system (SVS-PFD+MFD)
  - GAWS and Flight testing

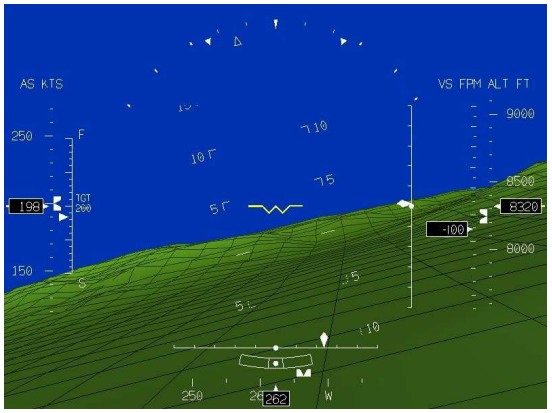
Research Facilities

- GAWS capabilities
  - Integrated Elite simulation with SVS displays
    - Enhanced data output for research purposes
    - Can simulate several aircraft
  - 40 degree FOV front visual scene
  - Modular instrument panel configuration
  - Physiological data
  - Various audio/video recording
- Cessna C-206 capabilities
  - High-capacity alternator
  - Substantial payload capabilities
  - Seagull GIA-2000 ADAHRS
  - SGI/Intergraph Zx10 research computer
  - Control/position transducers
  - MX-20 installed

SVS-GA CRAs

An Affordable, Certifiable Low End Thrust Synthetic Vision System

•Team led by **AvroTec**, Inc., Portland, OR. Members: BF Goodrich, Lancair/PAC USA, Massachusetts Institute of Technology, Raytheon Aircraft, Seagull Technologies, Inc., and FAA-Civil Aeromedical Institute.



A Low cost Synthetic vision Display System Capability for General Aviation

•Team led by **Research Triangle Institute**, Research Triangle Park, NC. Members: Archangel Systems, Inc., Flight International Inc., Seagull Technologies, Inc., Dubbs & Serverino, Inc., Crew Systems, Inc., and FLIR Systems, Inc.

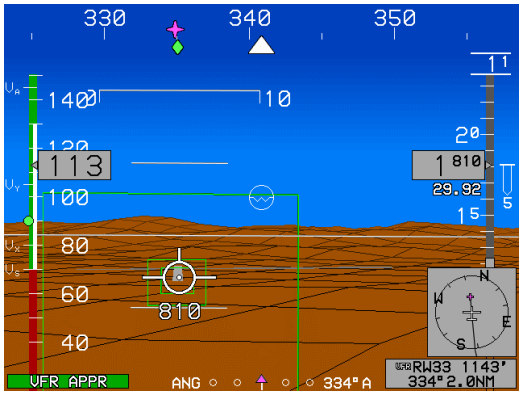
Low-cost Attitude and Heading Reference System (AHRS) to Enable Synthetic Vision

•Team led by **Seagull Technology Inc.**, Los Gatos, CA. Members:Dynamatt, BARTA, S-Tec Unmanned Technologies, Inc., Reichel Technology; Rockwell Collins, Inc., Cedar Rapids, Iowa; Stanford University, Stanford, California; Raytheon Aircraft, Wichita, KS

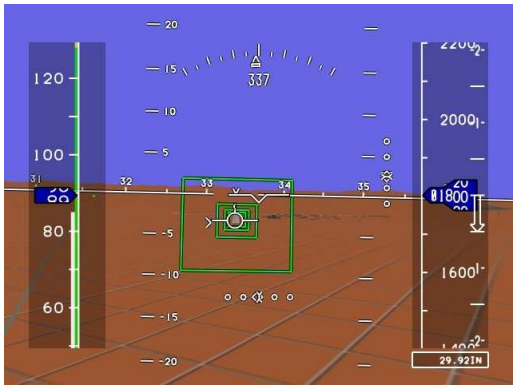
Capstone Support

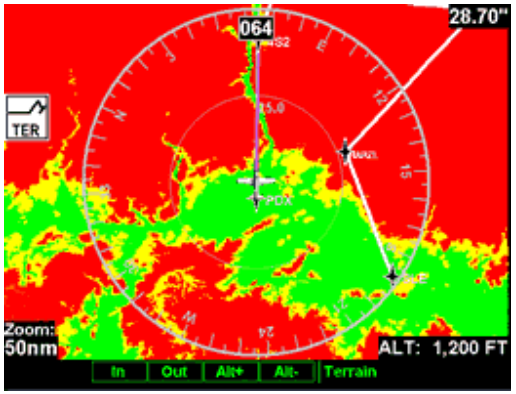
- Planning on equipping up to 200 aircraft at Juneau, AK
- Helped write the Request for Proposal
- Participated in the Source Selection activity
- Provided informal technical transfer
  - Phone calls
  - Use of FAA personnel as research pilots (sim/flight)
- Included Chelton style terrain portrayal and tunnel in TP-HDD
- Evaluated tunnel on/off for Chelton concept in TP-HDD

Chelton SVS PFD and MFD



NASA SVS PFD with UPSAT MX-20 MFD



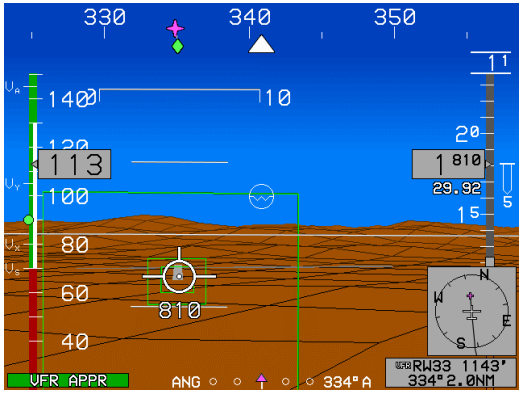


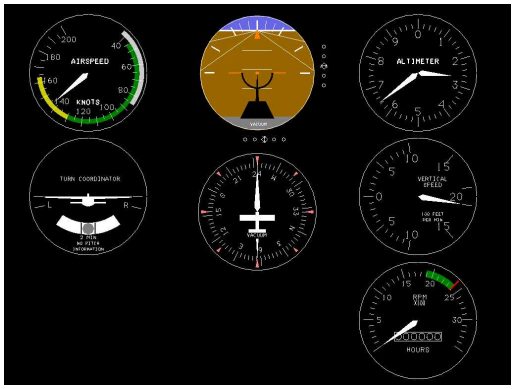
University Grants

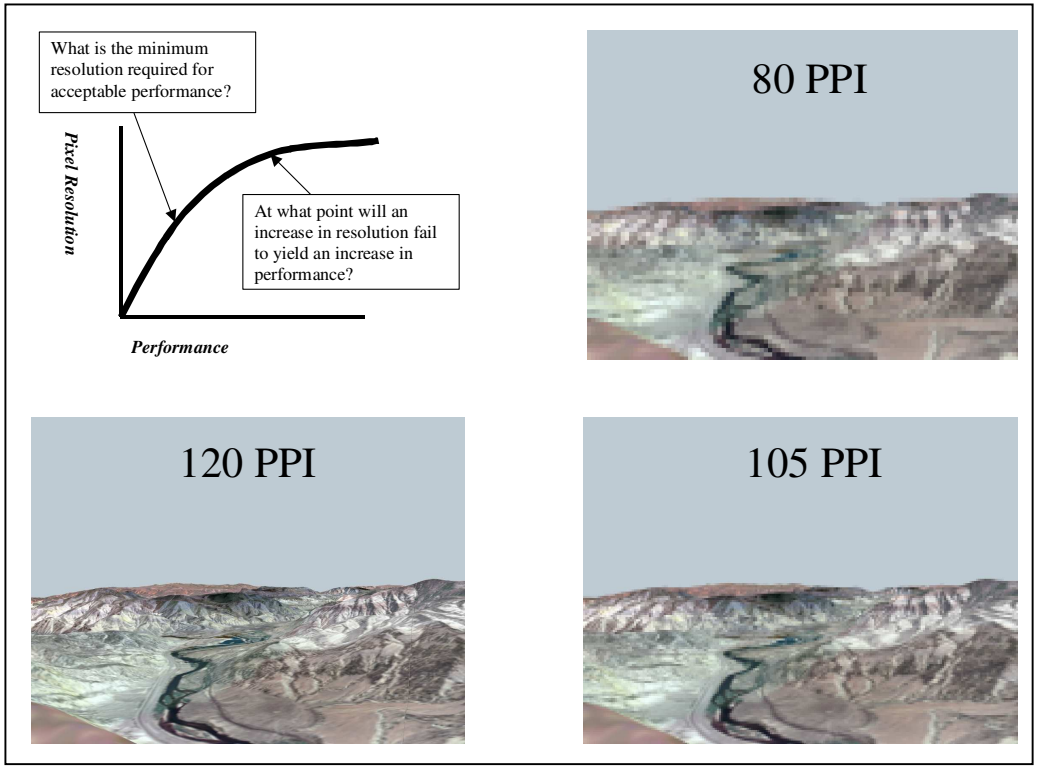
Aviation Safety Program: Synthetic Vision Systems – General Aviation

- Embry Riddle Aeronautical University (Dr. Dick Newman)
  - *Title: Training and Transition with Advanced Displays*
  - Will install Chelton Capstone-2 equipment in ERAU Cessna-172
  - Will train 12 Private Pilots to fly to instrument standards with SVS display
  - Cross-train control group to fly SVS
  - Cross-train experimental group to fly standard gauges
- University of Iowa (Dr. Tom Schnell)
  - *Title: Synthetic Vision Displays: Optimal Display Characteristics*
  - Independent variables include:
    - Field of View (FOV)
    - Display resolution
    - Terrain texture
    - Terrain database resolution
    - Terrain type (hilly/mountainous)
    - Aircraft altitude
  - Static and dynamic evaluations
  - Endeavors to identify maximum useful FOVs and display resolutions

Chelton SVS vs. Conventional Instruments







Concluding Remarks

Motivation for the SVS-GA/FAA workshop

- Present data from completed studies
  - LVLOC
  - TP-HDD sim
- Provide status of current research
  - TP-HDD flight
- Facilitate technology transfer to/from NASA
- Stimulate discussion regarding certification of SVS displays
- Identify issues for future research activities