The Consequences of Adding Runway Symbology To The Head-Up Display

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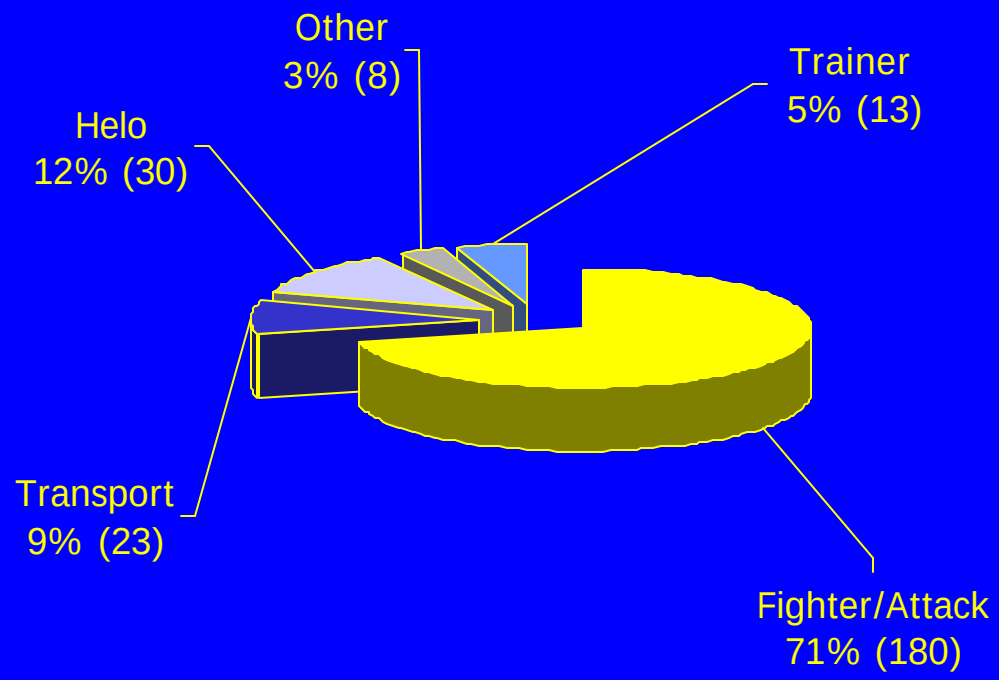
Commercial CFIT Mishaps in Russia and USA

- 52% of Russia's Civil Aviation mishaps occur on landing approach phase in poor visibility conditions (Teymurazov R.A., 1997)

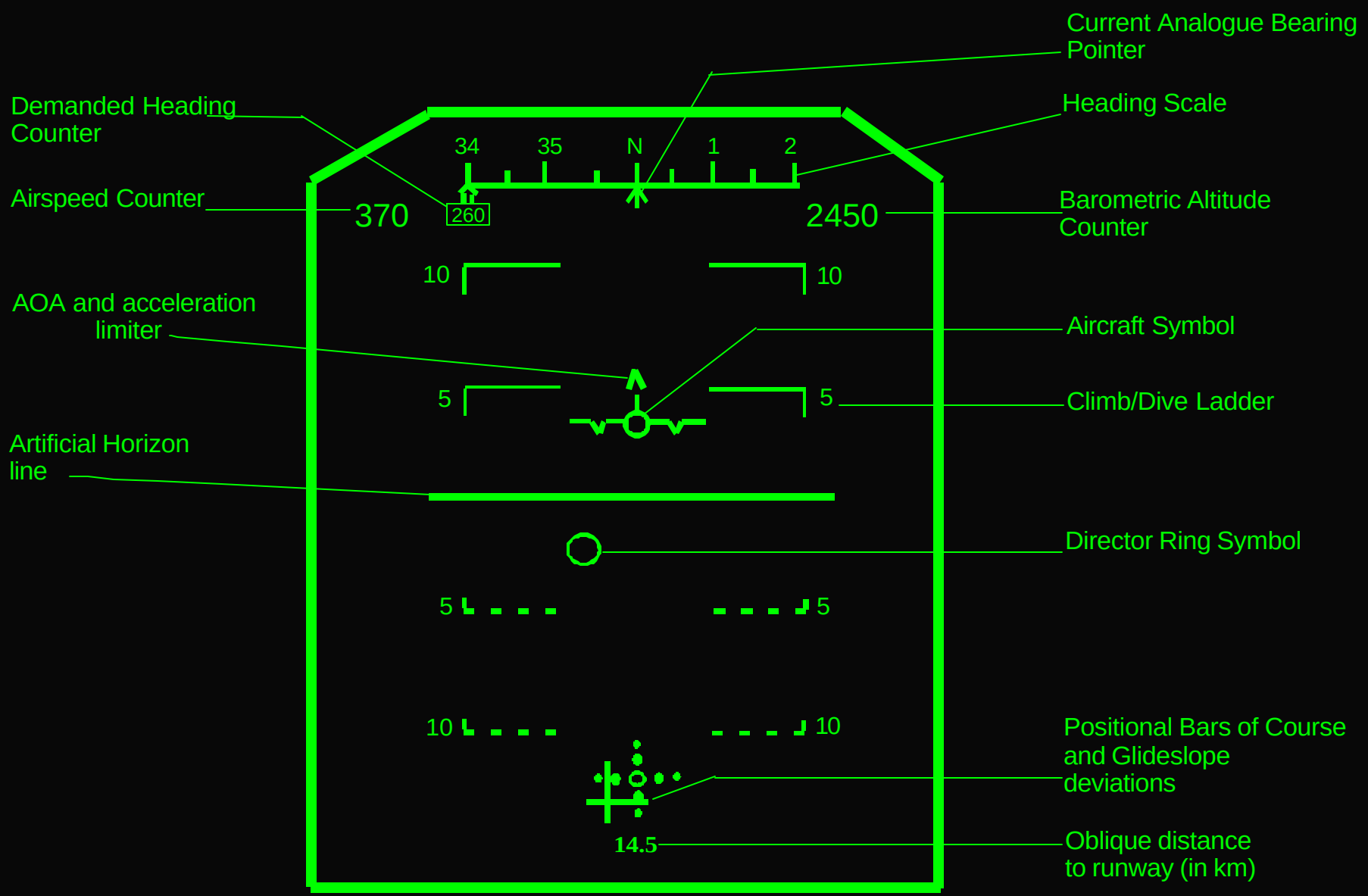
- 40% of *all* accidents are CFIT accidents (Matthew, 1997)
- 70% of CFIT accidents occur during "landing phase" (Khatwa & Roelen, Scott, 1996)
- 40% of CFIT landing-phase accidents occur when no significant terrain features (Scott, 1996)
- 87% of these accidents occur during Instrument Meteorological Conditions (IMC) (Scott, 1996A)
- 20% occur when the aircraft inadvertently transitions from Visual Meteorological Conditions (VMC) into IMC (Scott, 1996A)
- 75% of CFIT accidents have 100% fatalities (Khatwa & Roelen, Scott, 1996)

The What of USAF CFIT - Aircraft

Total 1980-1997 ~ 254



Standard version of HUD



HUD version with runway projection

Artificial Horizon Line

Airspeed Counter (km/h)

Mach Number

Demanded Bearing Angle

AOA Indicator

Index of Aircraft Energy Management

Climb/Dive Ladder

Radio Bearing Index

Radar Altitude Counter

Heading Scale

Current Analogue Bearing Index

Animated Runway Image

Aircraft Velocity Vector Symbol

Flaps and Landing Gear Indicator

FPA Marker

Oblique distance to runway (in km)

Conditions of IFR landing approach task

- 1st variant
  Oblique distance to runway-15 km
  Height - 600 m
  Airspeed - 350 km/h
  Ceiling - 25 m
- 2nd variant
  Oblique distance to runway-15 km
  Height - 600 m
  Airspeed - 350 km/h
  Ceiling - 25 m
  Cross wind velocity - 10 m/s, +? 90? constant
- 3rd variant
  Oblique distance to runway-15 km
  Height - 1100 m
  Airspeed - 650 km/h
  Ceiling - 25 m
  Bearing deviation to the left - 500 m

Average values of psychophysiological tension (cardiac rate) of pilots during landing approach at IFR conditions

HUD version	Conditions of IFR landing approach task		
✝ STANDARD	1st variant	2nd variant	3rd variant
CARDIAC RATE, beat/min *Control values -75,66 ? 8,22*	81,22 ? 6,29	79,66 ? 3,03	78,71 ? 5,75
✝ With animated runway projection			
CARDIAC RATE, beat/min	81,22 ? 9,18	80,77 ? 7,77	80,66 ? 9,55

Average values of workloading of pilots (time-sharing task or attention resources) during landing approach at IFR conditions

HUD version	Conditions of IFR landing approach task		
† STANDARD	1st variant	2nd variant	3rd variant
Total number of reactions (per min)	8,5 ? 6,87	9,25 ? 7,31	4,43 ? 3,34
Number of correct reactions (per min)	8,5 ? 6,87	8,57 ? 7,15	4,43 ? 3,34
† With animated runway projection			
Total number of reactions (per min)	20,33 ? 4,29	21,77 ? 6,69	26,66 ? 6,59
Number of correct reactions (per min)	20,33 ? 4,29	21,77 ? 6,69	26,11 ? 6,09

Outcomes of modeled landing approaches in IFR conditions with use of HUD symbology set

- **HUD version with runway projection**

- **Total number of landings - 10**
- **Number of successful landings - 10**

- **Standard version of HUD**

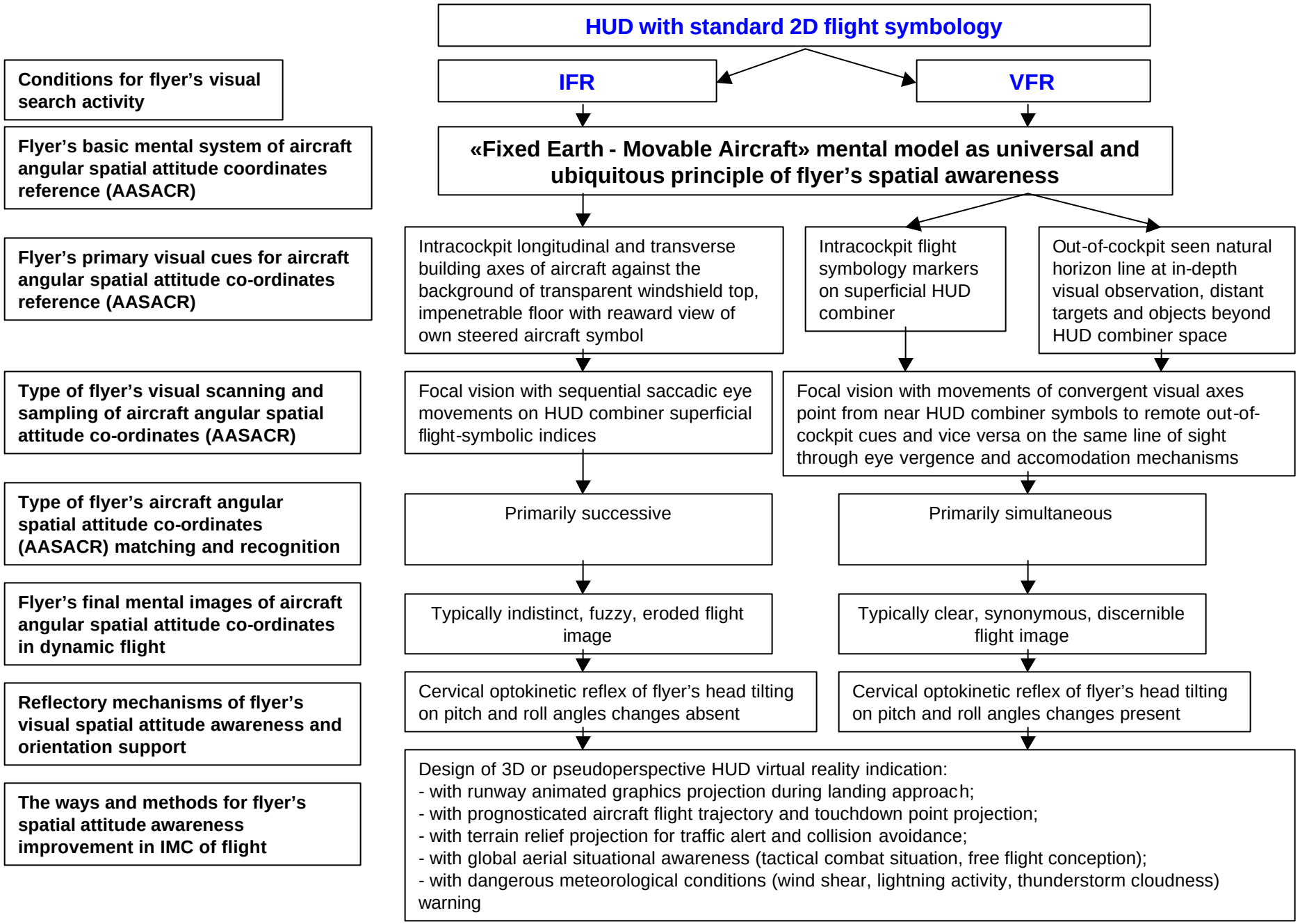
- **Total number of landings - 10**
- **Number of successful landings - 4**
- **Number of CFIT - 5**
- **Missed Landing Approach - 1**

Distribution of CFIT and Missed Landing Approach Events

- **Number of CFIT - 5, including:**
- ✍ **2 - at landing approach with strong cross wind**
  ✍ **2 - at landing approach with great initial deviations from localizer and glideslope flightpath zone**
  ✍ **1- at landing approach with zero deviation from localizer and glideslope flightpath zone**

- **Missed landing approach with go-around maneuver- 1**
  ✍ **1 - at landing approach with great initial deviations from localizer and glideslope flightpath zone**

Scheme of flyer's HUD flight symbolics processing in maintenance of spatial attitude awareness at IFR and VFR




THANK YOU FOR YOUR KIND ATTENTION!!!
Neville Dawson