Reno Flight Trials

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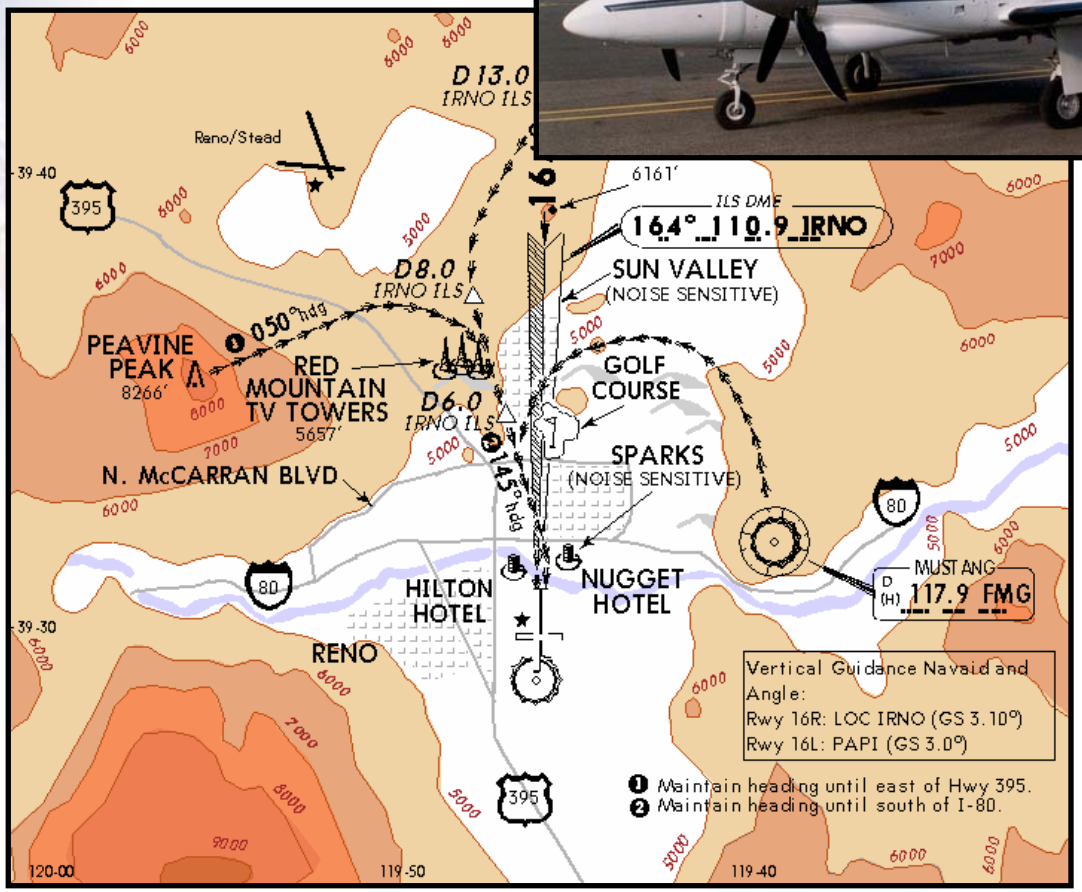
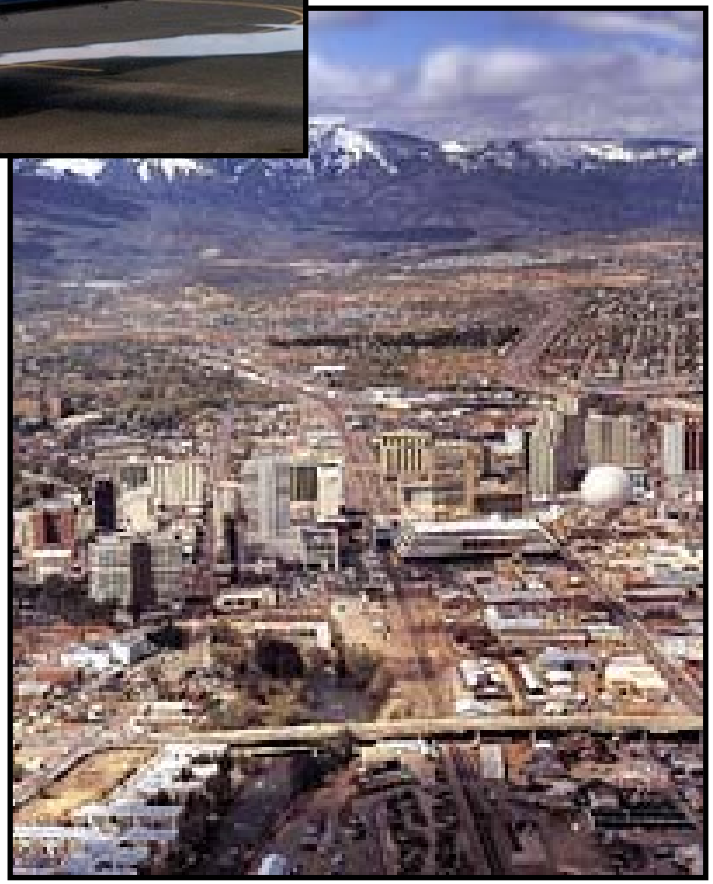
In support of NASA Aviation Safety Program

Reno Flight Trials





Reno Flight Trials: Purpose

- Support key NASA Synthetic Visions Systems (SVS) program objectives
- Validate commercially available 2D situation awareness system
- Validate experimental 3D flight guidance system
- Verify the quality of underlying databases
- Evaluate the usability of multiple integrated databases

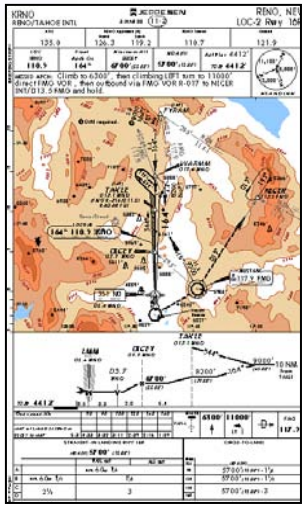
Reno Flight Trials: Apparatus

- Aircraft
  - Cheyenne I Super 500
  - Marinvent
  - Glass Cockpit
  - AHRS + GPS

- Pilots
  - Seven pilots were IFR rated, avg. 4775 hrs
  - Six pilots VFR-only, avg. 203 hrs
  - Age of the test subjects between 22 yrs and 63 yrs, avg. 42 yrs

Reno Flight Trials: Displays

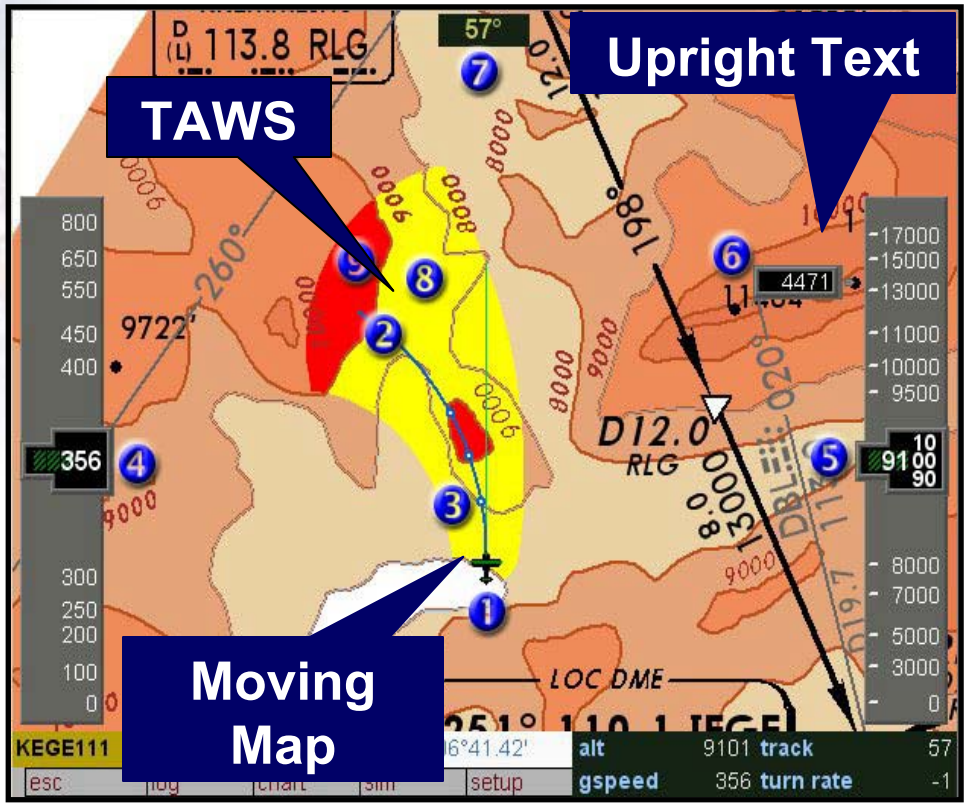
1. Traditional EFIS
   - Meggitt, plus
   - Paper Chart



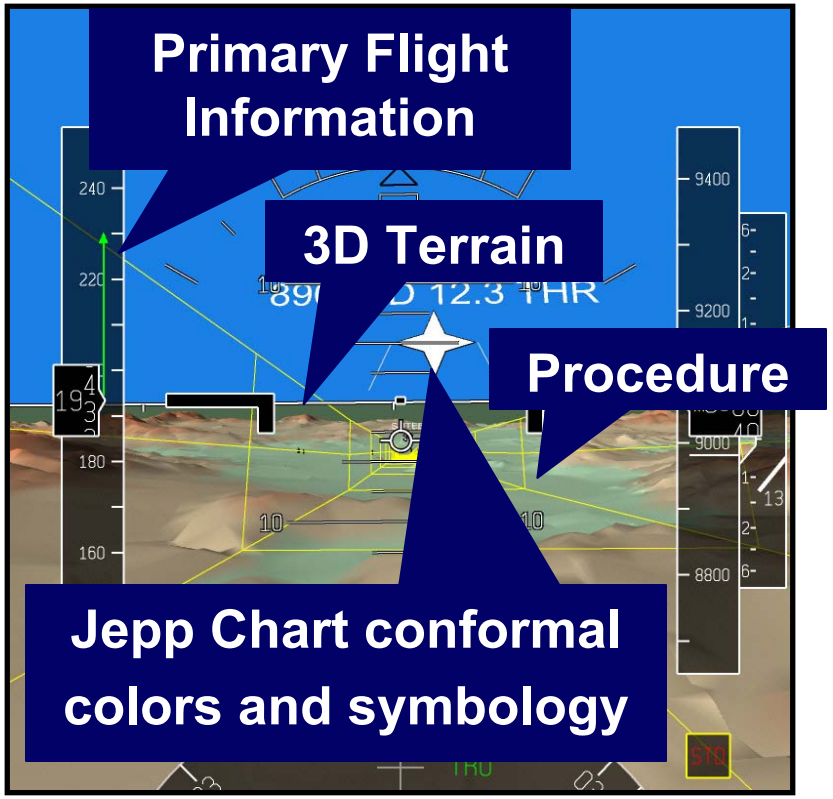
2. Moving Map
   - Meggitt, plus
   - MX20™ ChartView™

Reno Flight Trials: Displays

3. SmartChart plus FliteDeck3D



2D - SmartChart



3D – FliteDeck3D

Reno Flight Trials: Displays

- Jeppesen FliteDeck3D Placement

Primary SVS Display:
Rockwell Collins LCD in Cockpit

Secondary Observation:
Laptop in Cabin

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Procedure 1 of 5: Steep turns and reversals

- Pilots
  - seven IFR rated pilots only 
- Procedure
  - steep 360° turn with 45° bank followed by a reversal maneuver
- Results:

Flight Test Measurement	Using Standard EFIS	With 3D SVS
Completed within 10° Hdg	50%	**66%** ✓
Performance Improvement	n/a	P<0.05 ANOVA

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Procedure 1 of 5: Steep turns and reversals

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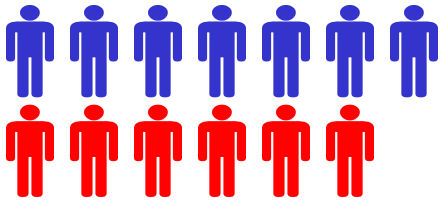
Procedure 2 of 5: Unusual Attitude Recovery

- Pilots
  - seven IFR and six non-IFR rated pilots



- Procedure
  - a 30° nose up or down & 45° bank left or right
  - callout “you have control” test subject took over to identify and react
  - display readability rating and NASA TLX
- Results:

Flight Test Measurement	Using Standard EFIS	With 3D SVS
Pilot Workload (lower number is better)	16.6	**11.9** ✓
Readability (subjective)	ok	**Better** ✓
Performance Improvement	n/a	P<0.05 ANOVA

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Procedure 2 of 5: Unusual Attitude Recovery

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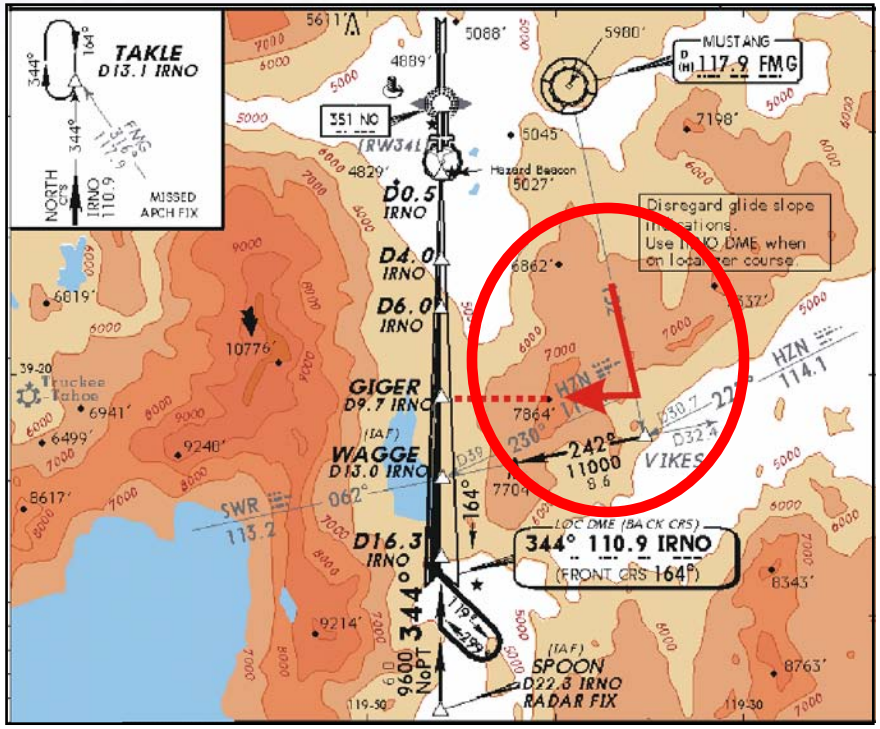
Procedure 3 of 5: Radar Vectors towards Terrain

- Pilots
  - IFR rated pilots only
- Procedure
  - Radar vector into terrain
  - NASA TLX and SART
  - Stress
  - Rate Level of Terrain Awareness
- Results:



Flight Test Measurement	Using Standard EFIS	With 3D SVS
Terrain Awareness (higher number is better)	3.8	**6.7** ✓
Dangerous Terrain Recognition	0%	**50%** * ✓
Performance Improvement	n/a	P<0.05 ANOVA

* It is believed this number would be significantly higher with inclusion of a Flight Path Indicator (this was a prototype design oversight)

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Procedure 3 of 5: Radar Vectors towards Terrain

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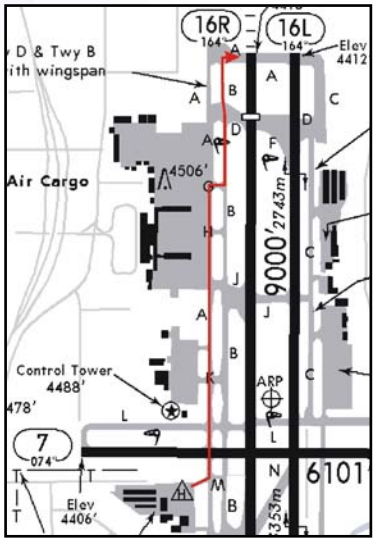
Procedure 4 of 5: Taxi on Complex Route

- Pilots
  - all pilots
- Procedure
  - follow complex ATC taxi
  - NASA TLX and SART methods
- Results:



Flight Test Measurement	Using Jeppesen Paper Chart	Using MX20 ChartView	Using Taxi Position Awareness Map (TPA)
Perceived Situation Awareness, IFR Pilot (higher number is better)	12.85	12.70	**14.37** ✓
Perceived Situation Awareness, VFR Pilot (higher number is better)	9.50	no data	**10.43** ✓
Readability (lower number is better)	2.07	3.66	**1.81** ✓
Performance Improvement, insignificant (taxi speeds)	n/a	n/a	P<0.05 ANOVA

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Procedure 4 of 5: Taxi on Complex Route

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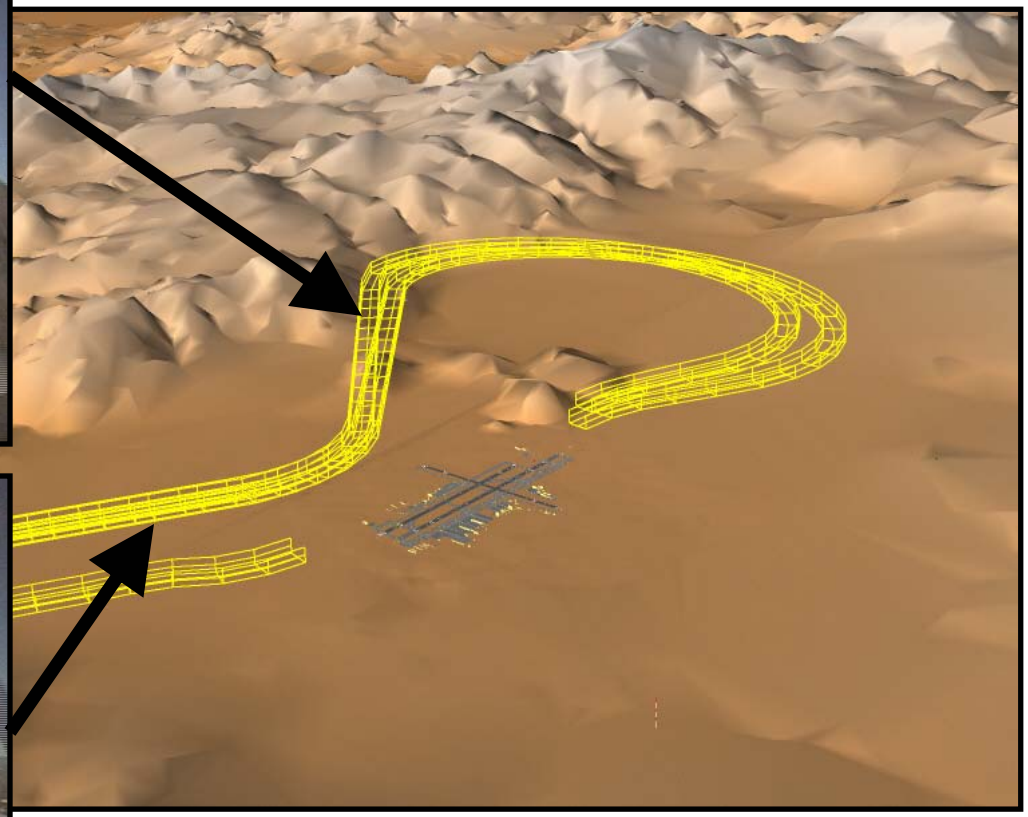
Procedure 5 of 5: Simulated B-757 One-Engine Out



- Pilots
  - One IFR Pilot (due to high risk)

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Procedure 5 of 5: Simulated B-757 One-Engine Out

Video Segment: 2 min 5 sec

Reno Flight Trials: Conclusions

- Pilot Performance
  - 3D SVS pilot performance is equal to or greater than using the traditional systems
- Pilot Workload
  - 3D SVS decreases pilot workload
- Situation Awareness
  - Situation Awareness is measurably increased with 3D SVS
- IFR vs. VFR Pilots
  - With 3D SVS, VFR Pilots could fly IFR procedures
- Flight Test Procedure Itself was a Success
  - Good Model for Evaluating Potential future EFB Functions
    - Particularly future charting and navigation awareness functions, which are promised to undergo rigorous certification scrutiny

Reno Flight Trials: Acknowledgements

- NASA Aviation Safety Program (AvSP)
  - Jeppesen contract NCC-1-343
- Darmstadt University of Technology
- Marinvent
- Rockwell-Collins

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