Air Force Research Laboratory
Warfighter Training Research Division

Spatial Disorientation in Night Vision Goggle Operations

16 Nov 00

Spatial Disorientation

DON'T FORGET,

IN CERTAIN CIRCUMSTANCES --

SPATIAL DISORIENTATION

IS

A NORMAL PHYSIOLOGICAL RESPONSE

Visual Characteristics of Night Vision Goggles

- Gain - 2,000 to 8,000 (10,000+ is possible)
- Reduced visual acuity
  - 20/25 or 20/30 under ideal conditions
  - 20/40 at best in aircraft
  - May be 20/80 or worse at mean starlight and/or low contrast conditions
- Limited FOV - 40 degrees (30 - 45) vs 180+
- Monochromatic image - no color contrast
  - Limits object detection and recognition

Review of USAF Class A NVG Mishaps Since 1990

- Spatial Disorientation - MH-60
- Spatial Disorientation - A/OA-10
- Wire Strike - MH-60
- Spatial Disorientation - A/OA-10
- Spatial Disorientation - F-16
- Unknown / Mid-Air Collision - HH-60s
- Brown Out / Loss of Control - MH-53
- Channelized Attention / Mid-Air - F-16
- Misperception / Hard Landing - HH-60
- Misperception / Tail Rotor Strike - MH-53

Review of USAF Class A Fighter / Attack NVG Mishaps

- Spatial Disorientation - A/OA-10
- Spatial Disorientation - A/OA-10
- Spatial Disorientation - F-16
- Channelized Attention / Mid-Air - F-16

Visual Perception with Night Vision Goggles

- What NVGs do is obvious - but, what they don't do must be learned
- Aviators ***consistently overestimate*** their visual performance with NVGs
- A tendency to **misperceive distance & closure** is especially important (and almost universal)

Visual Perception with Night Vision Goggles

- Overreliance on visual cues frequently leads to a poor / breakdown of cockpit scan
- Combined with the limited FOV of NVGs, the likelihood of an unusual attitude is increased

Visual Perception with Night Vision Goggles

- Misperceptions of distance resulting from an overreliance on visual cues sometimes result in a flight path that is lower and closer (and steeper?) than intended
- This Loss of Situational Awareness is not an uncommon occurrence
- This is a significant TRAINING issue !!

Demonstration vs Training

- It is ABSOLUTELY ESSENTIAL that the distinction between demonstration and training be understood
- TRAINING implies that the trainee has undergone a process resulting in an actual change in behavior, performance, perception or response
  - not just “informed” regarding some fact or principal
- Merely demonstrating something is NOT training

Training vs Demonstration

- **TRAINING** is accomplished most effectively in the context of weapon system "operation"
- It is best done in conjunction with other relevant tasks in an actual aircraft or high-fidelity weapon system trainer
  - It is important to duplicate the actual flight environment as realistically as possible

Limitations of Training

- It also MUST BE UNDERSTOOD that even the most effective training has definite limits
- Learned strategies or responses are effective only when there is some recognition that they are required in a particular situation (a change in behavior or perception)

Limitations of Training

- Effective training can acquaint aircrew with regimes of flight that predispose them to disorientation (changing their behavior, performance, perception and / or response)
- Training can be an effective means of enabling aircrew to recognize a Spatial D event (convert Type I to Type II), <u>BUT</u> -

Limitations of Training

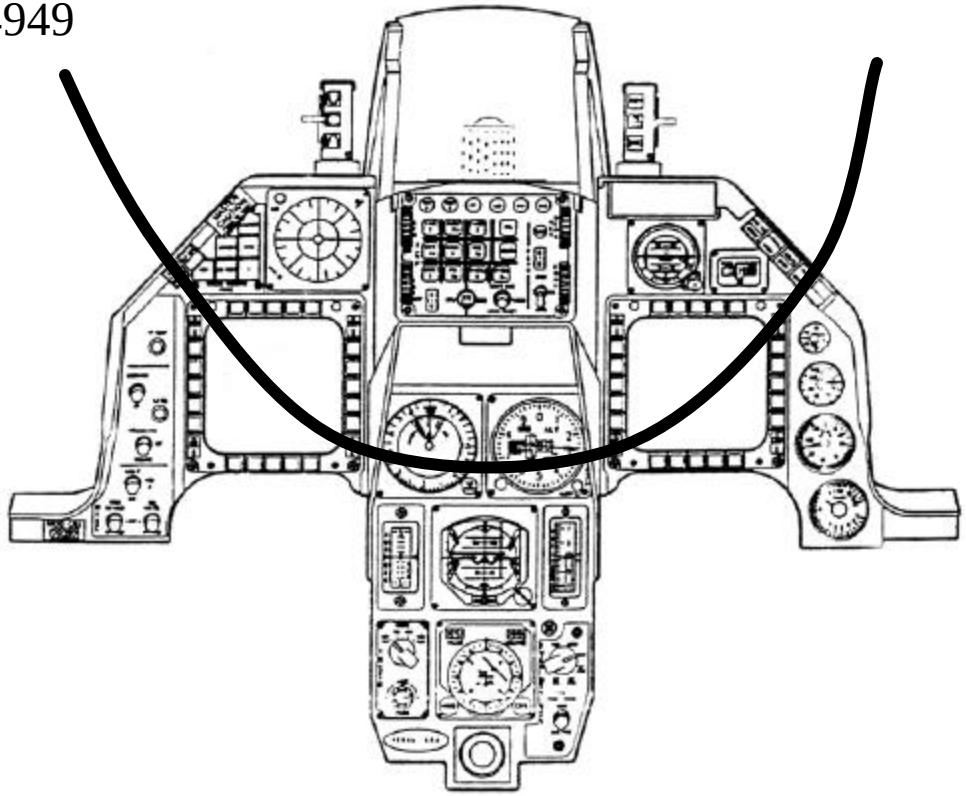
- **We must concede that training per se is not a specific solution for Type I Spatial D or GLOC**
- **Aircraft ground collision avoidance systems can be *infinitely more effective !!***

Goggle Effects on Unaided FOV and Scan Patterns

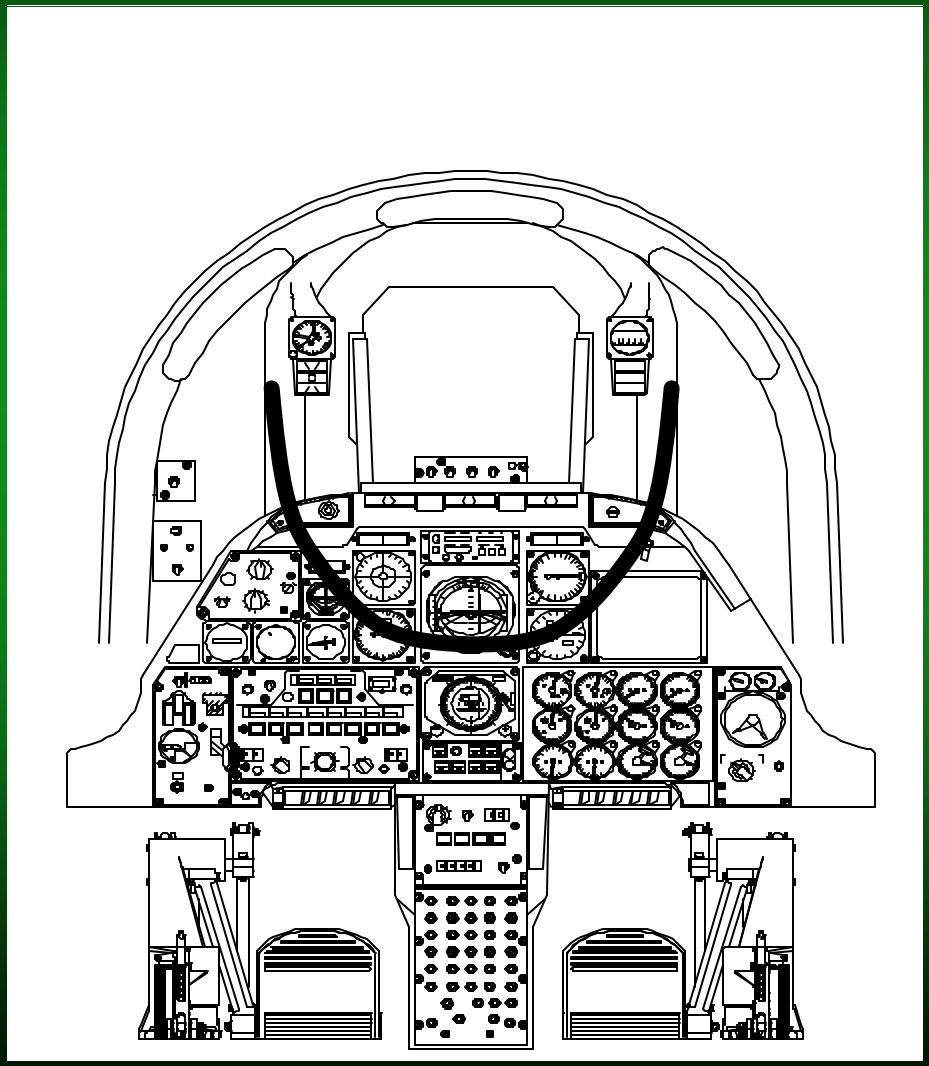
- NVGs are used to look outside the aircraft
- Cockpit Instruments and displays (except a HUD) are viewed by looking beneath or around the goggles
- The goggle obstructs a +/- 45 degree cone of vision (40 degrees + 2.5 degrees surrounding the image)
  - Pilots must modify their cockpit scan to accommodate this obstruction of vision

NVG Obscuration of F-16 Displays

F-16 F4949



NVG Obscuration of A-10 Displays



Increased FOV of Integrated Panoramic NVG (IPNVG)

- The increased FOV of the IPNVG will improve, but not eliminate, the problems associated with limited FOV
- However, it will increase the obstructed area of the unaided FOV
  - This effect can be partially ameliorated by injecting flight symbology into the IPNVG image

40 Degree vs 40 X 100 Degree FOV

The Role of NVG Cockpit Lighting in Spatial Disorientation

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* Significant lighting deficiencies

The Role of NVG Cockpit Lighting in Spatial Disorientation

- Incompatible or partially compatible lighting is a particular hazard
- The natural tendency is to turn it down in order to reduce blooming and / or reflections
- However -- as a rule, an incompatible display *cannot be made compatible by turning it down*
- The result is a display that is less readable, or unreadable, AND still incompatible with NVGs !!

The Role of NVG Cockpit Lighting in Spatial Disorientation

- Poor illumination of primary flight instruments has been a significant problem in NVG operations (30% of mishaps)
- It can take up to several seconds to adapt from a bright NVG image to a dim cockpit display !!
  - The ADI has been a particular problem due to the “depth” of the instrument
  - ADI readability can vary dramatically with changes in aircraft attitude

Human Factors Accident Prevention

- It is not enough -
  - To identify the specific causes
  - To understand the human factors
  - To "teach" aviators about the risks
- We also must -
  - Design aircraft and equipment and conduct our training and operations in ways that significantly reduce *unnecessary risk!!*

The Brain-Dead Customer's View of Spatial Disorientation Training

- Why hasn't the leadership "bought in" ??
  - Why hasn't the incidence decreased ?
  - The "Willie Sutton Principle" (go where the money is)
  - (But there isn't any money)
- Motion vs No-Motion training devices
  - We already have a motion-based system (THE AIRCRAFT)
  - (But there isn't any money for additional sorties)

The Willie Sutton Principle

Can you make our existing resources more effective?

Can you help keep us from making things worse?

- HUD's, HDD's and especially HMD's

Don't forget that our sole justification for existence is

TO KEEP THE PEACE !!

(But there isn't any money)

USAF Research Laboratory
Department of Philosophy

PEOPLE

DON'T MAKE MISTAKES

ON PURPOSE !!

FLY BY NIGHT TRAINING TEAM

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