HUDs, HMDs, and SDO
A Problem or a Bad Reputation?

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Recent Trends in Spatial Disorientation Conference
San Antonio, Texas
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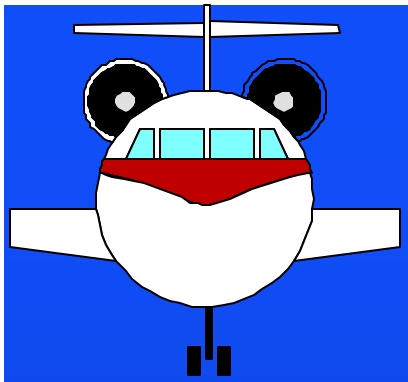
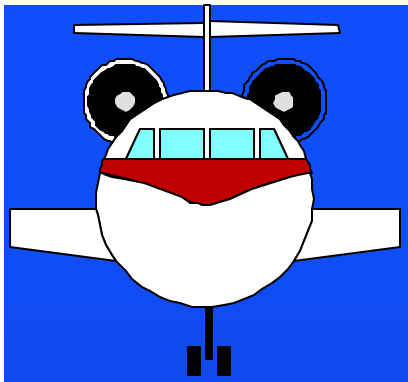


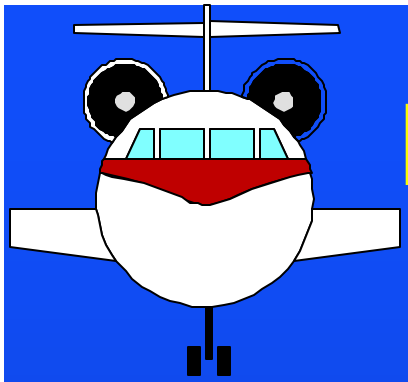
SUMMARY

- Background
- Development of Standards
- Unusual Attitude Research
- Unusual Attitude Issues
- Conclusions



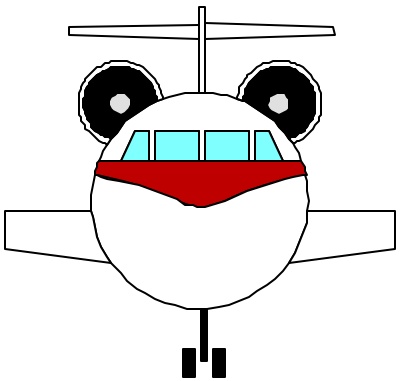
BACKGROUND

- HUD Characteristics
- HMD Characteristics
- Other Novel Displays

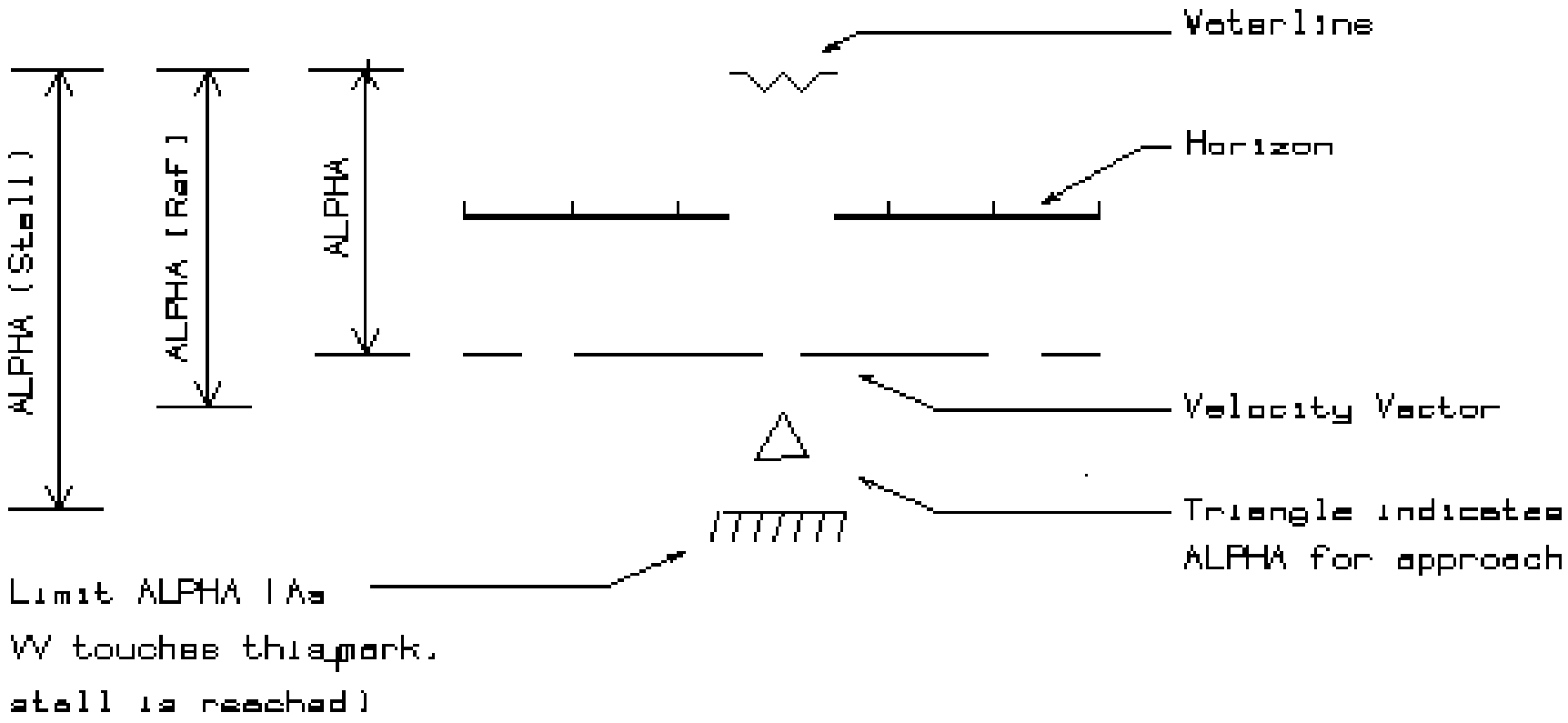


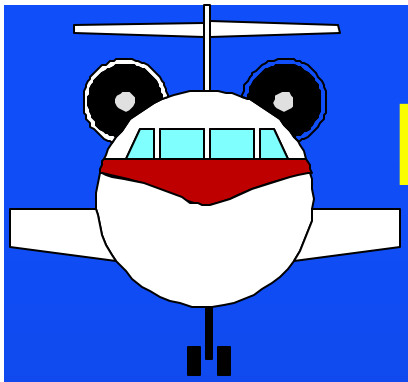
HUD CHARACTERISTICS

- Absence of Upright Versus Inverted Cues
- Clutter
- Digital Data and Rate Information
- Full Scale Pitch Angles
- Pitch Ladder Precession Passing Zenith or Nadir
- Accommodation Traps
- Framing
- Velocity Vector vs Pitch Control



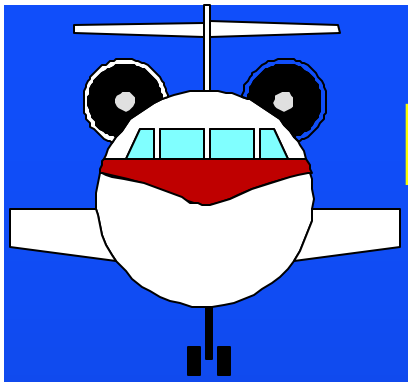
KLOPFSTEIN HUD





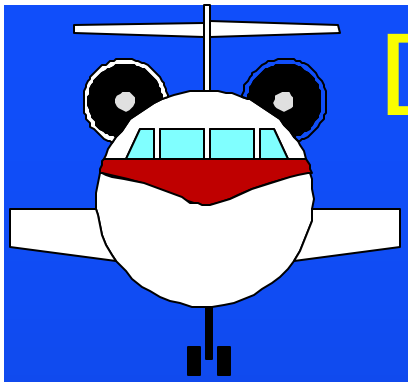
HMD CHARACTERISTICS

- Conflicting Frames of Reference
- Head-Tracker Shortcomings



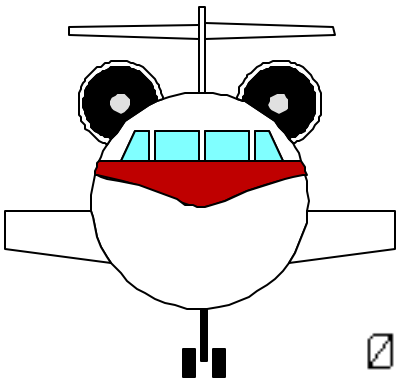
HDD CHARACTERISTICS

- Clutter
- Conflicting Frames of Reference
- Declutter of Important Information
- Standby Display

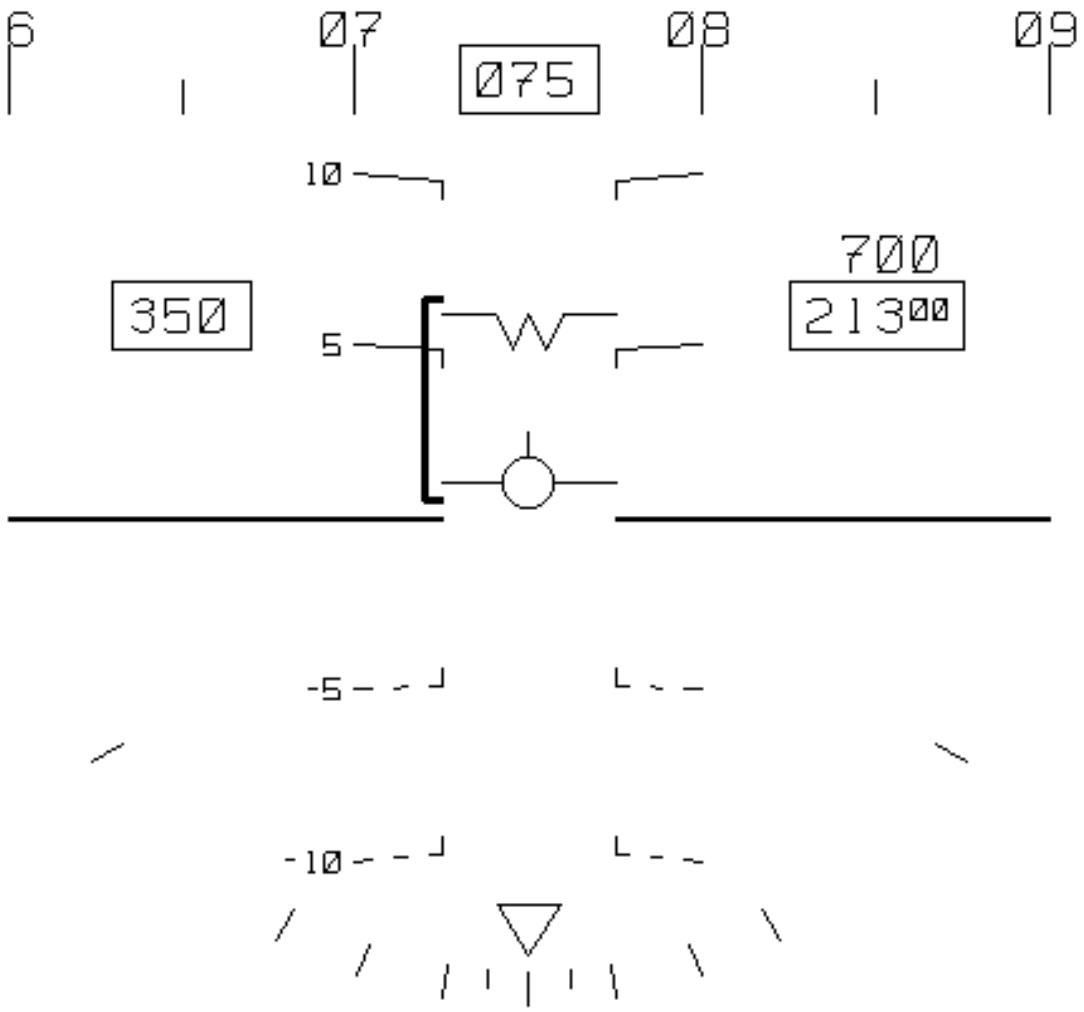


DEVELOPMENT OF HUDs AND HUD STANDARDS

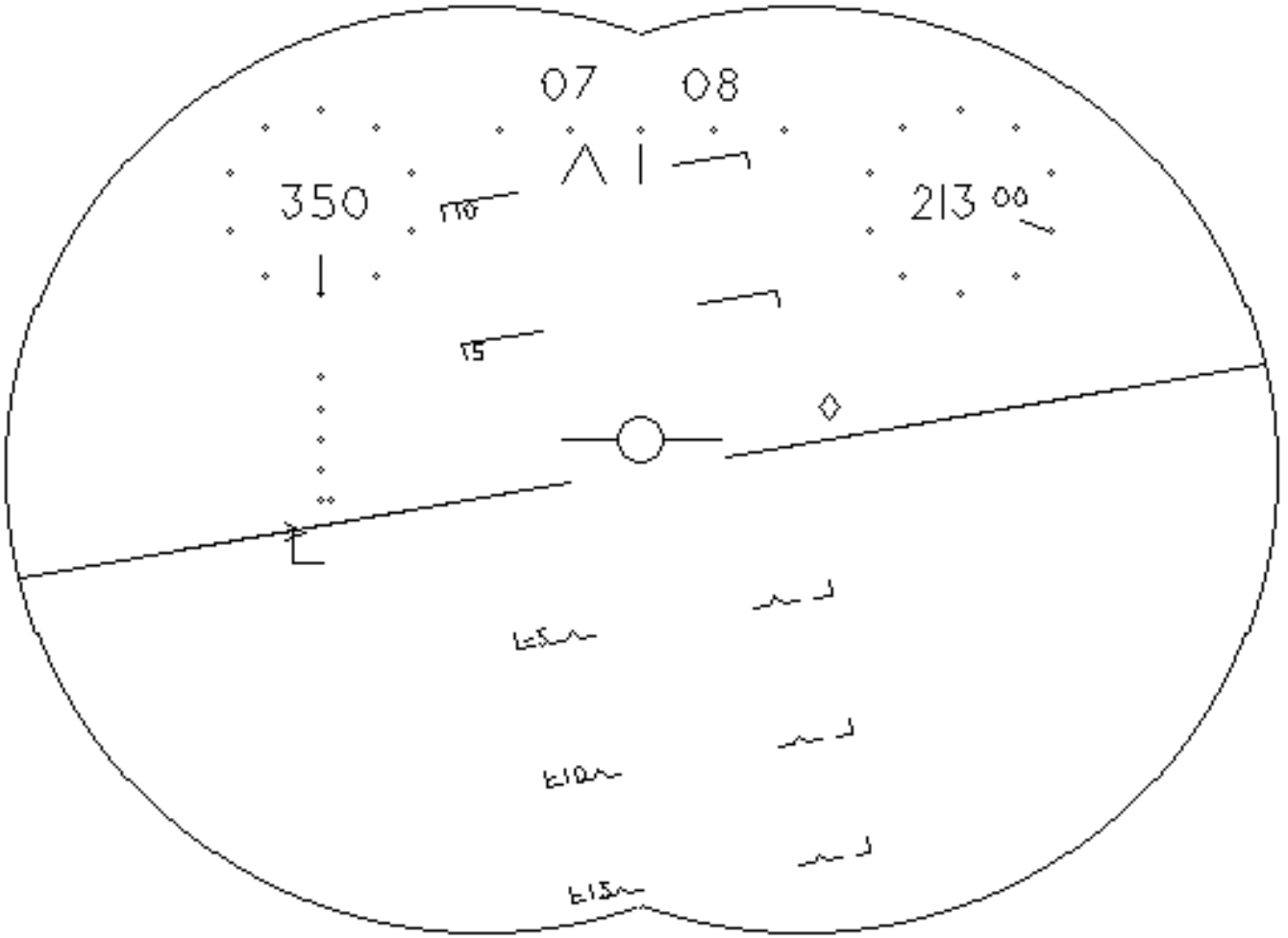
- First Step -- F-18
- RAE FastJet Development
- Development of Air Force Symbology
- Civil HUD Development
- Military Transport HUD Development

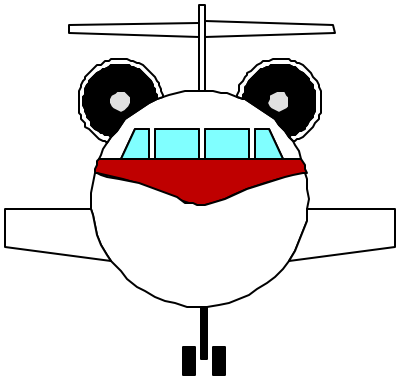


F-18 HUD SYMBOLOGY

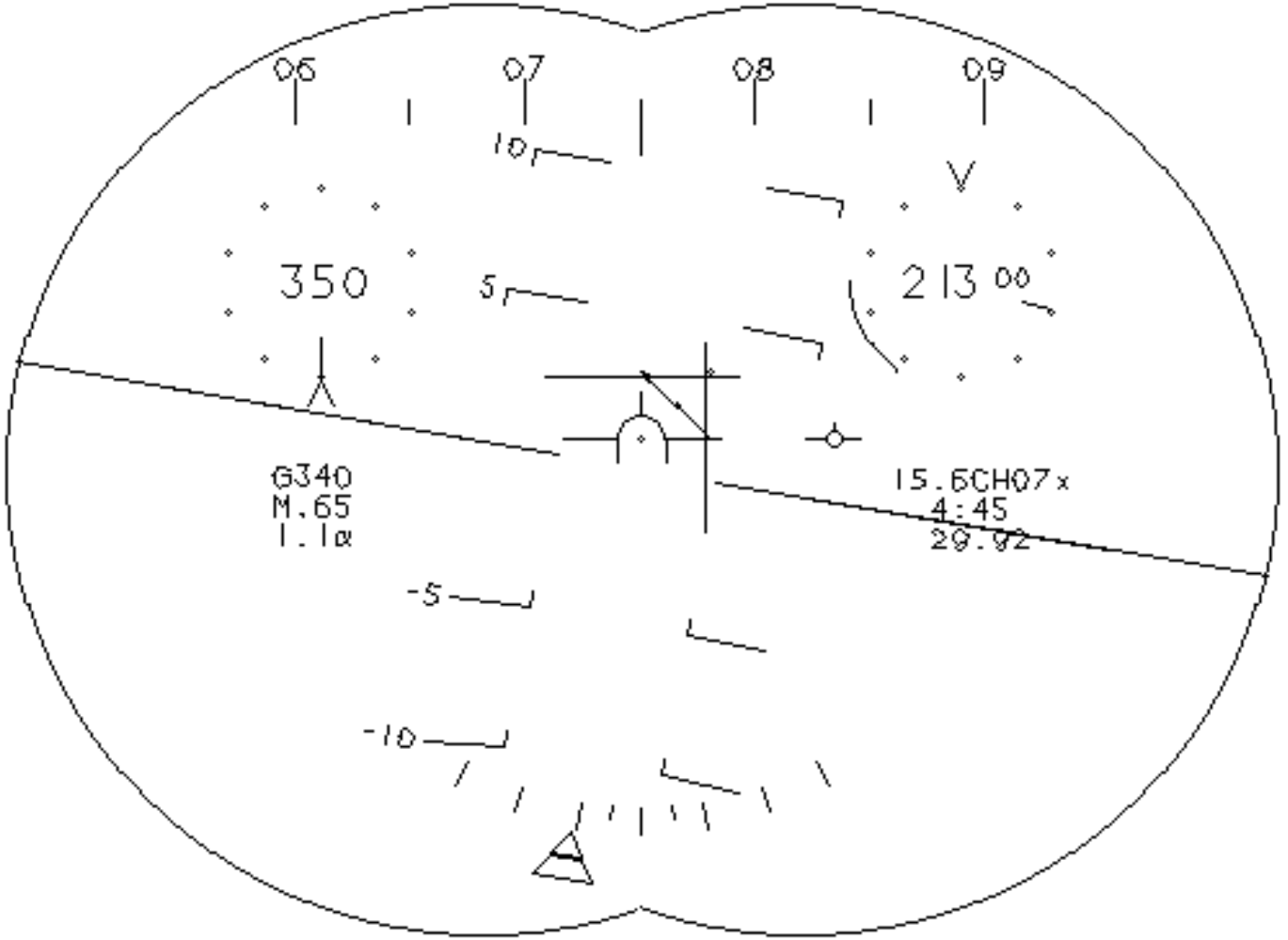


FASTJET HUD SYMBOLOGY

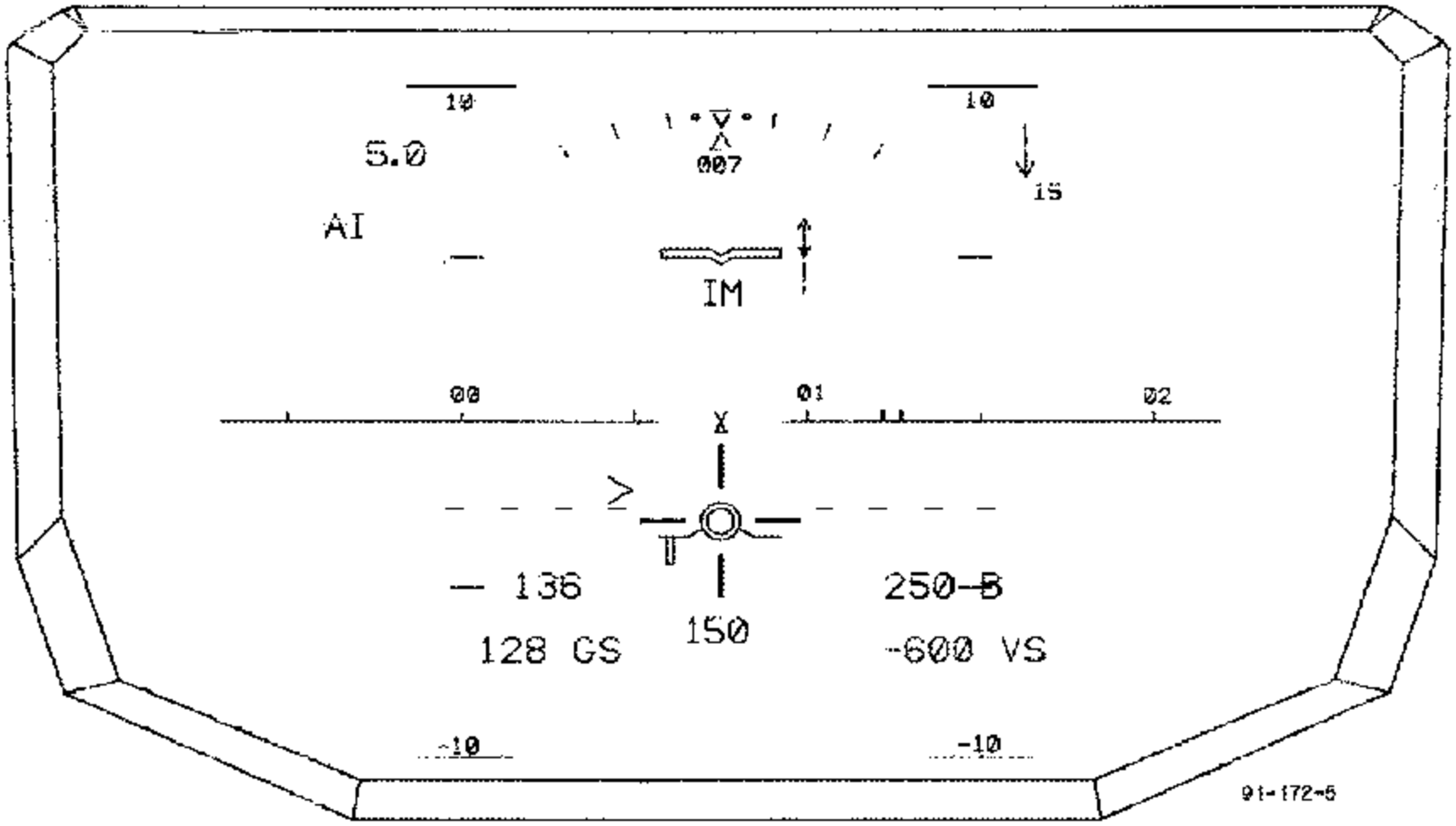




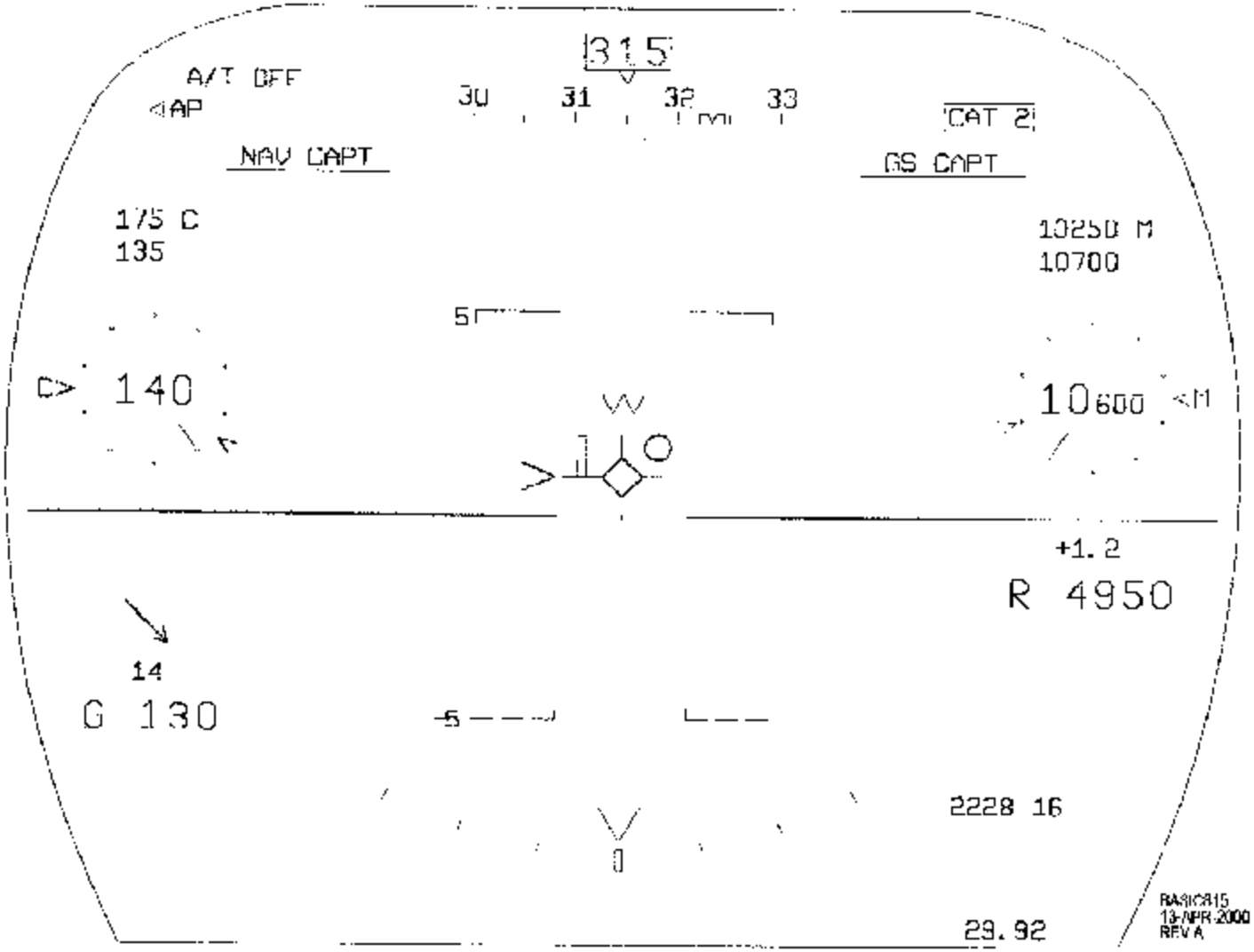
MIL-STD-1787 HUD SYMBOLOGY

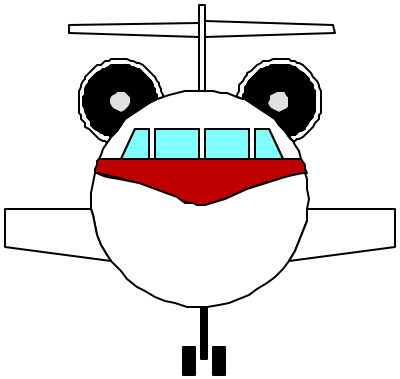


FLIGHT DYNAMICS HUD SYMBOLOGY

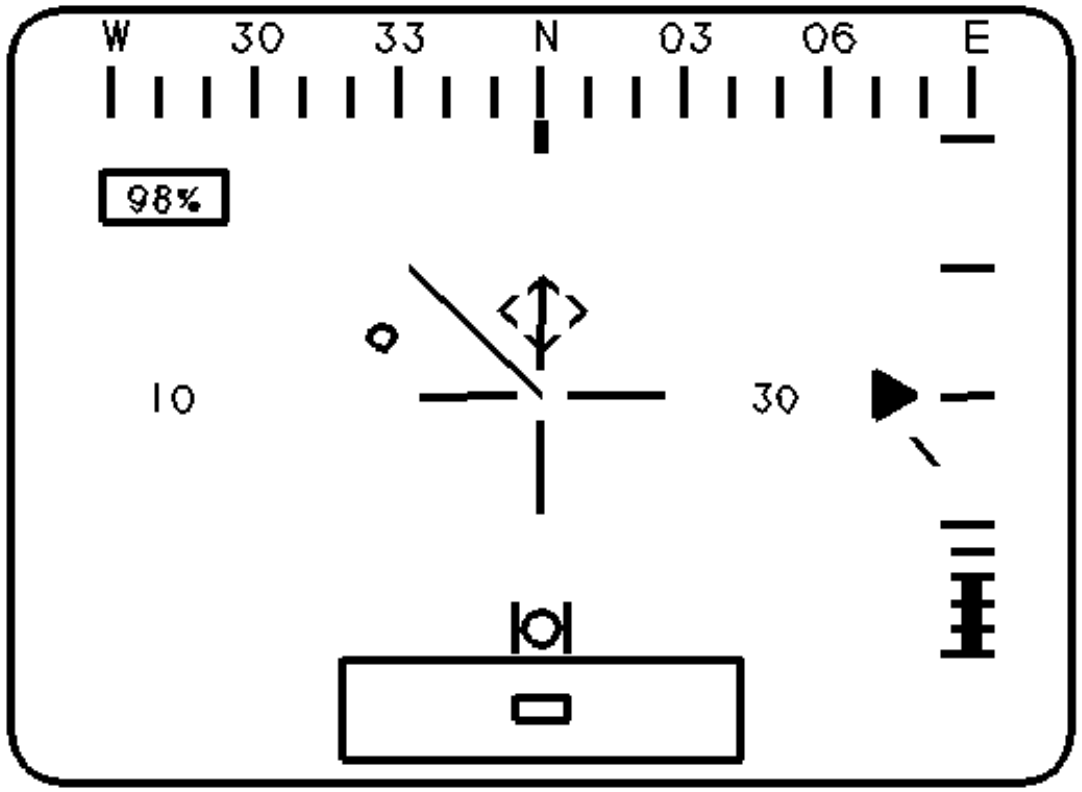


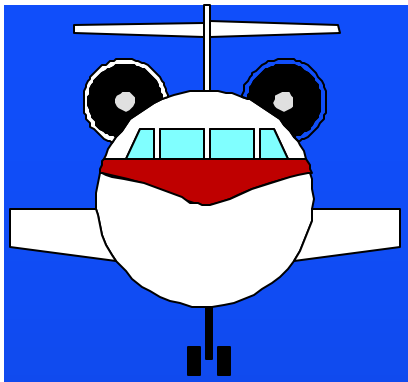
C-130J HUD SYMBOLOGY





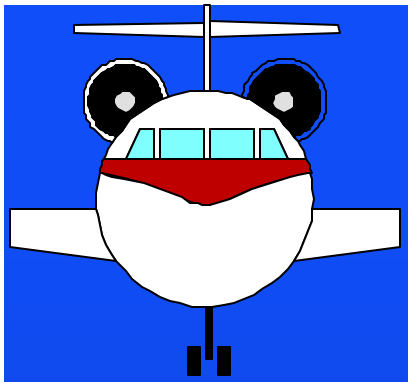
MIL-STD-1295 HMD SYMBOLOGY





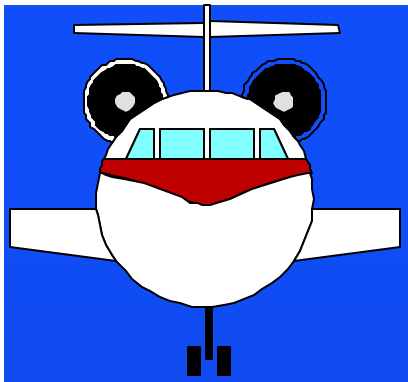
UNUSUAL ATTITUDE RECOVERY RESEARCH

- HUD Disorientation Studies
- HMD Disorientation Studies
- Pathway Unusual Attitude Study



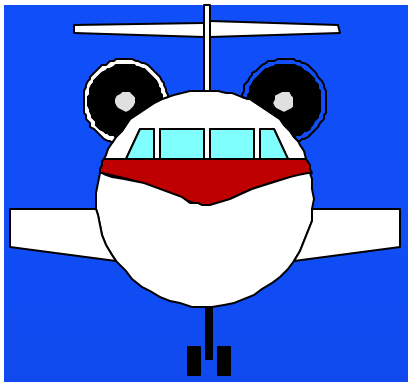
HUD DISORIENTATION STUDIES

- Navy Studies (HUD vs ADI)
- Pax River Studies
- Navy Orientation Cues
- Brooks Studies
- UK Studies



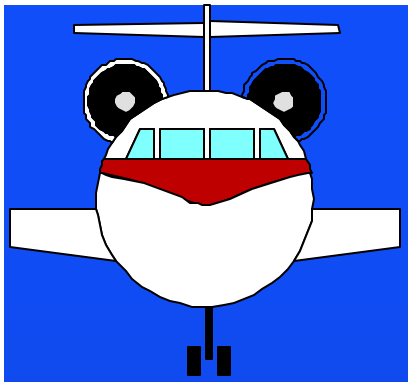
HMD DISORIENTATION STUDIES

- Fixed-Wing
  - Wright-Patt and Brooks
  - Optokinetic-Cervical Reflex
- Rotary-Wing
  - Display stabilization (Ames Studies)



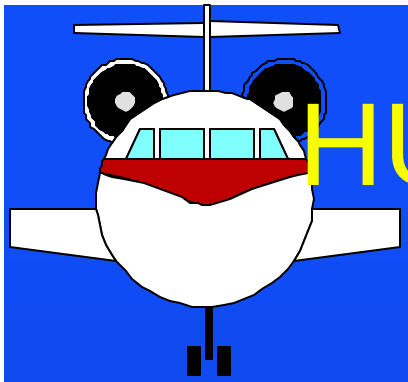
HEAD-DOWN STUDIES

- Helicopter Display (Ft. Rucker)
- Pathway (Wright-Patt)
- Synthetic Vision (NASA)



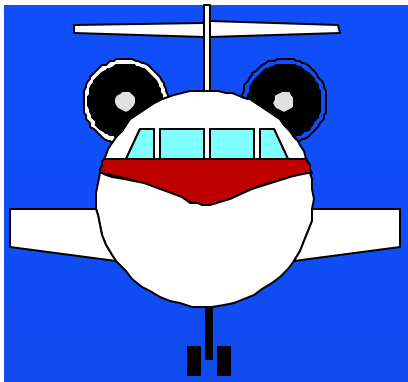
UA Recovery

- Review of HUD Characteristics
- UA Recovery Techniques
  - Fighter/Attack
  - Transport/Helicopter



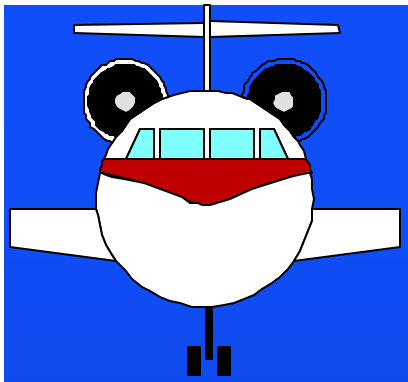
HUD UA CHARACTERISTICS

Format	UA Mode	Pitch Ladder	Scaling	Pivot	Aircraft Symbo	Other Cue	Scales
F-18	No	“bendy bars”	1:1	Pitch Marker	CDM or FPM		Digits
FastJet	No	tapered	variable	CDM	CDM		CP’s
‘1787	No	tapered/bendy	1:1	CDM	CDM	Ghost Horizon	CP’s
Civil	No	straight	variable	Pitch Marker	FPM		Digits
C-130J	Yes	straight	1:1	Pitch Marker	Pitch Marker	Augie Arror	CP’s



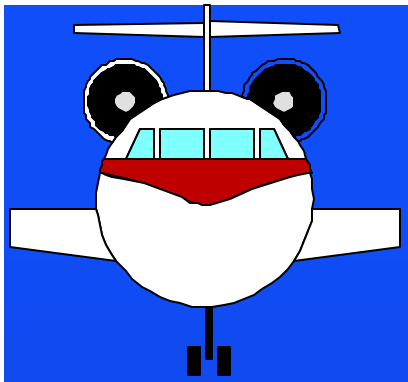
CONCLUSIONS

- HUDs do not cause spatial disorientation
- HUDs have some UA characteristics which can be improved.
- Research has had several benefits:
  - symbology
  - recovery standardization
  - pilot training
  - UA recovery as part of T&E



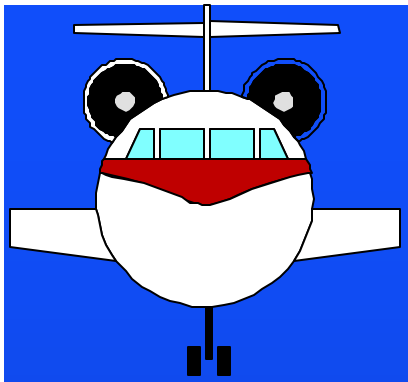
CONCLUSIONS

- HMDs still need research. (They are about where HUDs were in mid 1980s.)
- Does the HMD promote SDO?
  - conflicting orientation cues
  - head tracker
- What recovery techniques are appropriate?
- What symbology should be used?



CONCLUSIONS

- Novel displays (pathway or synthetic vision) are better off, but still need development.
- We must exercise the same care that we did for HUDs.
- Incorporation of spatial orientation and UA recovery must be part of test and evaluation
- Research is being applied to general aviation inadvertent IMC loss-of-control.



ACKNOWLEDGMENT

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