Synthetic & Enhanced Vision – Operational Benefits, Affordability and Availability

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Overview

- Instrument Flying in the Past
- Where we are Today
- The Changing Environment
- Enhanced Flight Vision System
- Synthetic Vision System
- Affordability and Availability
- Performance Measures
- Summary
- Questions
Blind Flying Goals of 1926

Guggenheim Foundation for Aeronautical Research – Study Directives:

• “The dissipation of fog”
• “The development of means whereby flying fields may be located from the air regardless of fog”
• “The development of instruments to show accurately the height of airplanes above the ground”
• “Improvement and perfection of instruments allowing airplanes to fly properly in fog”
• “Penetration of fog by light rays”

James Doolittle and the First Blind Flying Cockpit of 1929
Today’s CATII And CATIII Infrastructure

- Airport Light Structures
- Transmissometers at touchdown, mid field and rollout
- Surveyed Approach and Missed Approach Terrain
- Safety areas
- Guidance monitoring and integrity
- Specified runway dimensions, markings

Highly Effective, Reliable and Safe, But Costly to Maintain – Limited to Major Airports
Considerations for Enhanced and Synthetic Vision Systems

- Business Aviation Aircraft Require Flexibility and World Wide Access
- World Wide Airport Infrastructure is not CATIII
- Guidance Based Systems requires CATIII light structure
- Aircraft System Certification Extensive
- Crew Training Required Every 6 Months

A Simpler Approach was Required
The Coming Airspace

- USA’s Next Gen, New Airspace Design
  - A 20 year initiative to modernize the US Air Transportation System
  - Identified the development of Eight Key Capabilities, one being *Equivalent Visual Operations*

- Goal is to reduce airport infrastructure and increase access to airports

- Equipment will make a difference in access by users to airports

- The Challenge:
  - Development of vision based technologies that can be certified, are affordable and effective
Enhanced Flight Visibility System (EFVS) Definitions and Operations

- FAA EFVS Definition (FAR Part 1) _An electronic means_ to provide a display of the forward external scene topography _through the use of imaging sensors_, such as a forward looking infrared, millimeter wave radiometry, millimeter wave radar, and low light level image intensifying sensor.

- Operational Capability -- FAR 91.175 (l), (2)
  - “The pilot determines that the enhanced flight visibility observed by use of a certified enhanced flight vision system is not less than the visibility prescribed in the standard instrument approach procedure being used”

Lower Minimums Effectively Achieved

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Gulfstream’s Enhanced Vision System (EVS)

- Head-Up Display (HUD)
  - Displays flight guidance symbology
  - Synthetic runway displayed on ILS approaches
- EVS Sensor – Supplied by Kollsman
  - Cryo-cooled Infrared device
- EVS Image Superimposed on HUD
  - Image is conformal to outside environment
- Certified in 2001 and 2007
  - New FAA Regulation for EVS and official definition of EVS
- Provides improved pilot situational awareness in low visibility and night conditions

A Fully Qualified EFVS

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EFVS Uses

EFVS provides the ability to see at night and in low visibility

Night Operations

Low Visibility
Gulfstream EVS – Approach to Asheville, NC
13 August, 2007

AVL EVS II DVD.mpg
SV-PFD Operational Benefits

• Enhance aircrew awareness for improved safety
  – Night ops
  – Instrument conditions
  – Mountainous terrain
  – Instrument approach
  – Landing runway identification
  – Unusual attitude awareness

• Symbology improvements

• Possible future operational credits
## General Aviation Fatal Accident Statistics 2005

<table>
<thead>
<tr>
<th>Accident Cause</th>
<th>% of total</th>
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<tbody>
<tr>
<td>Loss of Control (Takeoff)</td>
<td>24%</td>
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<tr>
<td>Approach &amp; Landing</td>
<td>19%</td>
</tr>
<tr>
<td>Controlled Flight into Terrain</td>
<td>19%</td>
</tr>
<tr>
<td>Loss of Control (in flight)</td>
<td>18%</td>
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<tr>
<td>Loss of Control (Maneuvering)</td>
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<tr>
<td>Midair</td>
<td>1%</td>
</tr>
<tr>
<td>Other</td>
<td>8%</td>
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</tbody>
</table>

*SVS potentially helps up to 91% of fatal GA accident causes*
SV-PFD Features

- 0.1 nm terrain resolution to 12 nm with terrain out to 35 nm
- Widened, transparent Airspeed/Altitude Tapes
- SC, CP and improved Hud flight directors
- Terrain shading related to elevation
- Enhanced horizon line with cutouts
- Enhanced crosswind rendering
- Airport symbol & landing runway cyan outline with 15 nm extended centerline ‘breadcrumbs’
- 44 by 33 degree field of view

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SVS Operational Benefits

– **Terrain**
  - Provides “Day, VFR” flight conditions

– **Flight Directors**
  - Allows standard or HUD type and improved precision

– **Crosswinds**
  - Ability to follow flight path in high crosswinds

– **Pitch/Roll**
  - Enhanced precision, like HUD
  - Unusual attitude awareness
SVS Operational Benefits

– **Landing Runway awareness**
  - Highlight runway selected for approach
  - Show other runways

– **Approach path deviation awareness**
  - Glidepath and distance to runway awareness
  - Provides a “Time to go” intuitive cue

– **Obstacle Awareness**
“One peek is worth a thousand cross checks”
Provides crews intuitive awareness to help prevent accidents
Affordability and Availability

Future Considerations

Mike Mena
Affordability – Enhanced Flight Vision Systems

- EFVS = HUD + EVS
- FAR Part 25
- Gulfstream EVS – Certified in 2001
  - Approximate Range: $800,000 to $1,200,000
- Bombardier EVS – Certified in 2006
- Dassault EVS – Certified in 2007
- FedEx MD-10 EVS – Certified in 2008
- Boeing BBJ EVS – Will Certify in 2008
Affordability – Synthetic Vision Systems

- Range: $30,000 to $300,000
- Systems:
  - Chelton Flight System’s 3D Synthetic Vision System
    - FAR Part 23 Supplemental Type Certificate
  - Garmin G-1000® Synthetic Vision System
    - FAR Part 23 Supplemental Type Certificate
  - Gulfstream SV-PFD
    - Based on Honeywell’s Integrated Primary Flight Display (IPFD)
    - FAR Part 25 Amended Type Certificate for G350/G450/G500/G550
  - Universal’s Vision-1™ System
    - FAR Part 23 and 25 Supplemental Type Certificates

Pricing Appropriate Based on Model of Aircraft
The Future – Equivalent Visual Operations and Fusion of EFVS and SVS

- Equivalent Vision Operations – VFR-Like Tempo in Weather – The FAA’s Next Gen Plan
- New FAA Regulations being developed to promote operational capabilities with Equivalent Vision
- Integration of EFVS and SVS with Fusion is the next logical progression
- Fusion will apply to EFVS and SVS with Head Up and Head Down Displays

Concept:

- FL 450
- 500 ft.
- 300 ft.
- 0 ft.
- Distance
- Top of Descent
- SVS
- Other Sensor
- EFVS

Rockwell Collins

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EFVS and SVS Performance Can be Measured

- FAA regulations provide design criteria and performance measures
  - FAR 91.175
  - FAR 91.16
  - AC-120-28
- Performance measures include navigation performance, flight path accuracy

NEW EASA Operational and Airworthiness Criteria Under Development
Summary – The Value of Vision Based Technology

• Reduces reliance on airport infrastructure
• Improves safety
• The new airspace requires it
• Opens the door for greater airport use
• Is expandable

EFVS and SVS solutions are affordable and available to the Business Aviation Market
Vision Based Technology

Questions?