

# Verification & Validation Summit

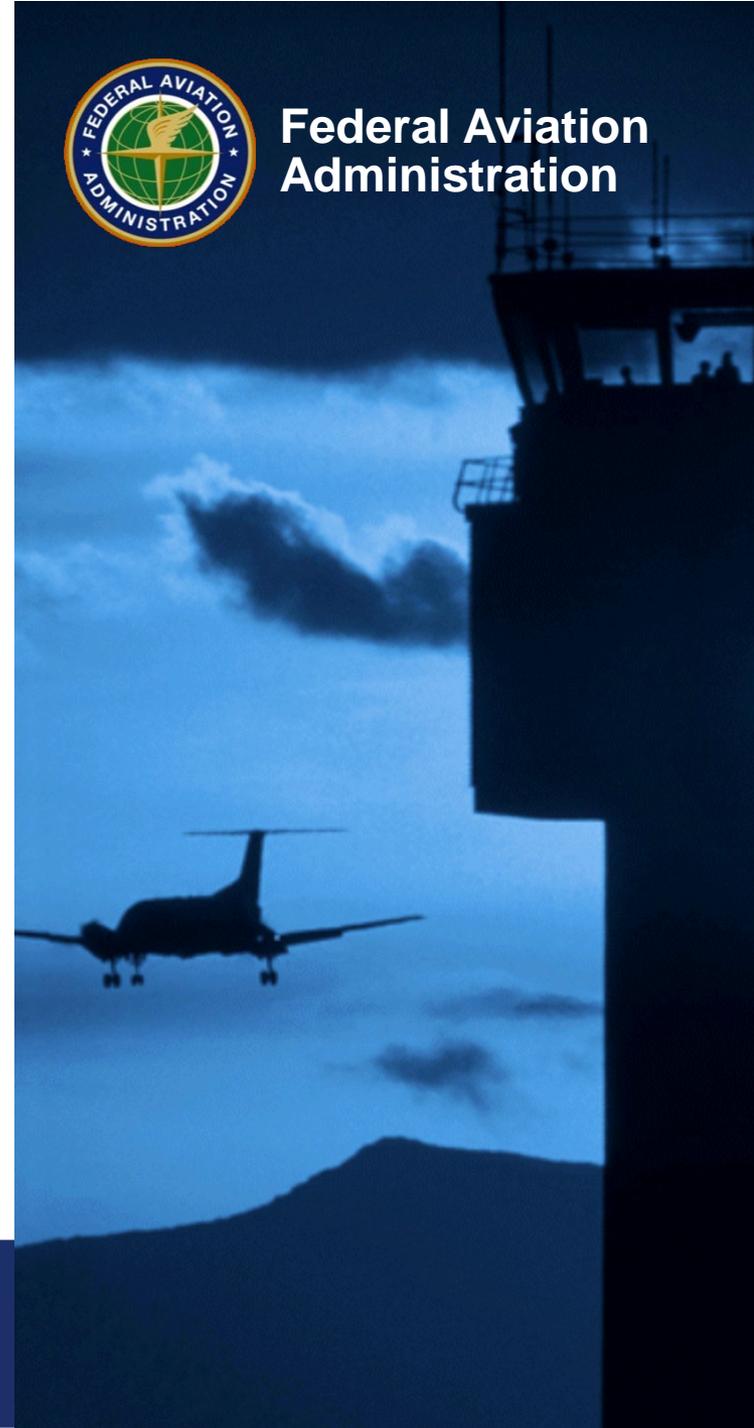
## Human Factors Test & Evaluation

Eric Neiderman, Ph.D., ANG-E25

October 20, 2011



Federal Aviation  
Administration





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# Overview

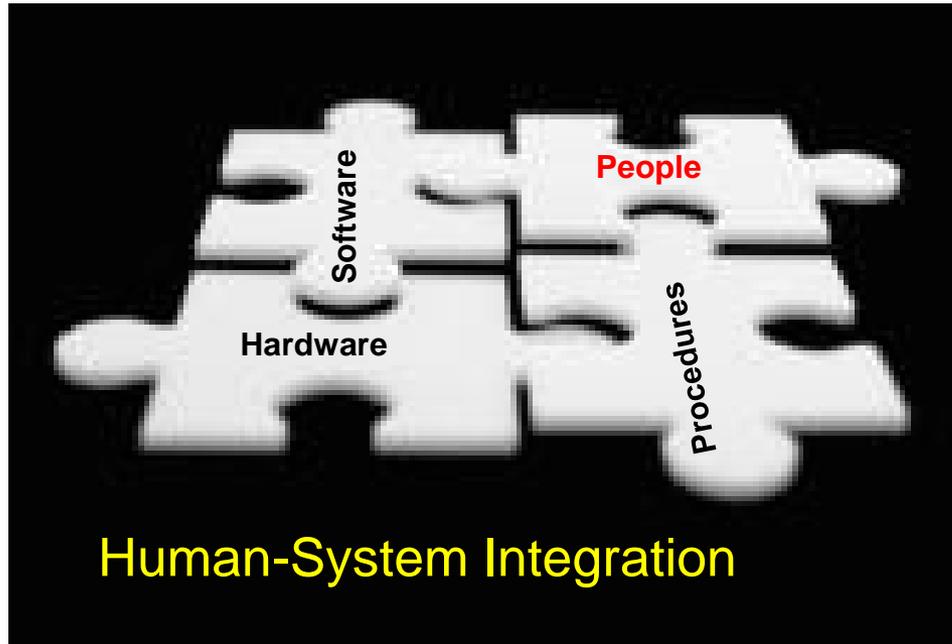
**Background / Human Factors Trends**  
**Test & Evaluation**  
**Capabilities and Tools: Issues**  
**Future Direction**



# Background Human Factors Trends



# Background: Human Factors Trends



# Background: Human Factors Trends

## 1. Unintended Consequences of Technology

**Acute Event = ↑ Technology + ↑ Chronic Attention**

(Tenner, 1997)



# Background: Human Factors Trends

## 2. Computerization / Interaction with Technology



(Cooper, 1999)

+



=



# Background: Human Factors Trends

## 3. Changing work and workforce



- On site specialist
- Corrective maintenance (fix it when it breaks)
- In depth, site-specific knowledge-in-the-head

***$\Delta$ Technology +  $\Delta$ Tasks = Human Factors Challenges***



# Background: Human Factors Trends

## 3. Changing work and workforce



- On site specialist
- Corrective maintenance (fix it when it breaks)
- In depth, site-specific knowledge-in-the-head



- Remote maintenance by generalist relying on integrated sensors
- Preventative maintenance (fix it before it breaks)
- Electronic database of knowledge

**$\Delta$ Technology +  $\Delta$ Tasks = Human Factors Challenges**



# Background: Human Factors Trends

## 4. Design philosophy

### Machine-Centered View

#### People

Vague

Disorganized

Distractible

Emotional

Illogical

#### Machines

Precise

Orderly

Undistractible

Unemotional

Logical

(Norman, 1998)



# Background: Human Factors Trends

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### Human-Centered View

#### People

Creative

Compliant

Attentive to

Change

Resourceful

#### Machines

Unoriginal

Rigid

Insensitive to

Change

Unimaginative

(Norman, 1998)



# Background: Human Factors Trends

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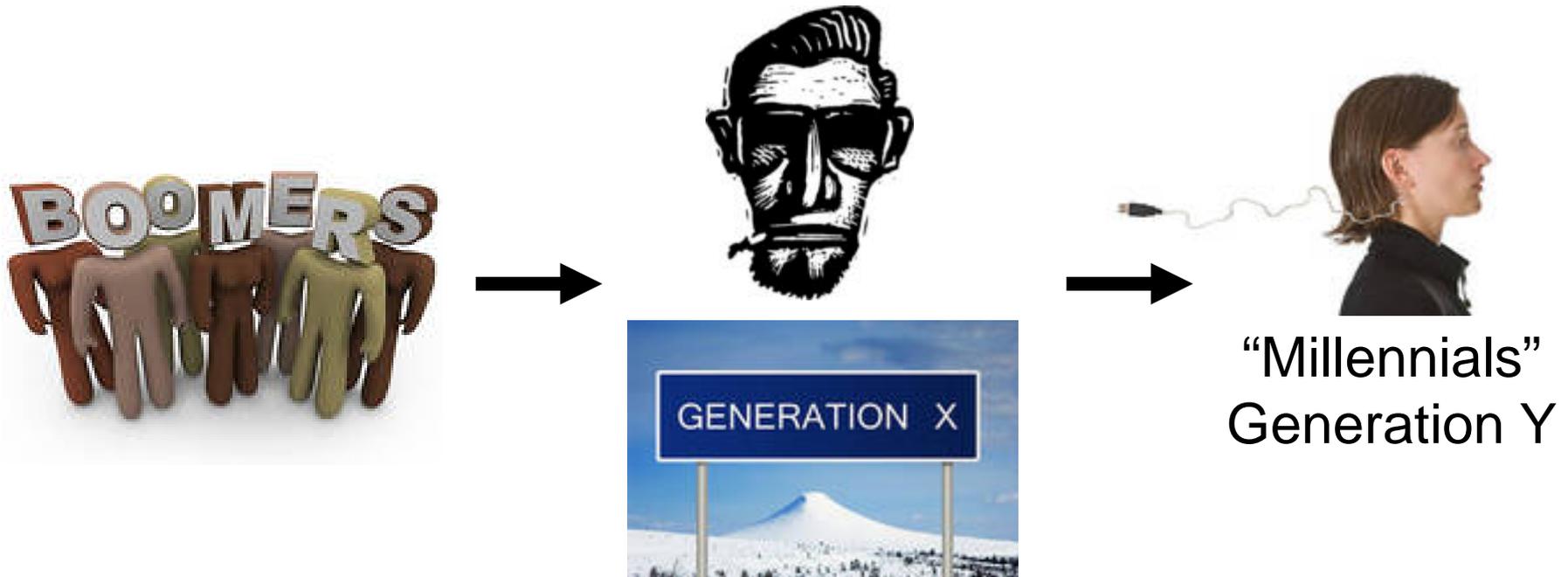
Unimaginative

(Norman, 1998)



# Background: Human Factors Trends

## 5. Generational Differences



# Background: Human Factors T&E



Voevodsky, J. (1974) Evaluation of a deceleration warning light for reducing rear-end automobile collisions. *Journal of Applied Psychology*, 59, 270-273.



# Background: Human Factors T&E



343 SFO taxis with third brake light

160 taxis with no additional lights

Randomly assigned drivers

Ran a 10-month test



# Background: Human Factors T&E



Third brake light:

60.6% fewer rear-end collisions

When struck,

61.1% less injuries

61.8% less repair cost



# Background: Human Factors T&E



Third brake light:

60.6% fewer rear-end collisions

Since the third brake light has been standard (1986):

4.3% fewer rear impacts

200,000 fewer crashes per year

60,000 fewer injuries per year

\$600,000,000 less in property damage per year



# **Test & Evaluation Human Factors Requirements**



# Human Factors Requirements



# Human Factors Requirements



**1. Usability**

**2. Trainability**

**3. Maintainability**



# Human Factors Requirements

## Key Questions

**What is the effect of variables X, Y, and Z on operator performance and how do they interact?**



# Human Factors Requirements

## Key Questions

**What is the effect of variables X, Y, and Z on operator performance and how do they interact?**

**Which of two designs, two sets of training manuals, two procedures (or anything else to be compared) produces more effective operator performance?**



# Human Factors Requirements

## Key Questions

**How effective (in an absolute, quantitative sense) are systems, equipment, and personnel in performing missions, functions, and tasks?**



# Human Factors Requirements

## Key Questions

**How effective (in an absolute, quantitative sense) are systems, equipment, and personnel in performing missions, functions, and tasks?**

**How do personnel feel about a system, equipment, phenomenon, or event; or what do they report about the way they performed; or how well they performed?**



# Human Factors Requirements

## Absolute requirements

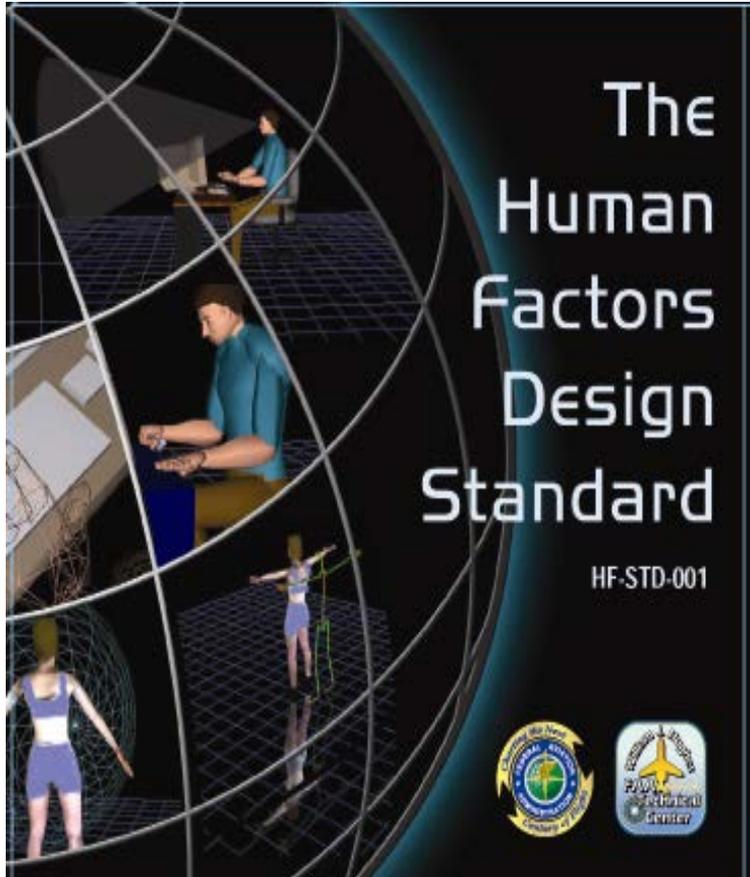
		RECOMMENDED COLORLIST					
		R	G	B	Y	x	y
Red		255	60	60	24.818	0.58033	0.32979
Purple		189	74	206	20.173	0.3001	0.17509
Green		162	240	2	70.006	0.36214	0.55028
Yellow		242	242	85	83.037	0.4024	0.47728
D. Blue		30	80	200	10.183	0.1731	0.12746
Blue 2		74	255	255	80.196	0.23217	0.32876
Brown 2		87	73	65	7.173	0.35549	0.35088
Amber		255	191	0	58.522	0.47316	0.4625
Black		0	0	0	0	0	0
White		255	255	255	100	0.31272	0.329

*Figure 9.* The recommended colors for displays using a black background. The RGB and the CIE-31 values are shown for the 9 color candidates on the black background. These colors, with the exception of amber, were discriminable by 100% of the participants. Amber was only confused by 2 mildly color deficient individuals and is included here.



# Human Factors Requirements

## HF Design Standard



- Available in hard copy, on CD ROM, and on-line.
- Can be tailored for specific acquisitions.
- Contents:
  - **Automation**
  - **Designing for maintenance**
  - **Displays and printers**
  - **Controls and visual indicators**
  - **Alarms, audio, and voice**
  - **Computer-human interface**
  - **Input devices**
  - **Workstation and workplace design**

[www.faa.gov/go/hftac](http://www.faa.gov/go/hftac)



# Human Factors Requirements

## What makes a good requirement?

Criterion	Description
Necessary	Can the system meet prioritized, real needs without it? If yes, the requirement isn't necessary.
Verifiable	Can one ensure that the requirement is met in the system? If not, the requirement should be removed or revised.
Unambiguous	Can the requirement be interpreted in more than one way? If yes, the requirement should be clarified or removed. Ambiguous or poorly worded requirements can lead to serious misunderstandings and needless rework.
Complete	Are all conditions under which the requirement applies stated? Also, does the specification include all known requirements?
Consistent	Can the requirement be met without conflicting with any other requirement? If not, the requirement should be revised or removed.
Traceable	Is the origin (source) of the requirement known, and is there a clear path from the requirement back to its origin?
Concise	Is the requirement stated simply and clearly?
Standard constructs	Requirements are stated as imperative needs using "shall." Statements indicating "goals" or using the words "will" or "should" are not imperatives.



# Human Factors Requirements

What about the squishy stuff?

Totally new capability.

“Soft” requirements – e.g., consistency; fatigue.



**Expert Evaluations /  
Consensus**



**Expert and User  
Evaluations**

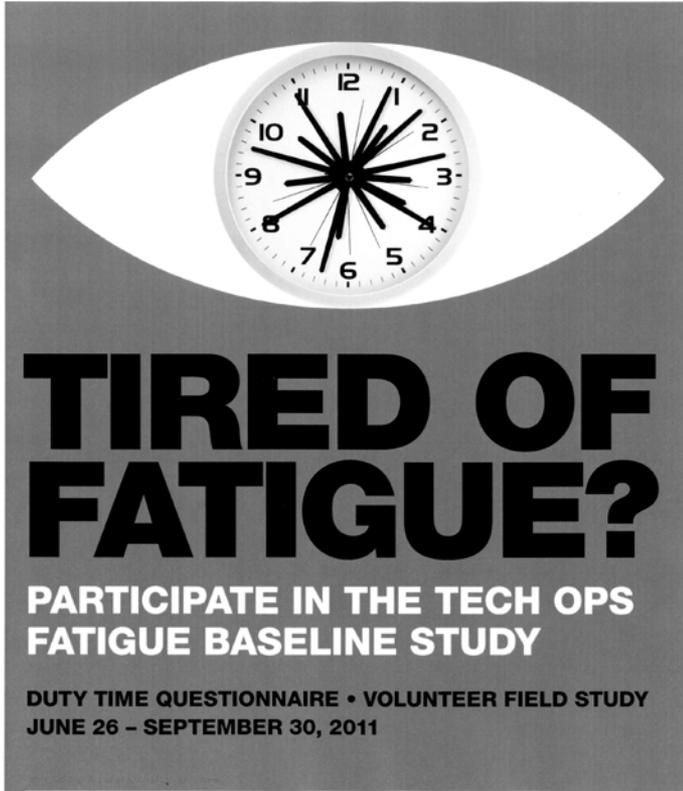


# Human Factors Requirements

Establish the baseline.

## Survey Approach:

- Sleep Quality
- Sleep Quantity
- Perceived Fatigue



**TIRED OF FATIGUE?**  
PARTICIPATE IN THE TECH OPS  
FATIGUE BASELINE STUDY  
DUTY TIME QUESTIONNAIRE • VOLUNTEER FIELD STUDY  
JUNE 26 - SEPTEMBER 30, 2011

employees.faa.gov/go/atofatigue  
Questions? Email: 9-ACT-TECHOPSFATIGUE@faa.gov

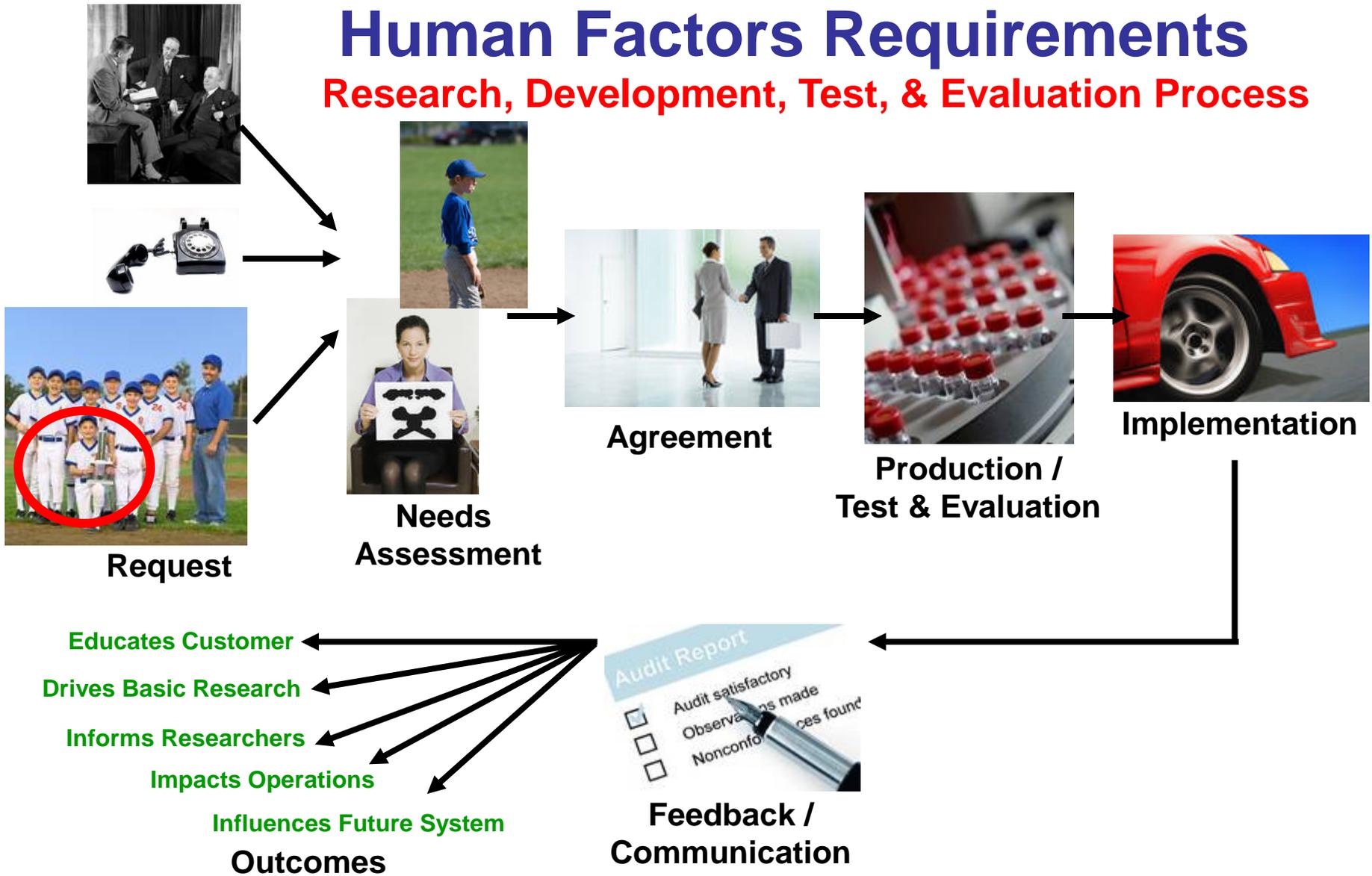


AW-2, AW-Spectrum, AW-Score



# Human Factors Requirements

## Research, Development, Test, & Evaluation Process



# Capabilities and Tools



# Human Factors Methods

- Cognitive Walkthroughs
- Usability Assessments of Existing Systems
- Design and Evaluation
  - Rapid Prototyping
  - Computer-Human Interface (CHI)
  - Workstations and Work Space
- Human-in-the-Loop Simulations
  - In the Laboratory
  - Distributed
- Field Observations & Operational Evaluations



Issue: Control v. Realism



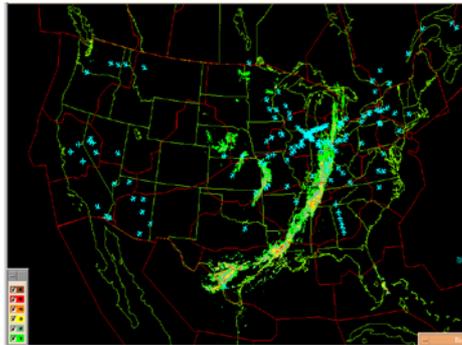
# Human Factors Laboratory Simulation Capabilities



**En Route**



**Terminal**



**Traffic Flow Management**



**Tower**

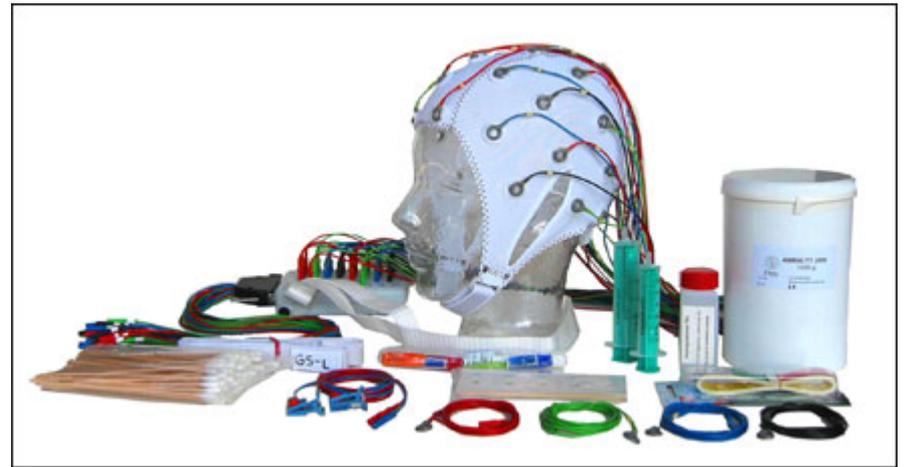
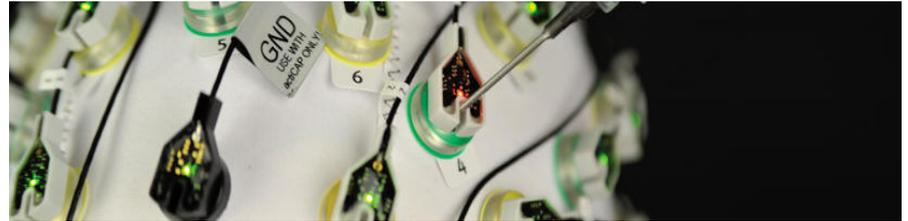
Issue: Integration and Fidelity



# Measurement Tools



**Subjective Workload Assessment**



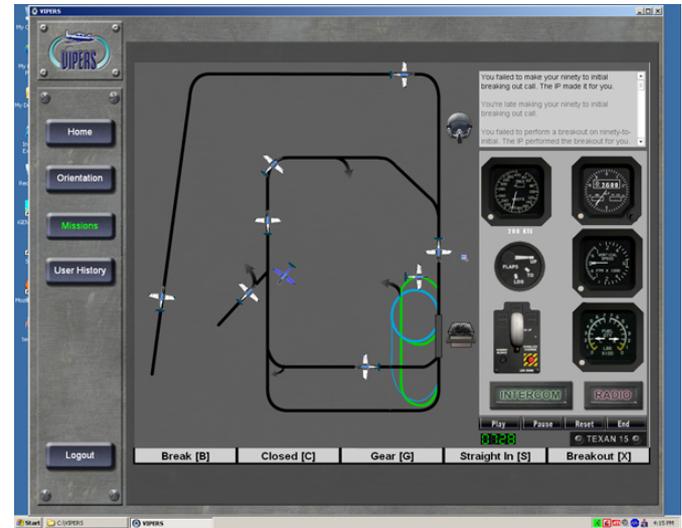
**Electro-Encephalography (EEG)**

Issue: Subjective v Objective Measurement



# Capabilities and Tools

## Cognitive Agents



Issue: Representative and reliable sample



# Capabilities and Tools

## Simulation Capabilities

### Technical Operations



**Traffic Flow Management**



**Tower**



**Terminal**



**En Route**



**Flight Deck**



**Cognitive Agents**



**Ops**

### Full Spectrum Simulation



- Human-System Integration**
- Off-Nominal Events**
- Mixed Equipage**
- Variable Fidelity**



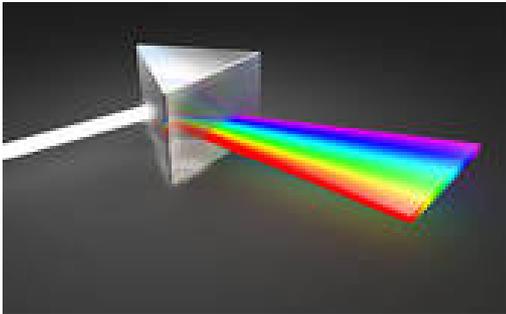
# Conclusion



# Conclusion / Future Directions



- Usability
- Trainability
- Maintainability



# **QUESTIONS ?**

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**Federal Aviation  
Administration**

