Shared Displays:
An Overview of Perceptual and Cognitive Issues

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Overview

- Observations
- Defining a Shared Display
- Perceptual Issues
- Cognitive Issues
- Current AFRL/HE Research
- Summary and Conclusions

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- **Observations**
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Data Wall*

Observations from JEFX-06

- Legibility problems
- Color reproduction problems
- Menus and control icons obstruct view
- COP too cluttered
- Lack of useful information

* Data Wall refers to large-screen shared displays

Large Screen Shared Displays

Issues:

- **Legibility, Use of Color, Formatting**
- **Navigation and Control**

the easy parts

- **Decision Quality Information**
  - **The right information at the right time in an easily understandable format**
  - **Support sensemaking in complex environment**
    - **Asymmetric warfare**
    - **Effects-based operations**
    - **Coalition**

the hard parts

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Defining a Shared Display

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Perceptual Issues

Can I see it? Can I read it?

- **Location**
- **Viewing Distance**
- **Viewing Angle**

Eye Rotation Only	
-	Optimum: 15° left to right
-	Maximum: 35° left to right
-	Optimum: parallel and down 30°
-	Maximum: 25° above parallel; 35° below parallel
Head Rotation Only	
-	Optimum: straight ahead
-	Maximum: 60° left to right
-	Maximum: 50° above and below parallel
Eye and Head Rotation	
-	Optimum: 15° left to right
-	Maximum 95° left to right
-	Optimum: parallel and down 30°
-	Maximum: 75° above parallel

Perceptual Issues

Can I see it? Can I read it?

- **Visual Acuity**

Subtended Angle: General Equations

On-Axis viewing

$$\omega_1 = \frac{3438 \times \text{Symbol Height}}{\text{Viewing Distance}^*}$$

Off-Axis Viewing

$$\omega_2 = \frac{\omega_1 (\cos \alpha)^K}{\text{Viewing Distance}^*}$$

ω = Subtended angle in minutes of arc

α = Off-axis angle

* = Distance from viewer to screen along line-of-sight

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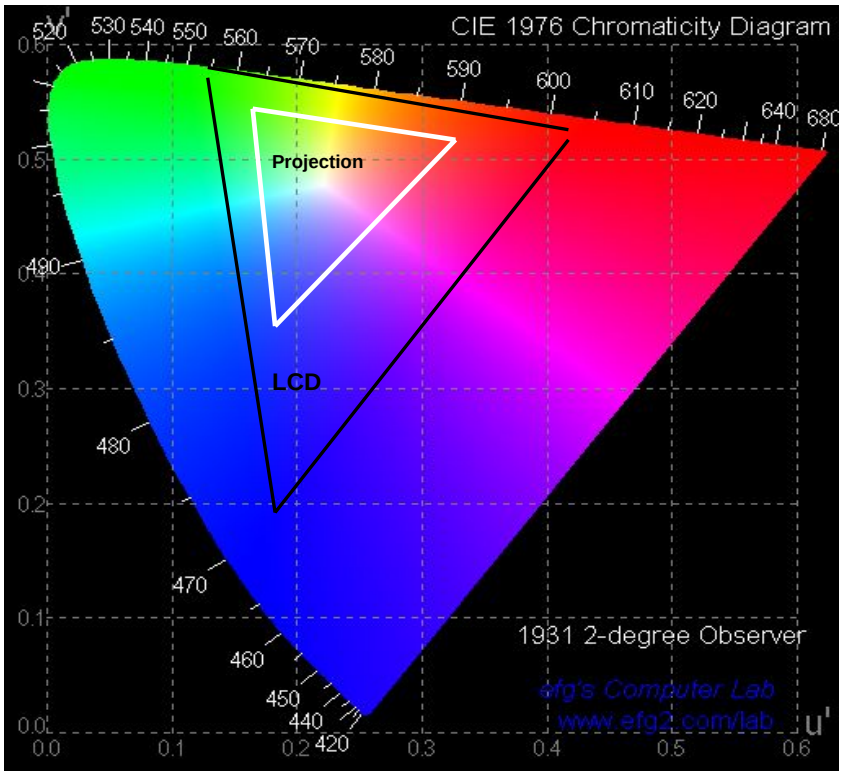
Perceptual Issues

Common Display Measurements

- Viewing Angle Effects upon Luminance, Contrast and Color
- Display Color Gamut & Color Coordinates
- Display Luminance Range and Contrast Ratio
- Uniformity of color and luminance
- Ambient Illumination Effects upon Contrast
- Readability
- Power Consumption

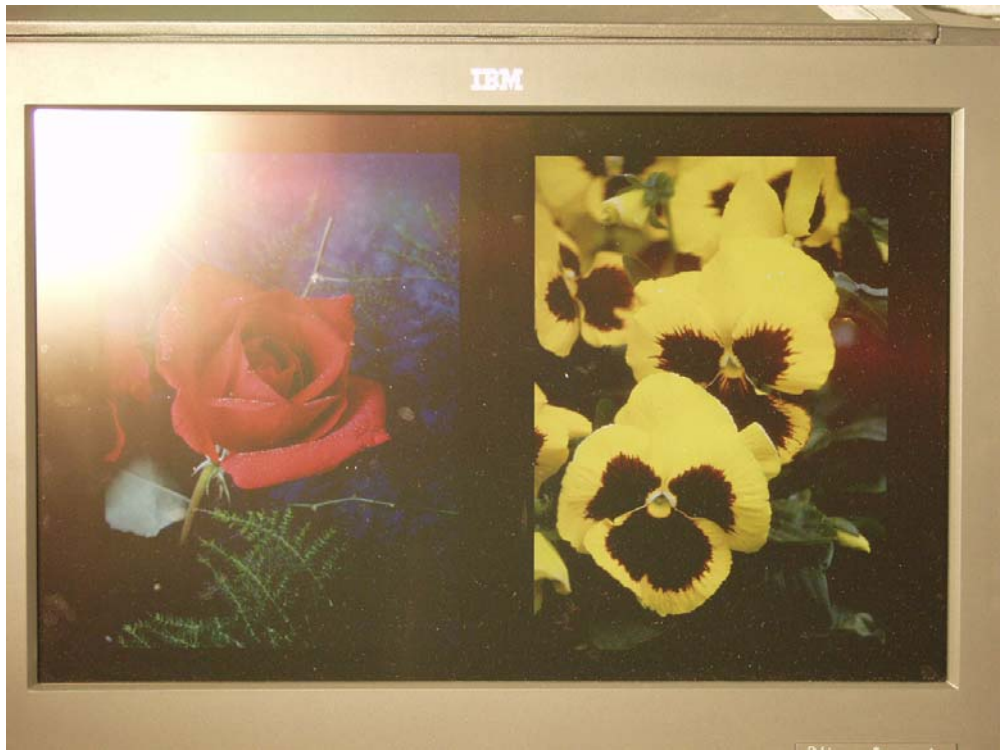
Perceptual Issues

Display Color Gamut



Perceptual Issues

Ambient Illumination Effects



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Cognitive Issues

Data Wall – Hardware that creates a large, wall size, computer driven graphic display with high resolution that operates as an integrated desktop.

Knowledge Wall – A concept for *the application of decision support tools to a data wall* that supports group decision making & collaboration.

Definitions from SPAWAR Command 21 Briefing – Jeffrey Morrison

Cognitive Issues

- Situation Awareness
- Cognitive Task Analysis
  - Task Definition and Task Support
- Data Visualization
- Information Sharing
- Display Control

Cognitive Issues

Situation Awareness

- **Perception of elements**
- **Understanding the elements**
- **Projecting future states**

Cognitive Issues

Cognitive Task Analysis

- Analytical tools for understanding task requirements and goals
  - Part of a Work Analysis
  - Normative approach
  - Human Computer Interaction (HCI)

Cognitive Issues

Cognitive Task Analysis

- **Observing is not enough**
- **Collaboration requirements**
  - **Teams or Cells**
- **Subject Matter Experts (SMEs)**

Cognitive Issues

Data Visualization

- Graphics
  - 2D or 3D
- Data
  - High level
  - Low level

Cognitive Issues

Information Sharing

Cognitive Issues

Display Control

- **Many users or few users**
  - **Individuals**
  - **Teams**

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Current AFRL/HE Research

Change Awareness

Current AFRL/HE Research

Situation Awareness

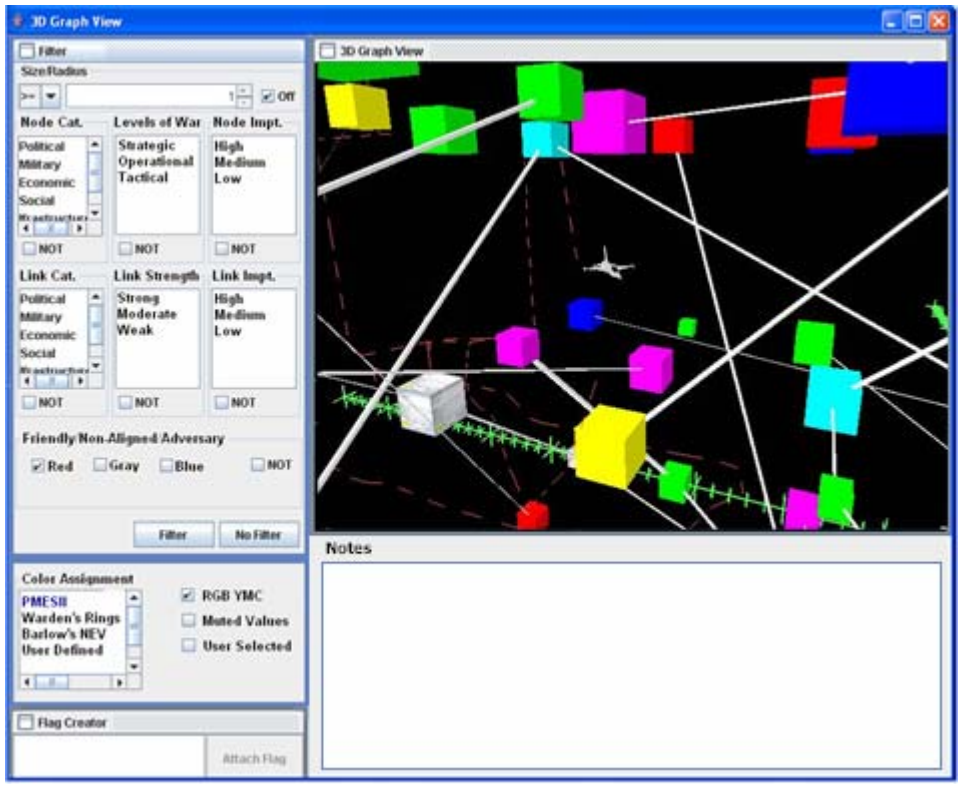
Current AFRL/HE Research

Data Visualization and the Tailored COP

Current AFRL/HE Research

Data Visualization – 3D

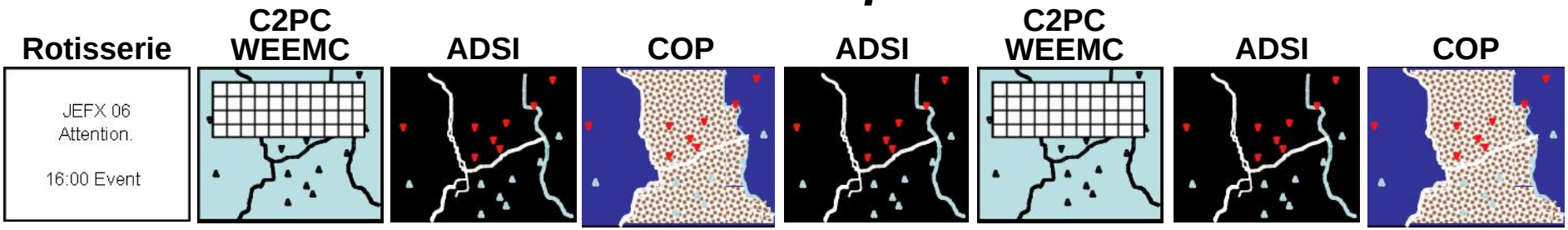
3-D OE Understanding



2D Workspace

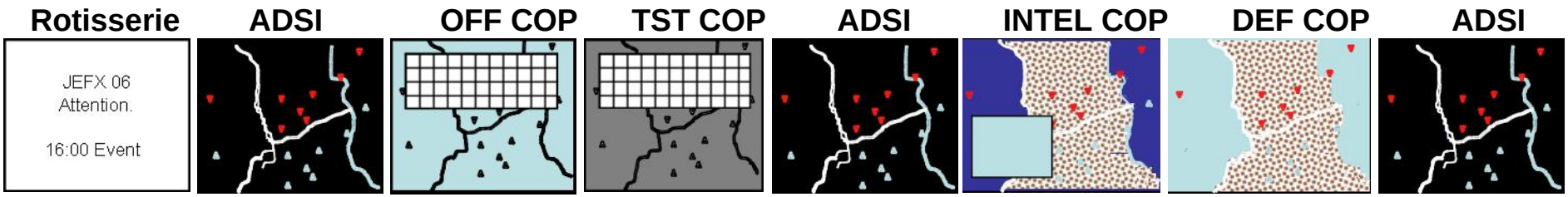
Tailored COP

JEFX-06 Combat Ops Data Wall



Data Wall arrangement on Jan 15 of Spiral 2.

A Possible Solution to Cluttered COP: *Tailored COPs*



Other Possible Solutions

Other COPs used in JEFX'06 Main-Ex

- **High value targets**
- **Tracking blue forces and CAS**
- **Naval surface tracks**

Tailored COP

Approach

- **Perform Cognitive Work Analysis**
  - **Determine what information would be most useful on shared displays**
  - **Explore whether some shared displays should be focused / tailored for specific groups / teams.**
    - **Document novel ideas from experts**
  - **Explore how shared display usage complements individual workscreen usage**
  - **Determine how shared displays might be made interactive for collaboration**
    - **Operator control**
    - **Master modes - as in multi-place aircraft**
- **Prototype Combat Ops Knowledge Wall**
- **Test**
  - **Limited Objective Experiment**
  - **Operationally Relevant Environment**

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Summary and Conclusions

Shared Displays

- Goals
  - Support task performance
  - Facilitate shared display
- Functions

Summary and Conclusions

Shared Displays

- Perceptual Issues
- Cognitive Issues
- The Future