Equipment and Technology Solution

2009 Data – Were we making a difference?

- By mid-2009, we had our equipment in approximately 5,000 Technologically Advanced Aircraft (TAA)
- In mid-2009, we took a look at the incident data for all Cirrus aircraft in an effort to determine if our technology (pre-Avidyne autopilot) was making a difference

	Total occurrences per 1000 airplane years	Fatal accidents per 1000 airplane years	Injury accidents per 1000 airplane years	Loss of hull per 1000 airplane years
Pre-Avidyne	7.7	5.8	7.7	5.8
Avidyne	7.8	3.1	3.5	3.4

Pre-Avidyne: 520 airplane years (AY)

Avidyne: 14410 AY

The Premise

- Could we use some Avidyne technology/features/products to actually make a real impact to mitigate or prevent a mishap?

Yes, we probably could

Methodology to Test Premise

- Background as a USAF Flight Safety Accident Investigator
- Applied typical USAF methodologies to Cirrus aircraft mishaps with available accident reports
- Used Cirrus aircraft for several reasons:
  - Entire fleet of nearly identical aircraft
  - Most of fleet equipped with Avidyne gear so we had the potential to easily add technology to address issues
  - In many cases, we had theoretical access to the internal extensive data logs in the Avidyne gear

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Methodology (cont.)

- Built an “Accident Chain” for each mishap
  - Covered 121 individual mishaps
  - Spanned 10 April 2001 to 28 April 2009
- Mapped potentially mitigating/preventative technology/features/products into each mishap accident chain
  - Started exercise with no preconceived notion of technologies

A Few Example Accident Chains

Aircraft Info	Mishap Summary	Severity	Chain Link 1	Chain Link 2	Chain Link 3	Chain Link 4	Chain Link 5	Chain Link 6	Potential Mitigating/ Preventing Technology
15 Mar 2009 SR22 N213CP Gaithersburg MD	Spatial disorientation in IMC following door opening leading to CAPS deployment	Non-fatal	MP decision to fly into known adverse weather (400-2)	MP inexperienced in TAA aircraft	Failure to properly secure aircraft door	Failure to use on-board systems such as the autopilot	Pilot severely distracted leading to spatial disorientation	Post spatial-D recovery failed to maintain aircraft control leading to stall/spin	**Envelope Protection, SynVis display**
17 Feb 2009 SR20 N493DA Deltona FL	Apparent stall/spin during slow flight	Fatal (2)	Stall practice at 3000' AGL	Improper spin prevention technique while in stall	Delayed CAPS activation resulting in ineffective deployment				**Envelope Alerting, Envelope Protection, Automatic CAPS deploy**
16 Nov 2008 SR22 N224AG Cherbourg FR	Engine failure over the English Channel	Fatal (1)	Mismanaged energy due to channelized attention	Failure to recognize impending departure from controlled flight	Failure to maintain aircraft control resulting in departure from controlled flight	Failure to activate CAPS			**Envelope Protection, Automatic CAPS deploy**
8 Apr 2008 SR22 N868PC Big Bear CA	CFIT into mountainous terrain	Fatal (1)	Unintended / Inadvertent flight into IMC	Failure to maintain awareness of terrain-aircraft proximity	Failure to maintain altitude AND clearance from terrain resulting in CFIT				**Synthetic Vision, Active Envelope Protection**

Example Categories and Technologies

Category	Spatial Disorientation	Departure from Controlled Flight	CFIT (Maneuvering Flight)	Unintentional Flight into IMC	Fuel Starvation	Airspace Violation /Penetration	Mid-air / Near-miss	Practice Maneuvering	Cockpit Workload Reduction
% Total/Fatal	1% / 83%	7% / 40%	9% / 54%	2% / 84%	8% / 6%	2 incidents	5 collisions / approx 100 potentials	Did not compute	Did not compute
Potential Mitigating or Preventing Technology, Function, Product	Full width ADI PVHD Envelope Protection Virtual Instructor HUD TVV Straight and Level	Envelope Protection (passive) Envelope Protection (active) TVV	Envelope Protection TAWS PGCAS HUD Profile View TVV Synthetic Vision	Datalink Weather Virtual Instructor / Co-pilot	Virtual Instructor / Co-pilot Envelope Protection	Large Format Map Envelope Protection Virtual Instructor / Co-pilot HUD, if airspace depicted	Active Traffic Large Format Map 3D Sound	Virtual Instructor Envelope Protection HUD TVV	Charts depiction HOTAS “Super intuitive” displays HUD TVV Voice Activation Synthetic Vision Data Loader

Other categories: IFE Mishandling, CG Issues, Over G, Runway Incursion, Pilot Incapacitation

Other technologies: Radalt, AoA, CO Detectors, TOLM, FMS Automation, EVS, Icing Detect, etc

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Mapping and Weighting

- For all of the 121 mishaps, created a score sheet
- Was going to weight the mitigating technology too but didn't have to – envelope protection was the clear winner so that's where we went next
- Viewed these as "threats" and took a graduated response
  - Threat Awareness
  - Threat Avoidance
  - Threat Suppression
  - Threat Removal

DFC90 Autopilot and Envelope Protection

- Captive audience of 4500+ STec55X equipped Cirrus with the Avidyne Entegra PFD
- DFC90 autopilot is a form-fit slide-in replacement for the legacy rate-based STec 55X and it uses the existing STec servos
- DFC90 is a digital, attitude-based autopilot with features such as Straight & Level, Envelope Protection, Envelope Alerting
  - Envelope Protection and Alerting are currently speed-based calculations with knowledge of flap configuration
- Hit 25% market share in less than a year, well in excess of that % now

DFC90 Envelope Protection (cont.)

- Envelope Protection applies when servos are coupled
  - Will provide voice and text alerts when an envelope exceedance is approaching
    - "Speed Protection Active" aural
  - Will provide flight control input to prevent exceedance
    - Will roll and pitch the aircraft to maintain 1.2 Vs or 5 knots below Vne
- Envelope Alerting is always running in the background even when servos not coupled
  - Will provide voice and text alerts when an envelope exceedance is approaching
    - "Caution, Underspeed", "Caution, Overspeed", "Caution, Excessive Bank", "Caution, Flap Overspeed", etc aurals
    - It's still up to the pilot to do something about the condition
- Straight & Level was ops tested in all aircraft attitude and energy states with altitude lost/gained and airspeed lost/gained during recovery recorded.
  - Never found a condition where it failed to recover the aircraft in appropriate time, energy

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Potential Next Steps

- Run same type of safety impact analysis on the DFC as we did in 2009 for the displays
  - All we have now is anecdotal evidence of the impact
- Enhance Envelope Protection
  - Integrate AoA
  - Integrate FMS knowledge for auto recovery
  - Active Envelope Protection
    - Automatically turn on if sufficient pilot action is not taken while in Envelope Alerting including knowledge of the terrain