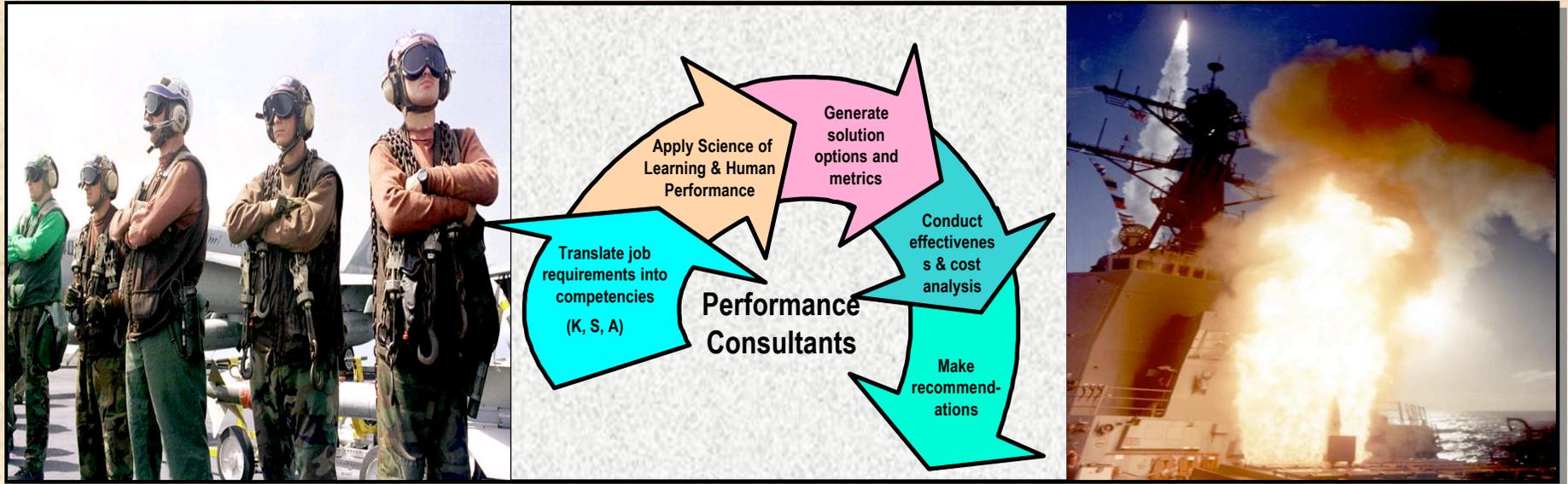




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Integrating HSI & HPI:
Leveraging Metrics to Achieve Performance

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Human Performance Center
N72 Measurement and Evaluation



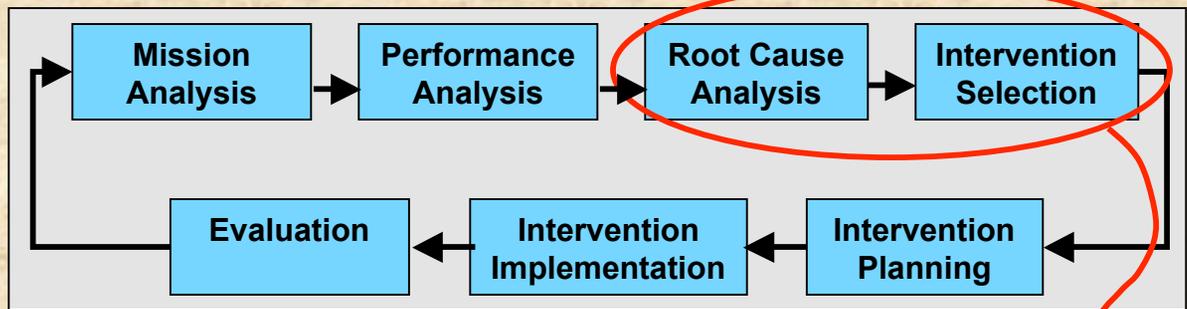
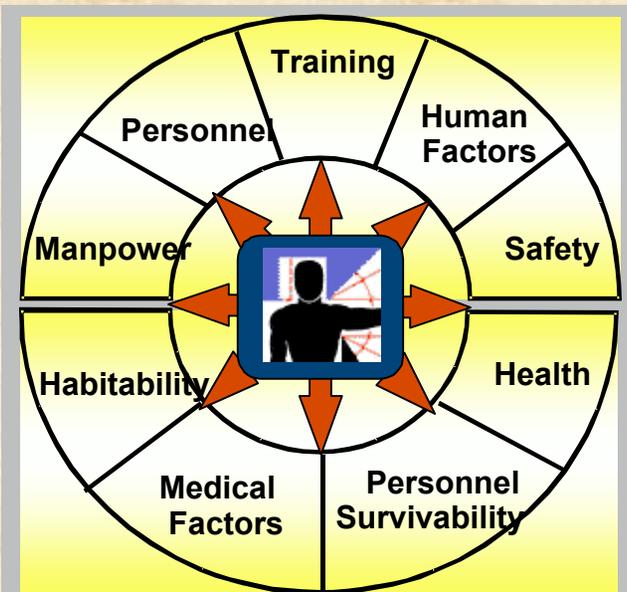
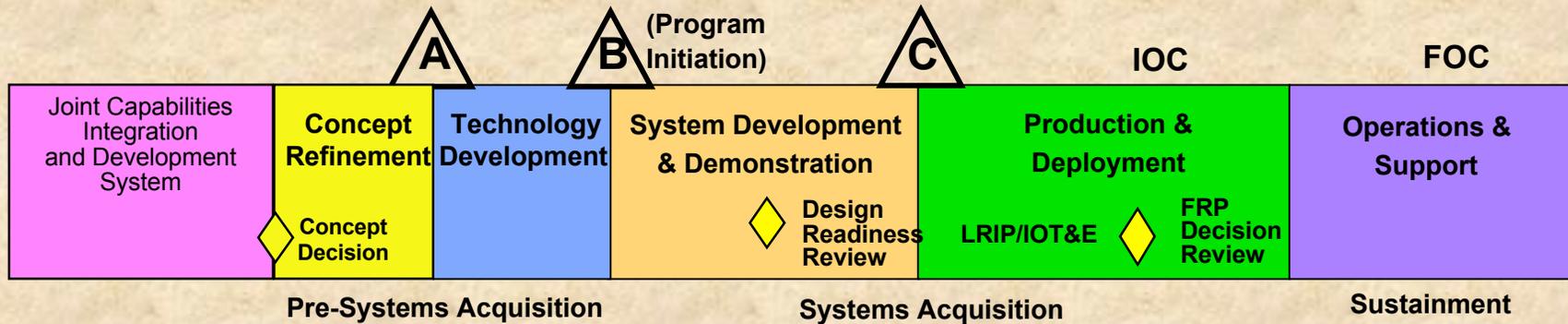
Overview

- **HP Role in Acquisition**
- **HSI vs. HPI: How Do The Disciplines Compare?**
- **HSI vs. HPI: How Do The Metrics Compare?**
- **HSI and HPI Metrics: Focus Should Be on The HUMAN**
 - Some Examples
- **Using The Full-Range Of Metrics**
 - HPC Measurement and Evaluation Handbook
- **Designed, Developed, and Implemented ...What Can Go Wrong?**



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HP Role In Acquisition



Human Performance Improvement Process

Root Cause Analysis and Intervention Selection will identify problems and possible solutions (materiel / non-materiel, both need to be human-centric).



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HSI vs. HPI: How Do The Disciplines Compare?

HSI ...

- Supports the System Engineering Model and the Acquisition Process.
- Is initiated by a requirement for System Acquisition – focuses on criteria for selecting systems.
- Is a needs-based approach: the solution is implemented to address specific requirements.
- Considers effective design, development, and implementation of materiel solutions.
- Focuses on nine elements to assess system performance, primarily at the individual and team/unit level.
- Uses a systematic approach:
 - Cyclical / Iterative
 - Analytic

HPI ...

- Employs the Human Performance Improvement Process Model.
- Is initiated by a request for problem solving – focuses on solving organizational problems.
- Starts with desired organizational results (or business problem) and works backward to determine performance gaps and solutions.
- Considers materiel and non-materiel solutions.
- Focuses at the individual, team/unit, and/or organizational level – because it views the organization as a “system.”
- Uses a systematic approach:
 - Cyclical / Iterative
 - Analytic



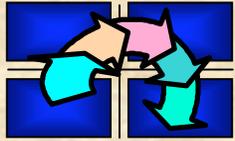
HSI vs. HPI: How Do the Metrics Compare?

HSI ...

- Is primarily focused on mission outcomes.
- Evaluates human performance while using systems.
- Measures at the individual and/or team/unit level.
- May be categorized as follows: (NAVSEA)
 - Timeliness
 - Accuracy
 - Availability
 - Workload
 - Situational Awareness

HPI ...

- Is primarily focused on outcomes, i.e., accomplishments and products, rather than behaviors.
- Evaluates human performance in all settings.
- Measures at the individual, team/unit, and/or organizational levels – because it views the organization as a “system.”
- May be categorized as follows:
 - (INDUSTRY HPI)
 - Better
 - Cheaper
 - Faster
 - Safer



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HSI and HPI Metrics: Focus Should Be on The **HUMAN**

The reason for acquiring materiel solutions that emphasize human-centered design is ...

- To enable humans to employ them more effectively to achieve the mission.

Propose that to better achieve desired “outcomes” ...

- The full range of human performance metrics be employed (to the extent possible) at various phases of system acquisition.
 - By “moving away” from diagnostic process measures, we lose a valuable tool for achieving desired outcomes.
 - TADMUS: A *process-focused* approach ... “Cannot guarantee that the team will make the right decision, but that it will make the decision right.”
 - The right processes lead to consistently better outcomes.

Some Process Examples ...

TADMUS

DECISION SUPPORT SYSTEM (DSS)

View
2-D 3-D

Background
Coastline Topology
Black Blue Gray

Show
Air Lanes

Track Nos 7000

Course Ldrs

Histories

Weapons

Track Types
Air Surface

Threats

Unknowns

Friends

Range Scale
256 nm

32 64 128 256

7037 Type Super Puma Helo Assess THREAT

Nation Status IMMED

Brng 161 deg 161 - 166 INTEL ASPECT

Range 27.0 nm 27 - 39 Attack Possible

Course 000 deg CPA ?

Speed 110 kn 0 - 110

Alt 3000 ft 400 - 3000

Verify airspace

1st warning

CIWS to auto/ready self defense systems

2nd warning

Cover

Execute EW packages

3rd warning

Illuminate

Report to senior

Report to senior

Alert Stinger Detachment

Deploy Decoys

Fire Flares/Warning Shot

Engage / Do not Engage decision

IFF No IFF Response

Last Alert Inside enemy weapon's range Age 0:2:48

Basis for Assessment Evidence in Support Neccs Assumptions

THREAT ES-Platform ID (Threat) Carrying weapon IFF Inoperative/off

NonThreat Unfavorable track history No IFF response Closing in range

unknown

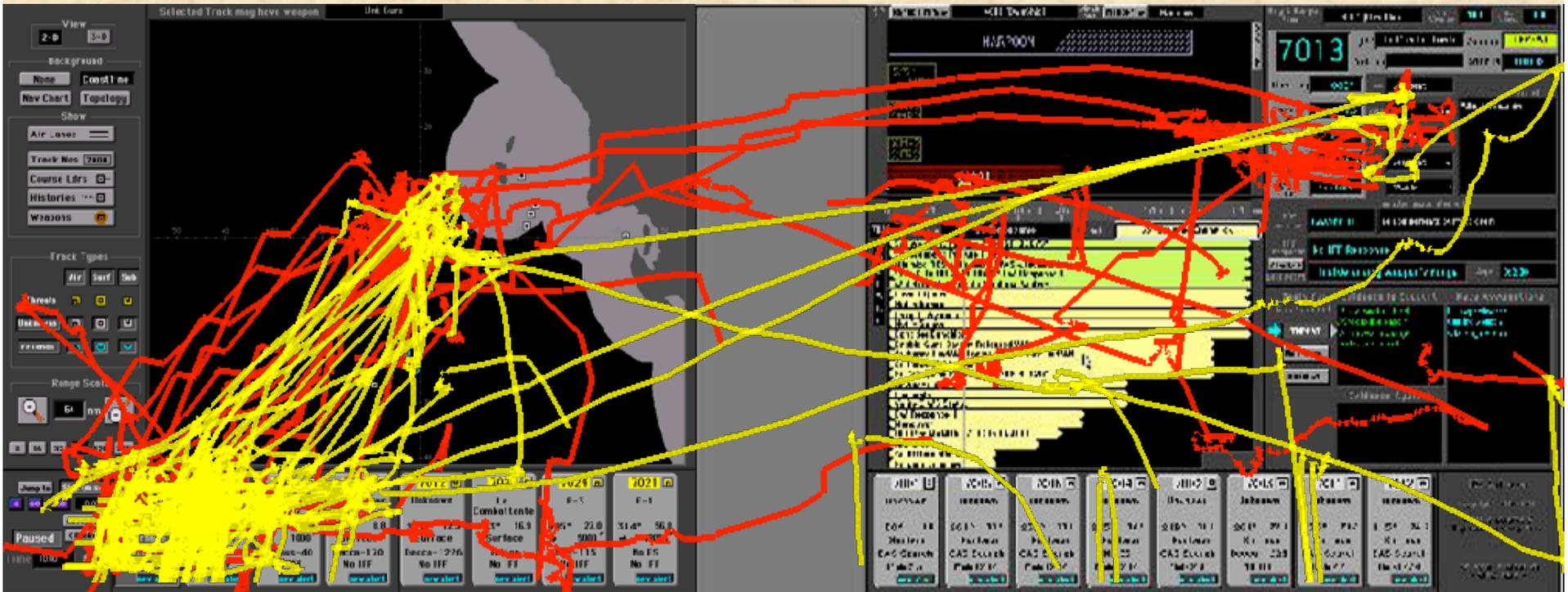
Evidence Against

Supporting Counter Missing

Time 10:36	7013 La Combatante 079°/15.2 Surface Castor II No IFF alerts	7037 Super Puma Helo 161°/27 → 3000 Primus-40 No IFF alert	7001 Unknown 190°/8.9 Surface Decca-1226 No IFF alerts	7023 P-3 075°/23 → 5000 APS-115 No IFF alert	7020 Helo/Lt Air 041°/34 → 3000 No ES No IFF alert	7036 F-4 065°/54 → 2400 APQ-120 No IFF alert	7034 Unknown 121°/88 → 15000 No ES No IFF alerts	7035 Unknown 121°/87 → 15000 No ES No IFF alerts	7007 Unknown 277°/5.8 Surface Don-2 No IFF alerts	7025 Unknown 001°/7 Surface No ES No IFF alerts	7010 Unknown 171°/8.1 Surface Don-2 No IFF alerts	7026 Unknown 062°/9 Surface No ES No IFF alerts	7027 Unknown 064°/9 Surface No ES No IFF alert	7005 Unknown 262°/12.7 Surface LN-66 No IFF alert	7006 Unknown 264°/12.7 Surface No ES No IFF alert	7004 Unknown 256°/15.5 Surface No ES No IFF alert	Profile & Resp Mngr Intent Analysis
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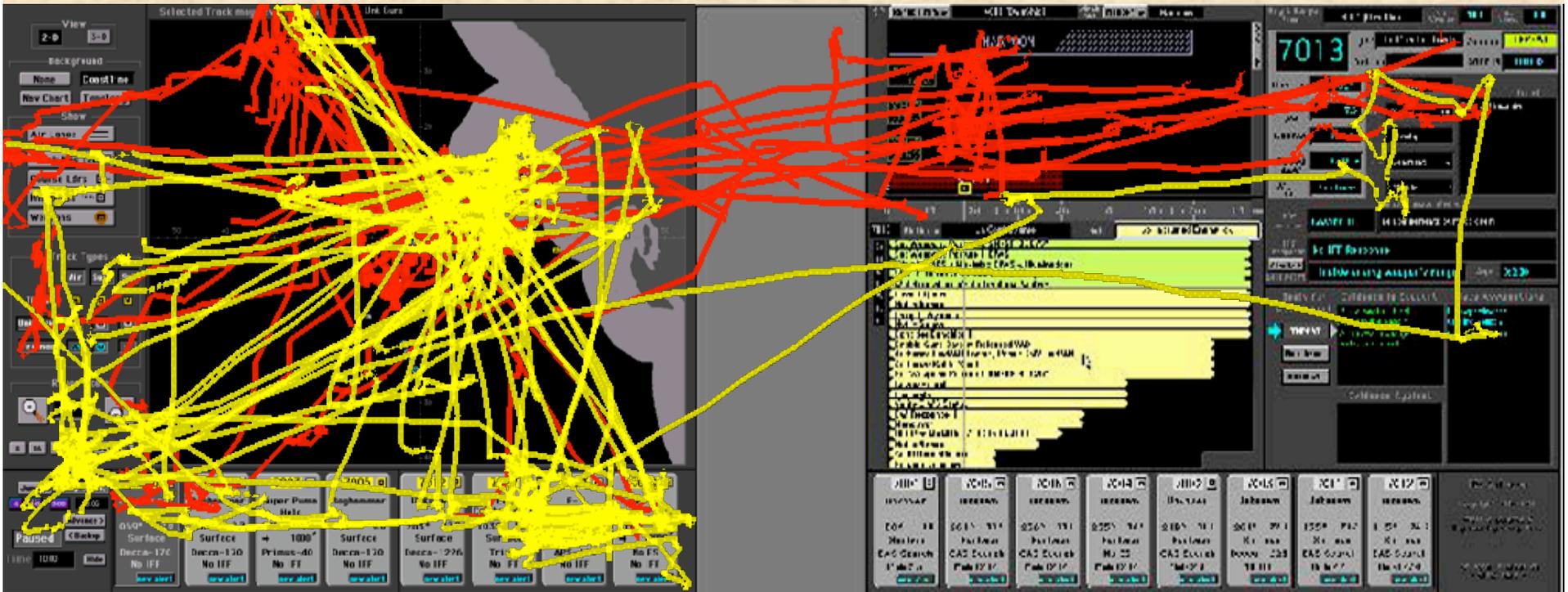
Minute 1:00 - 2:00: **Setup/Surface ships**

- More Experienced TAO
- Less Experienced TAO



Minute 6:00 - 7:00: **P-3 detected**

- More Experienced TAO
- Less Experienced TAO



AUGMENTED COGNITION: Physiological Process Measures



MITIGATING COGNITIVE PROCESSING BOTTLE-NECKS VIA REAL-TIME MEASUREMENT OF COGNITIVE STATES AND MANIPULATION OF RELEVANT INPUT TO THE USER.

Changes in / patterns related to:

- EEG (Electrical Activity: Brain)
- ECG (Electrical Activity: Heart)
- EMG (A Electrical Activity: Muscles)
- FNIR (functional near infrared)
- P-300 (attention tracker),
- Eye tracking
 - Eye fixation duration
 - Eye gaze location
 - Pupil dilation
- Behavioral tracking (e.g. Head movements)

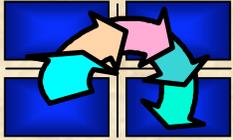
(Above are currently being used)

- Cortical blood oxygenation
- Cortical blood volume
- Event related optical signal

Changes in / patterns related to:

- Neuronal patterns
- Neuronal firing signatures
- Heart Rate
- Frequency of neuronal population firing, e.g., alpha, beta, theta
- Synchronization/ De-synchronization among neuronal structures
- Error related negativity
- Inter-beat Interval
- Respiration Rate
- Galvanic Skin Response
- Posture
- Mouse Pressure
- Rate of task completion
- Error rate

(Above may potentially be used)

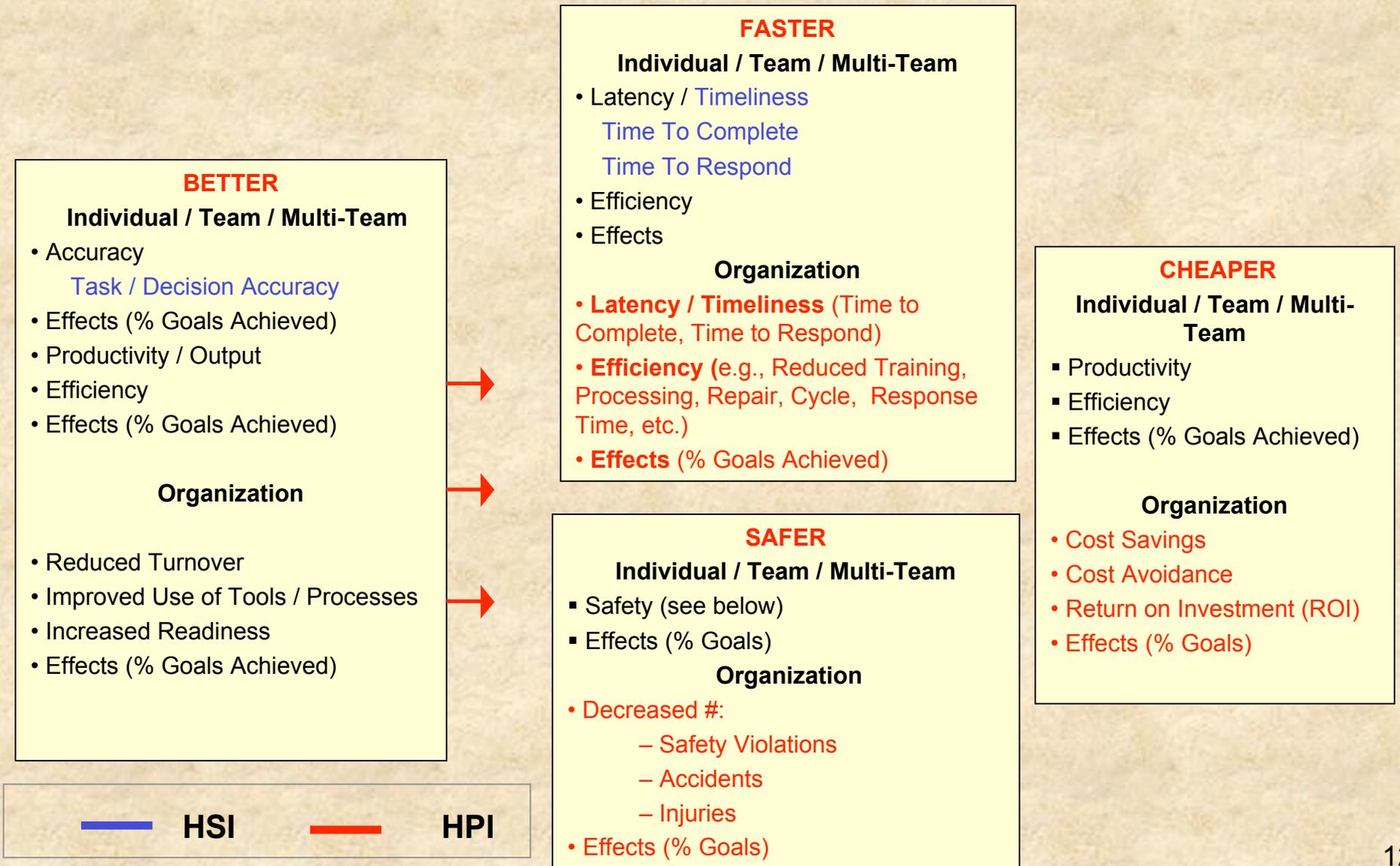


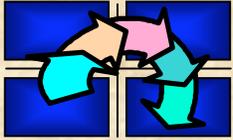
Using The Full-Range of Metrics

Levels of Analysis	Better — HSI — HPI	
	PROCESSES (EXAMPLES)	OUTCOMES (EXAMPLES)
Individual / Team Multi-Team	<ul style="list-style-type: none"> • Monitoring (e.g., Eye Tracking, Key Strokes, Communications) • Critical Thinking (e.g., SME Assessment Of Specific CT Behaviors) • Information Management (e.g., ATOM) ➔ • Situational Awareness (e.g., SART, SAGAT) • Adapting (e.g., TACT) • Workload (Cognitive / Physical) (e.g., NASA TLX, SWAT, Cooper-Harper, Secondary Tasks) ➔ • Operator Availability (e.g., % Available) • Time on Tasks (e.g., Time on Tasks) • Teamwork e.g., Information Exchange, Communication, • Supporting Behaviors, Leadership, Team Self-Correction (e.g., ATOM) ➔ • Planning (e.g., ATPI) 	<ul style="list-style-type: none"> • Accuracy Task / Decision • Effects (% Goals) • Productivity / Output • Efficiency (Ratio of Resources Required To Those Expended) • Effects (% Goals) • All of the Above
Organization	<ul style="list-style-type: none"> • Work Habits (e.g., Absenteeism) • Climate (e.g., Incentives / Rewards) • Job Match Indicators 	<ul style="list-style-type: none"> • Reduced Turnover • Increased Readiness • Effects (% Goals)



Using The Full-Range of Metrics





Using The Full-Range of Metrics

HPCs Measurement and Evaluation Handbook

Interactive Table of Contents

Examples of Topics

Planning Your Evaluation

- **Guidelines**
 - **Planning a Survey Study**
 - **Sampling Methods**
 - **Rater / Administrator Training**
 - **Confounds Table**
- **Job Aids For Planning Your Evaluation**
 - **Logistical Issues for Conducting Research**
 - **Measurement and Evaluation Planning Worksheet & Spreadsheet**
- **Protection of Human Subjects**



Using The Full-Range of Metrics

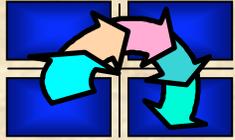
HPCs Measurement and Evaluation Handbook

Interactive Table of Contents

Examples of Topics

Creating Your Measures

- Review Of The Human Performance Measurement Literature
- Measurement Types, Methodologies, and Technologies
- Criteria For Human Performance Measures
- Guidelines For Validating Measurement Instruments
- Common Measurement Errors
- **Walk Me Through It: Step-by-Step Guidance**
- Repository of Measurement Instruments (*Forthcoming*)
- Return-on-Investment (Model, Analysis Plan, Websites)
- Job Aids For Creating Your Measures
- Websites for Measurement and Statistical Help



Designed, Developed and Implemented ...What Can Go Wrong?

Integrating HSI and HPI Disciplines / Metrics

- HPI complements and supports HSI:
 - An HSI “only” approach may fail to consider all human variables that are needed to support successful outcomes.
 - HPI analyses at each phase of system design can result in combining non-materiel (e.g., training) and materiel solutions to achieve desired level of performance.
 - HPI analyses at the individual / team / organizational level are likely to identify HUMAN variables that need to be managed and/or mitigated.
- The “Vincennes” Incident
 - The problem: Use of decision biases may have partially contributed to fatal outcome.



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Designed, Developed and Implemented ... What Can Go Wrong?

“The Vincennes Incident”

Framing

- Intel of probable incident around Independence Day likely to embarrass the U.S.
- Movement 3 days prior, of Iranian F-14 Tomcats to airport –Bandar Abbas--from which the Iranian Airbus departed.
- Vincennes and her LAMPS helicopter fired upon by Iranian Revolutionary Guard.
- P-3 lurking on radar screens -- which the CIC team may have surmised was providing targeting information to enemy .
- IFF responses first as “comair” then as “tacair” (probably originating from an F-14) still sitting on the airport runway.
- Airbus previously labeled on radar screen as F-14 was “anchor” to set stage for events that followed.

Availability

- USS Stark, in May of 1987 (only 1 yr. Prior) was damaged by 2 exocet missiles fired by an Iraqi aircraft. Lost 37 sailors.



Summary

- **HSI and HPI metrics are primarily *outcome-focused*.**

HSI (NAVSEA)

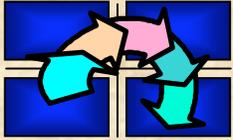
- Timeliness
- Accuracy
- Availability
- Workload
- Situational Awareness

HPI (Industry)

- Better
- Cheaper
- Faster
- Safer

- **HSI enables humans to employ systems more effectively to achieve the mission.**
- **Provided two examples of how process measures can be utilized to assess HUMAN interactions with the system.**
- **HPI and process measures may complement HSI by:**
 - Helping to define the effective role of the HUMAN in the system.
 - Revealing weaknesses in real-time use of the system.
 - Providing solutions to address weaknesses.
- **Integrating the HSI and HPI disciplines / metrics ensures the most optimal outcome.**

Questions?



Outcome Measures Defined

- **Accuracy:** Describes the precision with which a task is performed.
- **Timeliness:** Indicates the length of time in which actions are performed.
- **Productivity:** Describes the rate at which actions are performed or tasks are accomplished within a given situation or amount of time.
- **Efficiency:** Refers to the ratio of resources required to those expended to accomplish a task.
- **Safety:** Indicates the degree to which a task is accomplished in a way that does not unduly jeopardize human and capital resources.
- **Effects:** Indicates the degree to which the desired effect was achieved (% Goals Achieved)