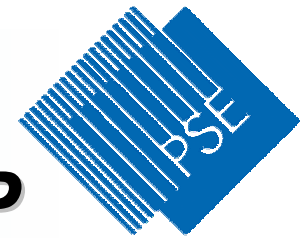




Limits of Display Realism: Human Factors Issues in Visualizing the COP



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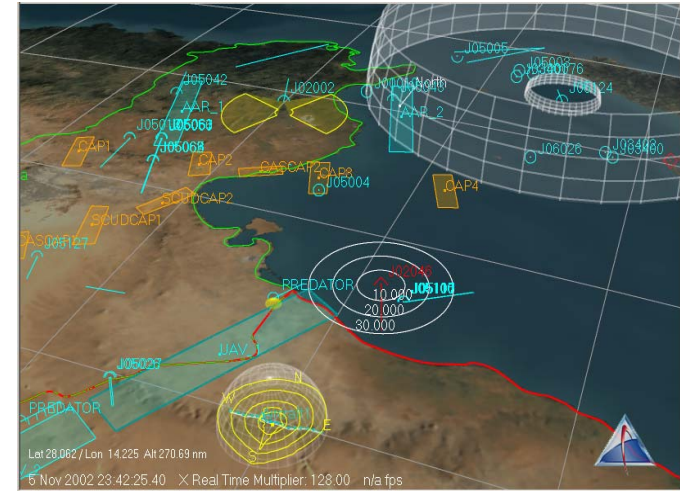
Overview

Vision of future COP

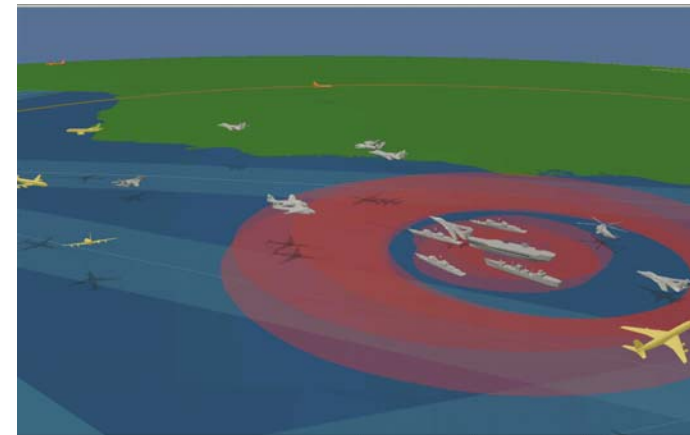
- Integrated, augmented tactical picture for SA

How to visualize COP?

- Realism thought intuitive, useful
 - » 3D spatial realism
 - » Temporal realism
- but realism is no panacea
 - » Naïve Realism



www.stk.com



from Dennehy, Nesbitt & Sumey (1994)

Our studies on tactical visualization

Promoting SA

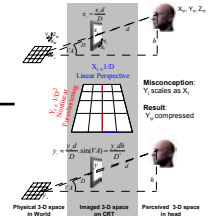
— Where (representing space) —————



— How (match displays to tasks) —



— Why (space perception) —————

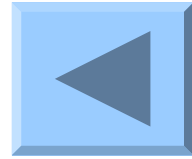


— What (representing objects) —



Maintaining / Recovering SA

— When (representing time) —————



Where: Our task distinction

St. John, Cowen, Smallman & Oonk (Human Factors, 2001)

3-D is better for understanding the overall shape of an object

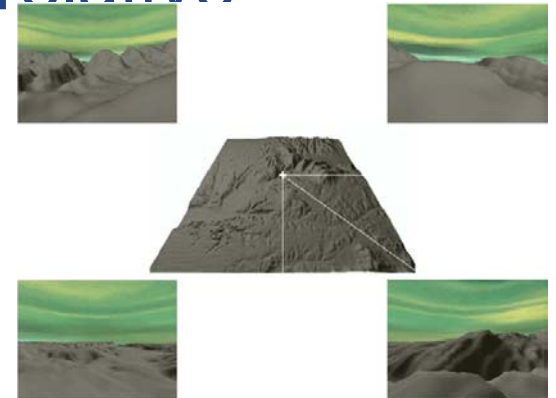
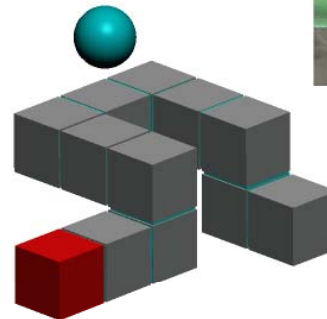
- Or *Gestalt* of a scene

2-D is better for precisely judging relative positions (RPs)

- Distances and angles

Series of experiments

- Simple block stimuli
- Terrain stimuli



How: New HF display guideline

StJohn, Smallman, Bank & Cowen (HFES, 2001)

Orient then Operate

Orient to a scene in 3-D

- Quickly understand scene layout

Operate on a scene in 2-D

- Precision judgments

Series of experiments

- Antenna task
- Initial route planning
- Display combinations



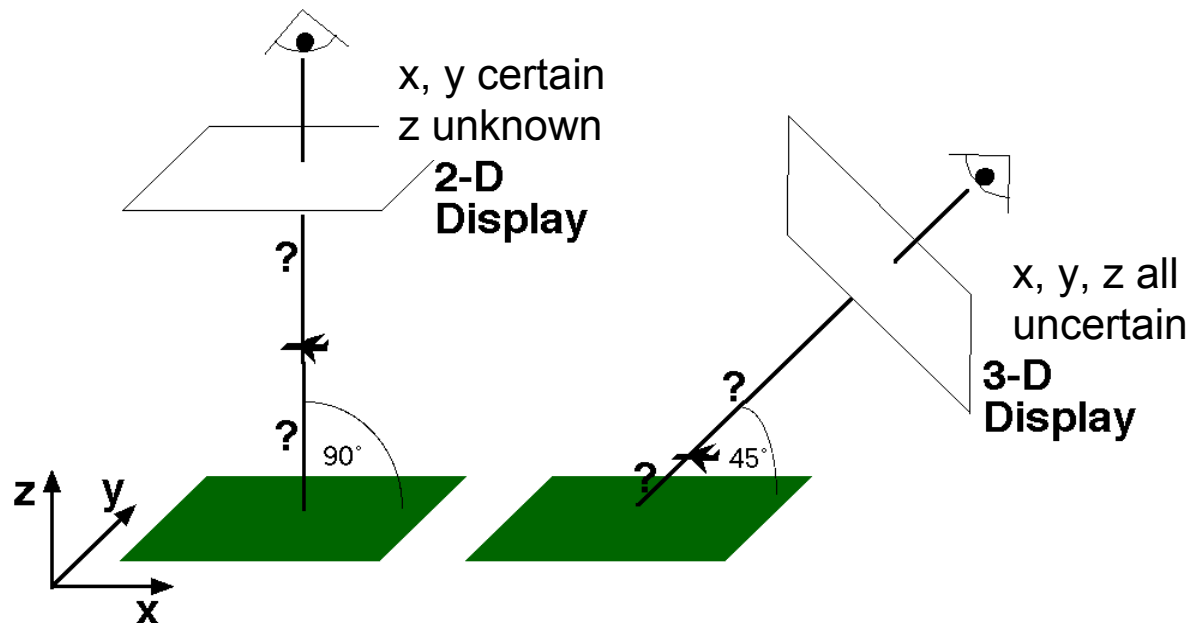
Why: Spatial Precision & Viewpoint

Always understood that 3-D views needed augmentations

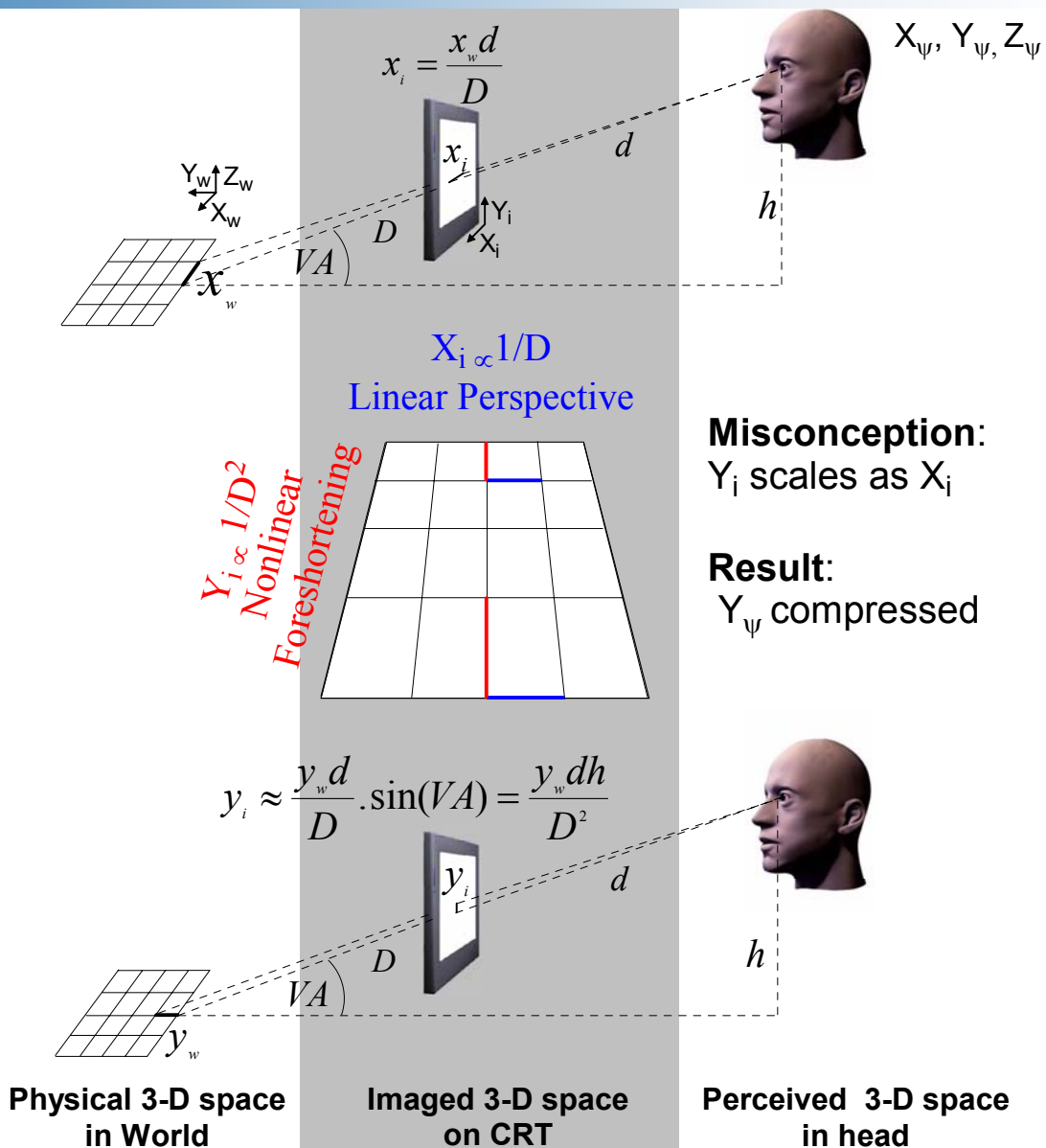
- Drop-shadows, drop lines

Inherent misperception of 3-D views less appreciated

- Flawed reconstruction
- Distance compression



Why: Cross-Scaling model

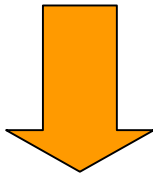


Misconception:
 Y_i scales as X_i

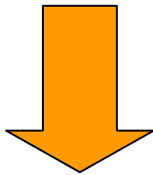
Result:
 Y_ψ compressed

Why: Modeling perceptual error

- **Misconception:** “things get smaller in the distance (equally in X and Y)”

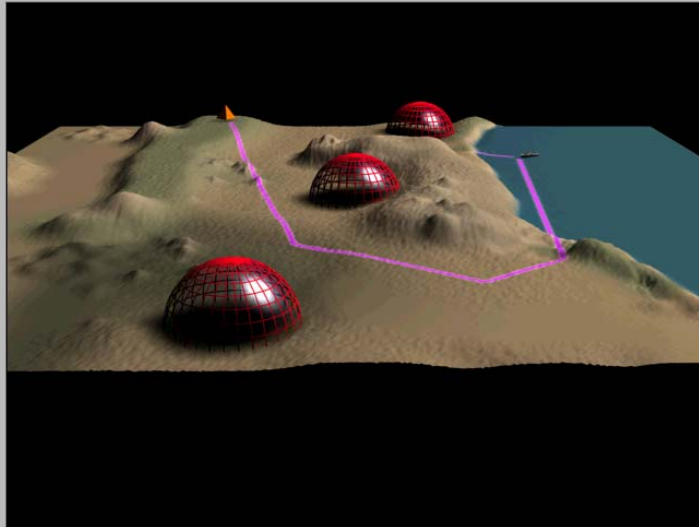


- **Misperception:** distances underestimated.



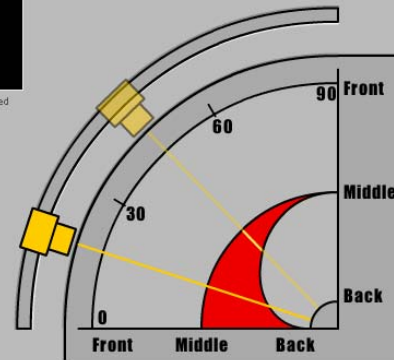
- **Human Factors implication:** Distorted space perception with 3D. Worse at shallow viewing angles.

3D display concept from the model



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Perspective View Modeling
3D Demo



What: The limits of realistic icons

e.g. Smallman, StJohn, Oonk & Cowen (*HFES*, 2001)

Realistic icons are poor for identification

- Better for heading and classification

Symbols are poor for heading and classification

- Better for identification and affiliation

Series of experiments

- Visual search
- Naming
- Memorization



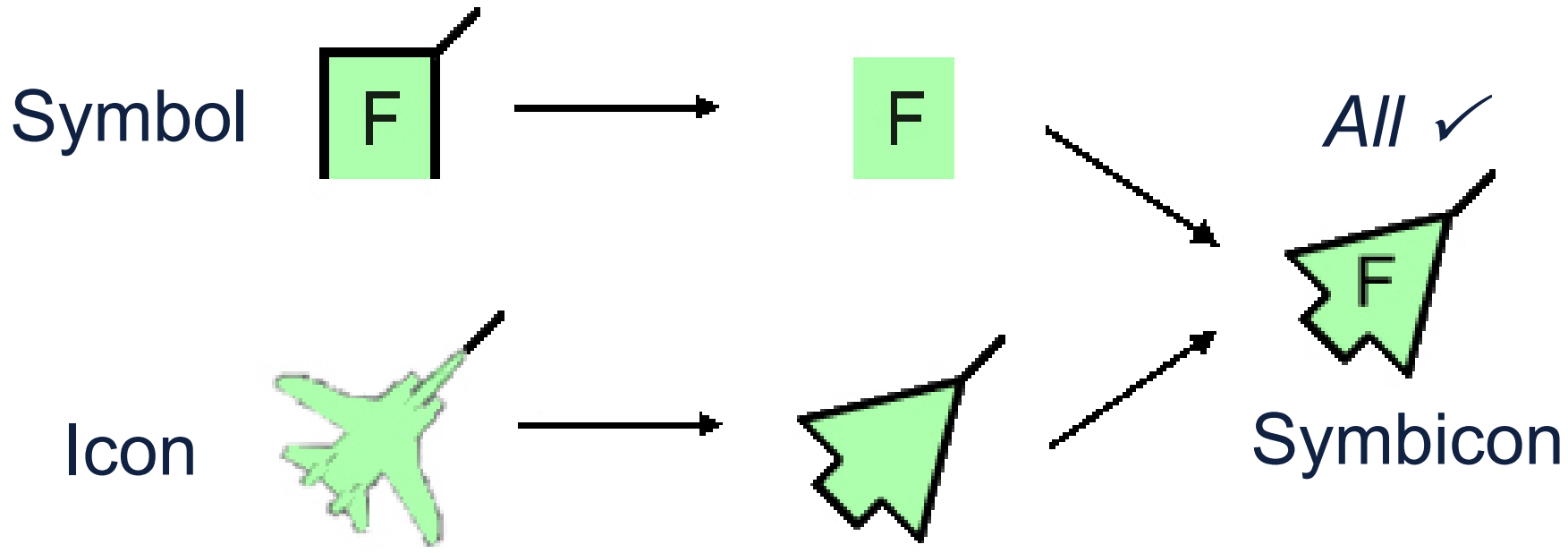
Mil Std. symbols



realistic icons

What: SYMBols + ICONs = SYMBICONS

Platform ✓ Affiliation ✓ Heading ✗ Category ✗

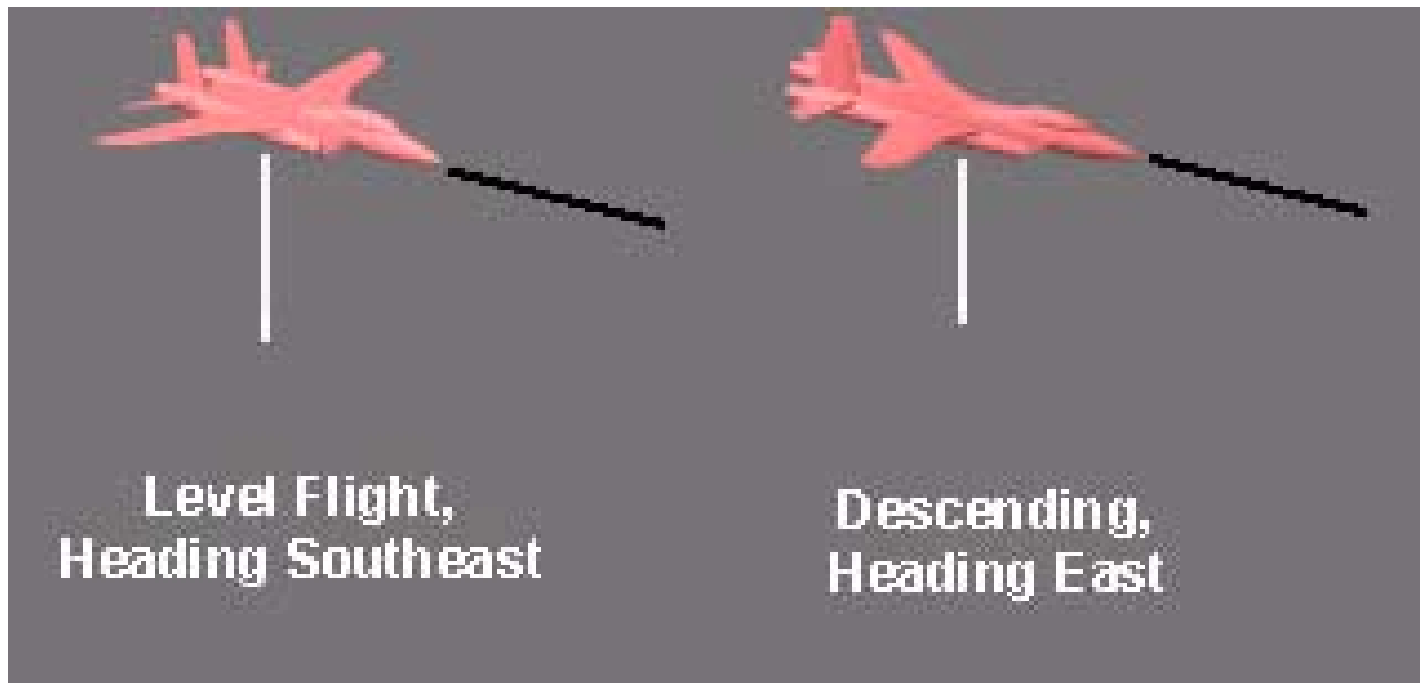


Platform ✗ Affiliation ✗ Heading ✓ Category ✓

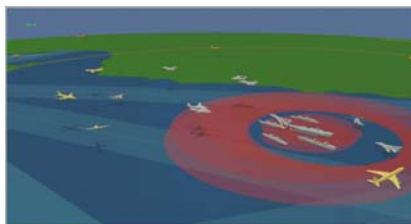
What: Beauty of 3D icons is skin deep

3D perspective views conflate symbolic and spatial information

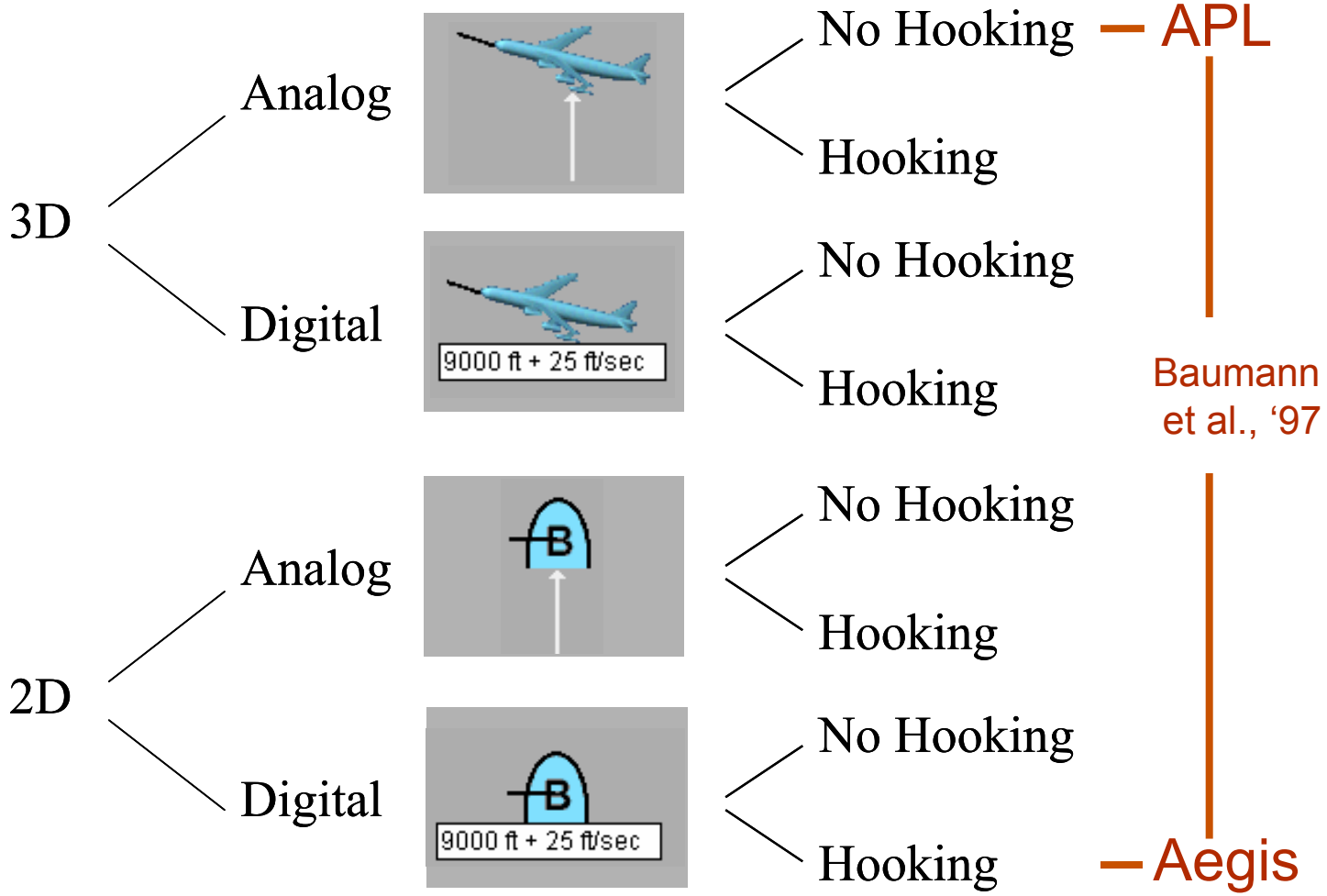
- Shape triple codes for identity, heading & pitch. Results in ambiguous depictions



What: 2D/3D interface details



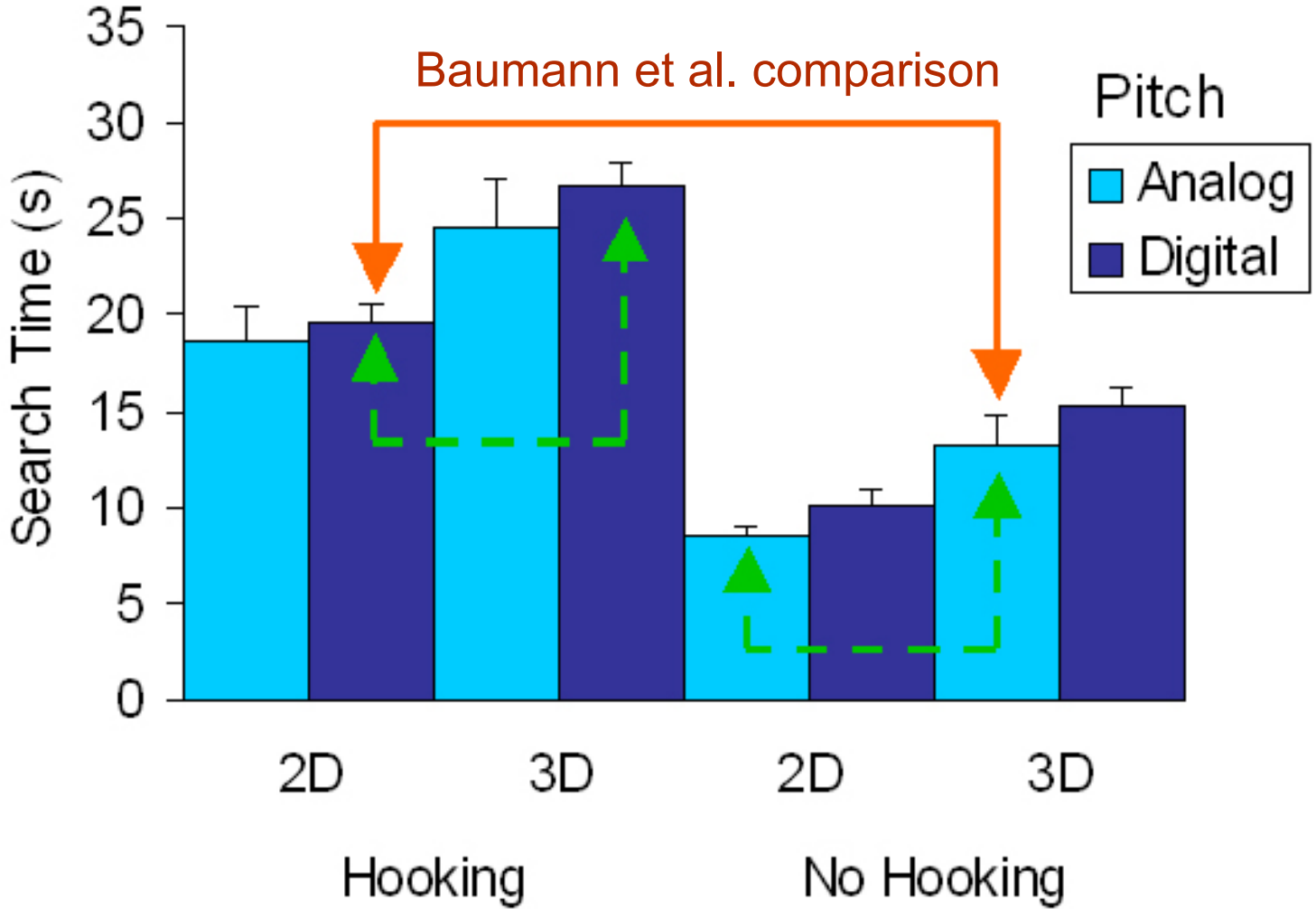
versus



Baumann et al., '97

What: 2D/3D interface details

Smallman, StJohn, Oonk & Cowen (*IEEE*, 2001)



When: Displays and change

Operators monitor displays for relevant changes
Attentional limitations make task extremely hard

- frequent task switching
- high workload
- multiple distractions
- unfiltered auditory alerts

SA tough to maintain, tough to rec
Change awareness key part of SA



When: “Change Blindness”

Spot the change...



(“Airplane.avi” file, Ron Rensink)

When: “Change Blindness”

Easier now?



(“Airplane no gray.avi” file, Ron Rensink) 17

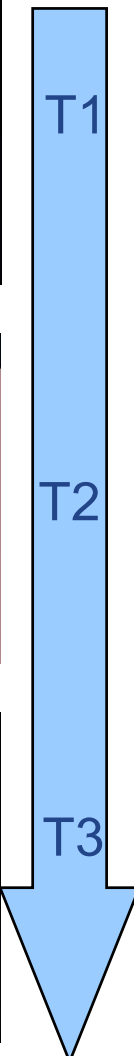
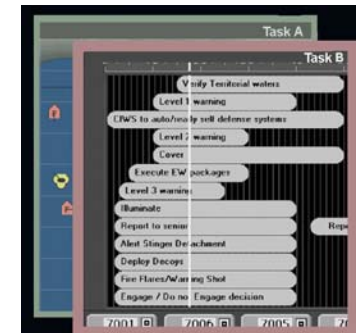
When: Evaluating SA recovery

Geoplots show present state

- Temporally realistic
- Requires cognitive integration/comparison over time
- Poor SA recovery

SA recovery tools

- Visual Replay
 - » Replay of sequence missed maintaining temporal integrity (realistic)
 - » Worse than no help at all (St. John et al., 2004)
- CHEX (Change History Explicit)
 - » Changes extracted and linked to display
 - » Temporal filtering necessarily unrealistic
 - » 80% RT improvement (Smallman et al., 2003)



What changed?

Metatheory: Naïve Realism

Origins in Perception

- Over-confidence in perceptual abilities from apparently effortless, rich perceptual world (e.g., Levin, Cavanagh)
- Perception actually **flawed** from simplifying heuristics and **Spartan** from attentional limitations

Implications for display design

- Users desire displays to mimic that which they represent
- Reinforced by existing HF principles (e.g., *Pictorial Realism* Roscoe, 1968)
- Enabled by advances in technology, push for photo-realism
- “Mimic the medium rather than facilitate the message” (Hollan & Stornetta, 1992)

Implications for research & development

- Emphasis on researching new ineffective realistic tools (e.g., animation, replay)
- Neglect of researching existing, ineffective realism (e.g., monitoring displays)

Conclusions / Recommendations

Real-Time 3D!

Spatially realistic

Temporally realistic

Technology is enabling it, users desire it,
designers think they should strive for it

But it forces users to fall back on their own,
flawed perceptual abilities

No substitute for task analysis and displays
that make task-relevant information
explicit, conspicuous and discriminable