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# **Towards Validating a Model for Assessing Team Tactical Decision Making**

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**NAVAIR ORLANDO TRAINING SYSTEMS DIVISION**

**Collaboration and Knowledge Management Workshop  
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# Report Documentation Page

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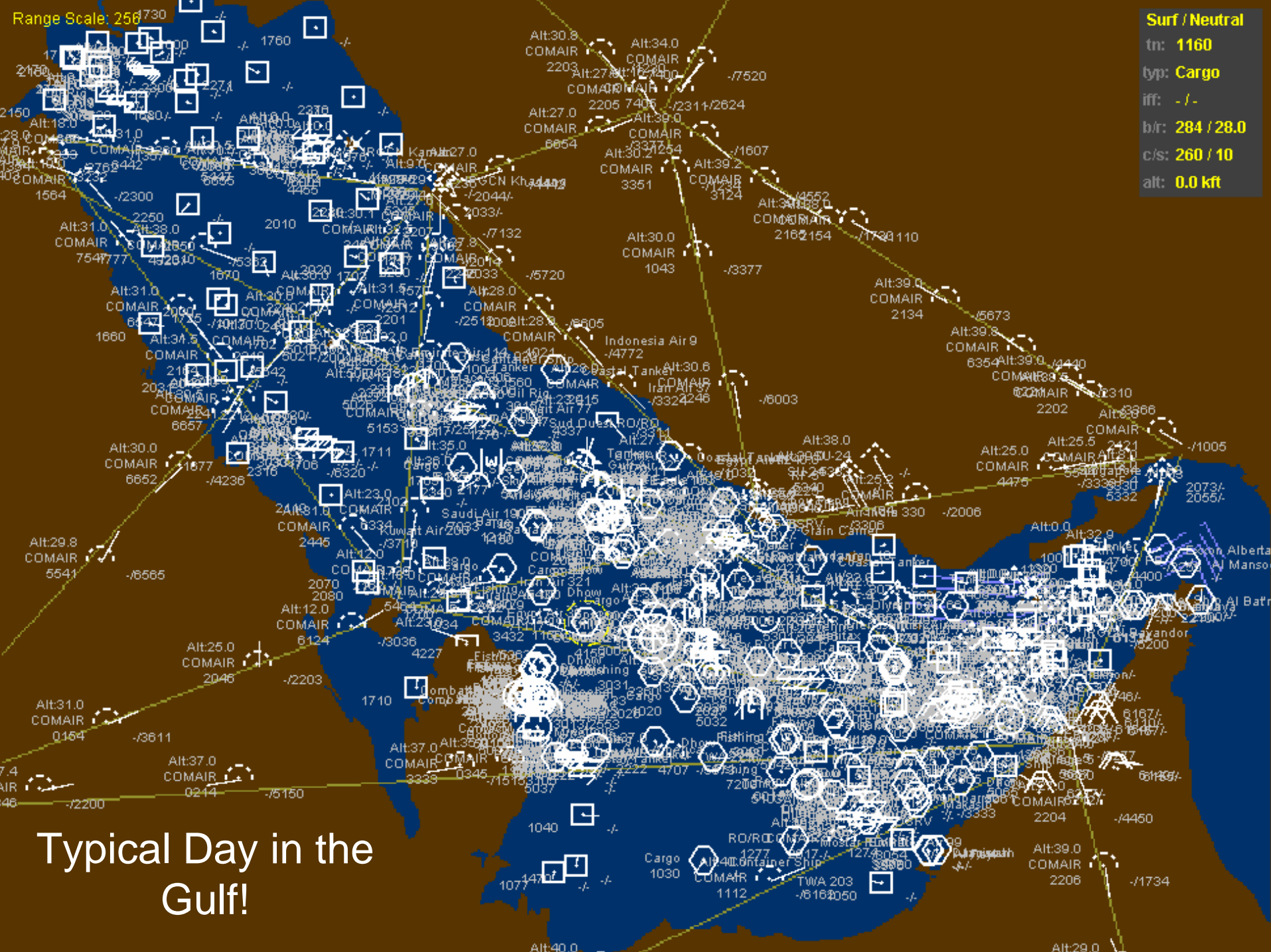
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# Introduction

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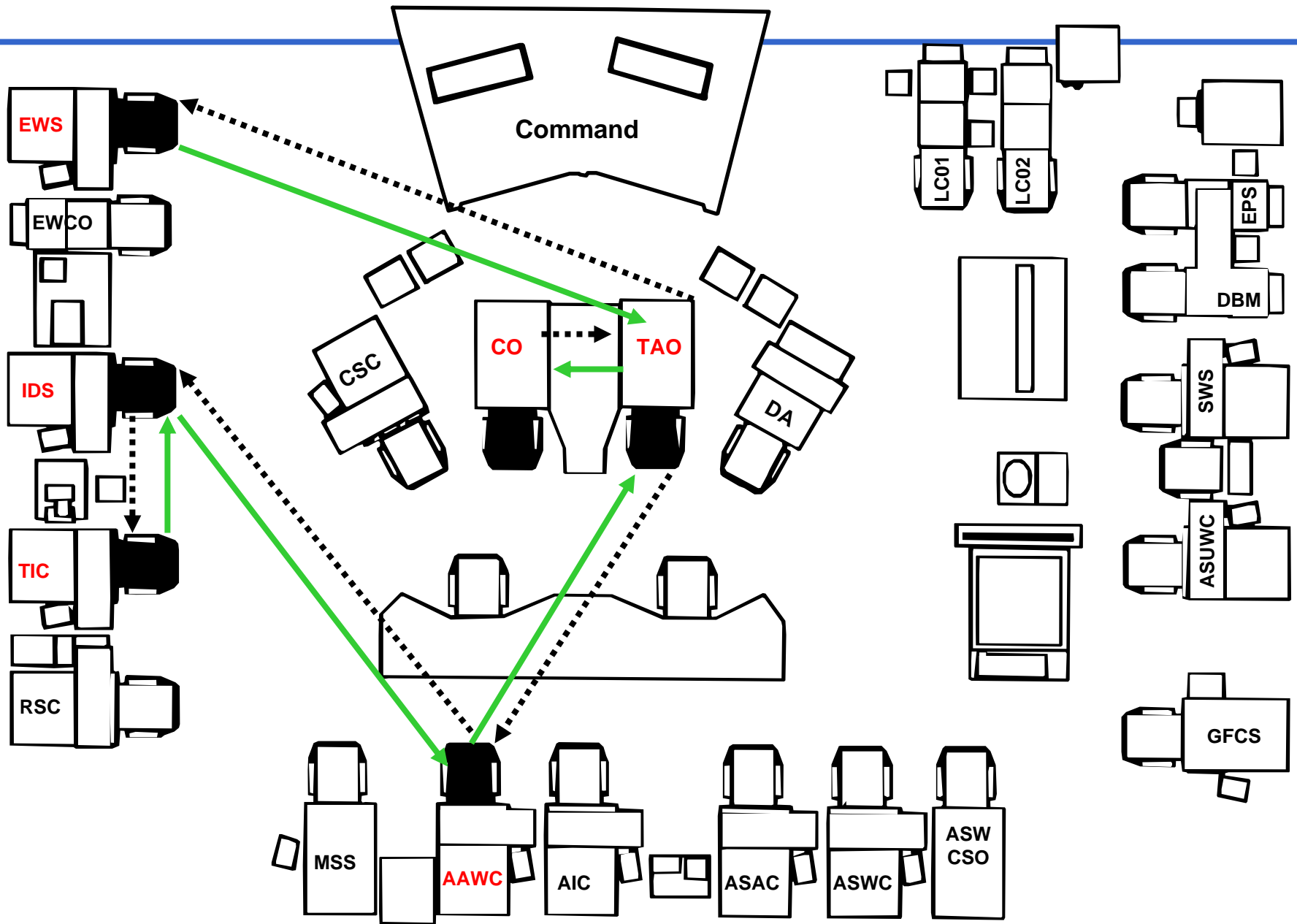
- Current R&D Requirements: Debriefing Distributed Simulation-Based Exercises
  - Team Performance Assessment & Diagnosis Technologies
  - After Action Review Tools
- *Presentation: Validation of a Measure for Assessing and Diagnosing Team Tactical Decision Making*
- Background & Approach
  - Tactical Decision Making Under Stress (TADMUS) 6.2
  - Context: Combat Information Center Teams In Air Defense Operations
  - Objective: Enhance The Quality Of Decision-making In High Stress Environments Via:
    - Phase 1 Products:
      - + Decision Support Tools & Individual and Team Training Principles
    - Phase 2 Products:
      - + Principles for Integrating Training and Decision Support



**Surf / Neutral**  
 tn: 1160  
 typ: Cargo  
 iff: - / -  
 b/r: 284 / 28.0  
 c/s: 260 / 10  
 alt: 0.0 kft

Typical Day in the  
 Gulf!

# Focus: Air Defense Warfare Team



# Combat Display Overload

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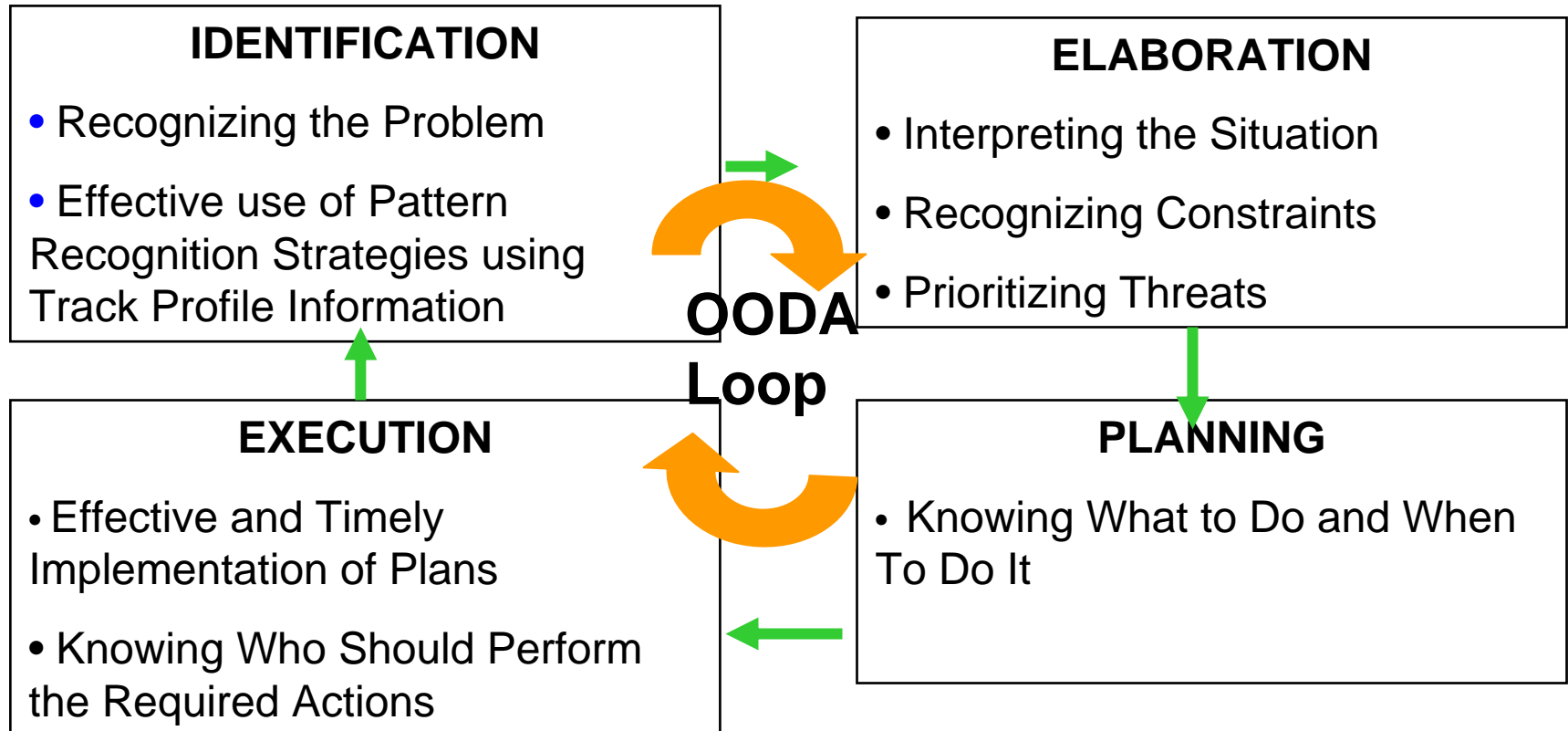


# Displays & Training Don't Support Managing the Tactical Task

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- Limitations in Memory
  - Forgetting or mixing up numbers assigned to radar contacts
  - Forgetting or confusing track kinematic data such as bearing, altitude, or range
- Memory Support Tools: Decision Biases
  - Persevering with incorrect threat assessments regardless of new information
  - Not considering all alternatives or hypotheses
- Memory Demands
  - Attention attenuation-competing cognitive tasks & team coordination requirements
  - Forgetting team communications
  - Not attending to team coordination requirements
- Team Coordination Requirements

# Decision Making Dimensions (Marshall et al., 1995)



# DECISION-MAKING DIMENSIONS & TADMUS Decision Support System

## Identification

Recognizing the Problem

Effective use of Pattern Recognition Strategies using Track Profile Information

## Planning

Knowing What to Do and When To Do It

## Identification

## Planning & Execution

Effective and Timely Implementation of Plans

## Elaboration

Interpreting the Situation

Recognizing Constraints

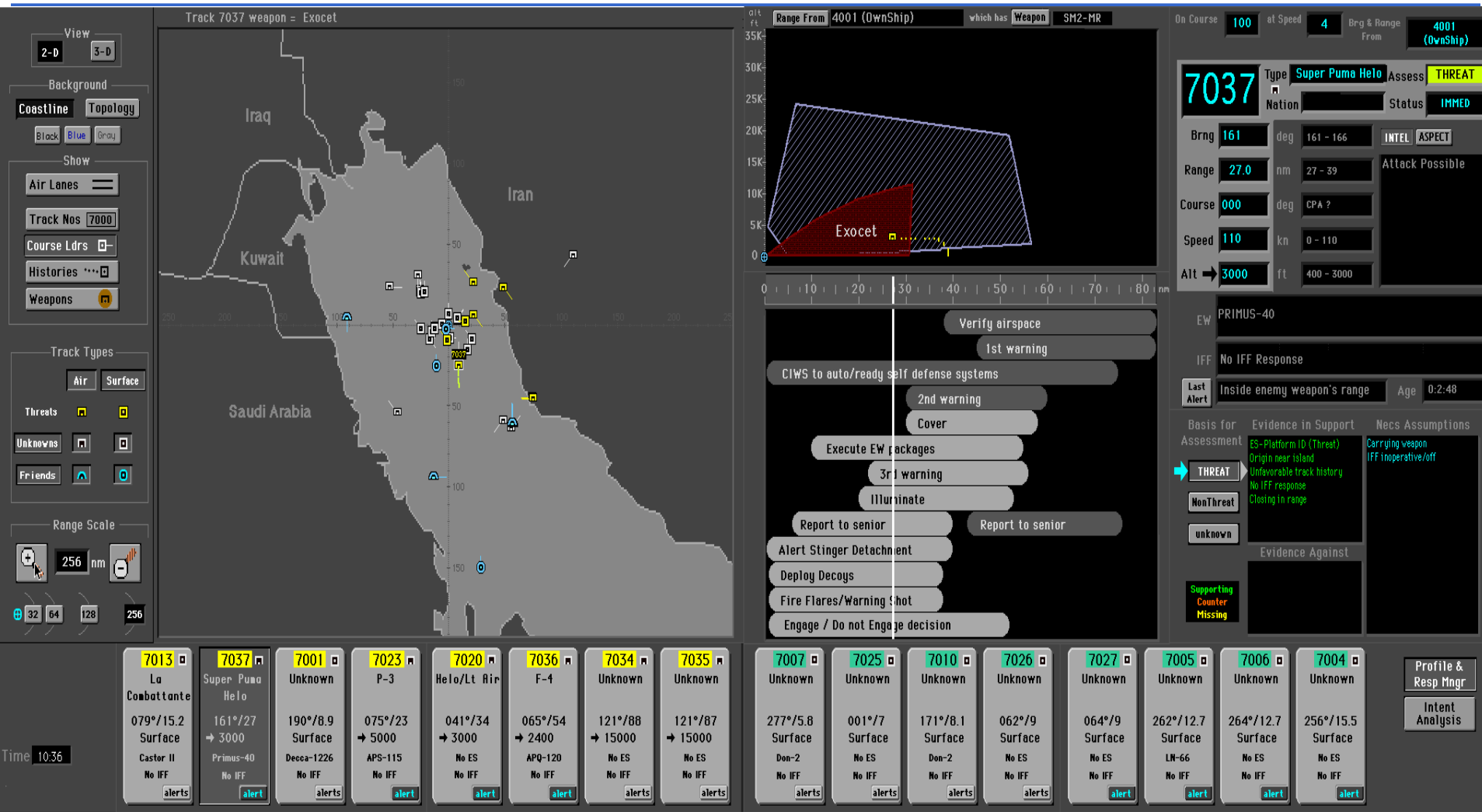
Prioritizing Threats

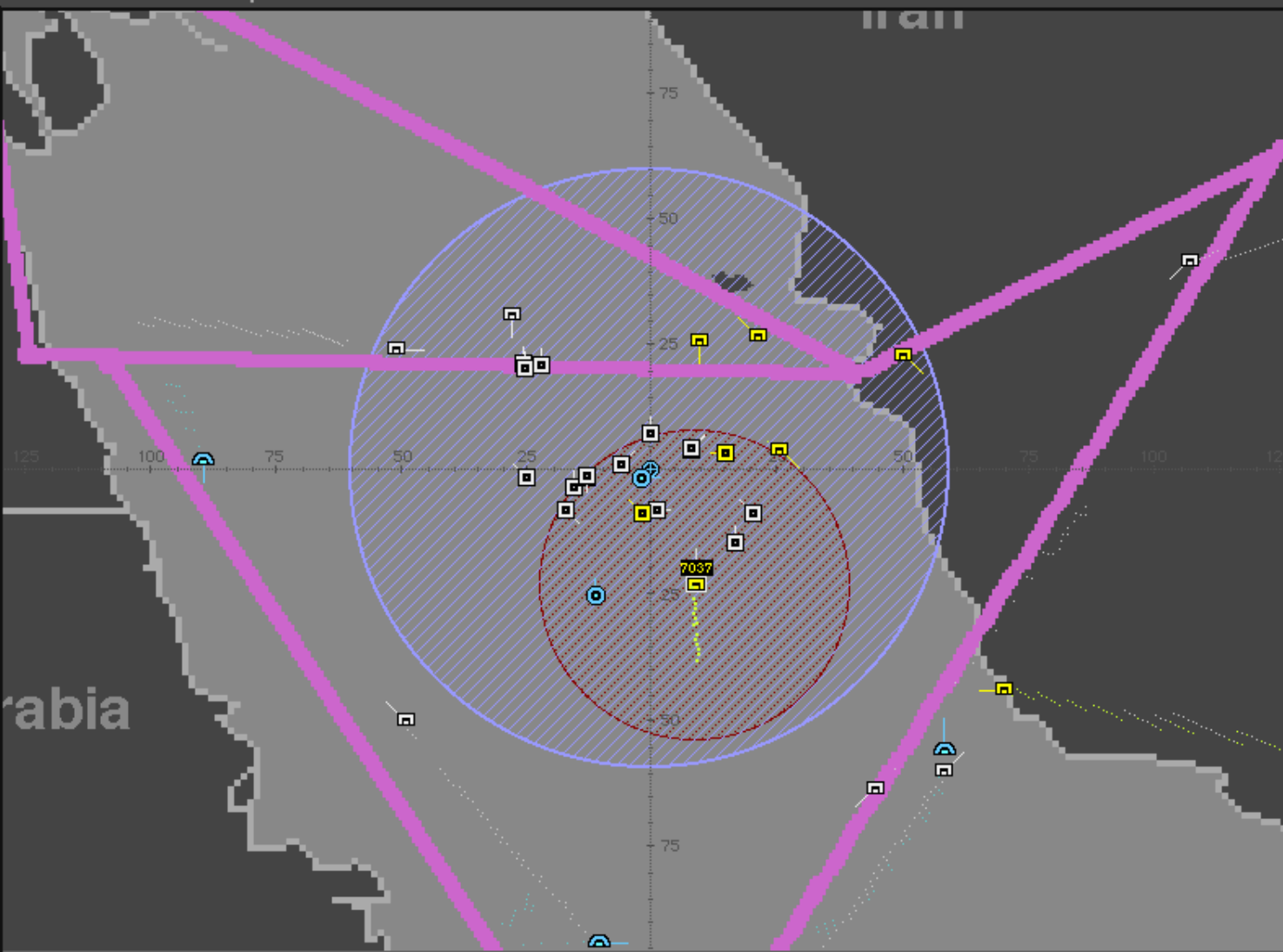
## Identification

## Identification

# TADMUS DECISION SUPPORT SYSTEM (DSS)

## Morrison et al. 1998





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

128 nm

32 64 128 256

**7013** □  
 La Combattante  
 078°/15.1  
 Surface  
 Castor II  
 No IFF  
 alerts

**7037** □  
 Super Puma Helo  
 160°/25  
 → 3000  
 Primus-40  
 No IFF  
 alert

**7001** □  
 Unknown  
 190°/8.9  
 Surface  
 Decca-1226  
 No IFF  
 alerts

**7023** □  
 P-3  
 081°/25  
 → 5000  
 APS-115  
 No IFF  
 alert

**7020** □  
 Helo/Lt Air  
 039°/34  
 → 3000  
 No ES  
 No IFF  
 alert

**7036** □  
 F-4  
 067°/55  
 → 2400  
 APQ-120  
 No IFF  
 alert

**7034** □  
 Unknown  
 122°/84  
 → 15000  
 No ES  
 No IFF  
 alerts

**7035** □  
 Unknown  
 122°/84  
 → 15000  
 Cyrano-IV  
 No IFF  
 alerts

Time 11:18



- 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

On Course 100 at Speed 4 Brng & Range From 4001 (OwnShip)

**7037** Type **Super Puma Helo** Assess **THREAT**  
 Nation Status **IMMED**

Brng 159 deg 159 - 166 INTEL ASPECT  
 Range 25.0 nm 25 - 39 Attack Possible  
 Course 000 deg CPA ?  
 Speed 110 kn 0 - 110  
 Alt 3000 ft 400 - 3000

EW PRIMUS-40  
 IFF No IFF Response  
 Last Alert Inside enemy weapon's range Age 0:3:48

Basis for Assessment	Evidence in Support	Necs Assumptions
<input checked="" type="radio"/> <b>THREAT</b> <input type="radio"/> NonThreat <input type="radio"/> unknown	ES-Platform ID (Threat) Origin near island Unfavorable track history No IFF response Closing in range	Carrying weapon IFF inoperative/off
Evidence Against		
<input checked="" type="checkbox"/> Supporting <input checked="" type="checkbox"/> Counter <input checked="" type="checkbox"/> Missing		

- 7035** Unknown 122°/82 → 15000 Cyrano-IV No IFF alerts
- 7007** Unknown 279°/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 063°/9 Surface No ES No IFF alerts
- 7027** Unknown 064°/9 Surface No ES No IFF alert
- 7006** Unknown 264°/12.7 Surface No ES No IFF alert
- 7005** Unknown 262°/12.8 Surface LN-66 No IFF alert

Profile & Resp Mgr  
 Intent Analysis

# TADMUS Training Strategies

## (Cannon-Bowers & Salas, 1998)

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- Scenario-Based Training/Event Based Approach (Johnston et al., 1998)
- Identification/Elaboration Cognitive Processes
  - Critical Thinking Training--Know Thyself... (Cohen et al., 1998)
- Planning & Execution Team Tasks: Knowing Who Should Perform The Required Actions
  - Team Dimensional Training (Smith-Jentsch et al., 1998)
    - Team Leader Training--The Blind Pass... (Tannenbaum et al., 1998)
    - Team Coordination Training--He Ain't Heavy...(Serfaty et al., 1998)
    - Team Self-Correction-- Replay in the Bar...(Smith-Jentsch et al., 1998)
  - Cross Training--Walking in Each Other's Shoes...(Blickensderfer et al., 1998)

# PERFORMANCE MEASUREMENT SCHEME

P  
R  
O  
C  
E  
S  
S

## INDIVIDUAL

- Decision Making Processes
- Task Strategy
- Information Seeking

*Behavior Observation Booklet*  
*Critical Thinking Strategies*

## TEAM

- Coordination Behaviors
- Communication Flow
- Team Strategies

*Air Warfare Team Observation Measure*  
*Anticipation Ratio*

O  
U  
T  
C  
O  
M  
E

- Accuracy
- Timeliness
- Decision Biases

*Sequenced Actions & Latencies Index*  
*Vocalized Priorities (SA)*

- Mission Effectiveness
- Team Level Timeliness & Accuracy
- Error Propagation

*Air Warfare Team Performance Index*

**DESCRIBE, EVALUATE, DIAGNOSE BEHAVIOR**

# TADMUS Final Demonstration

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- *Intervention: Combined Impact of Training and DSS on Team Performance*
- Hypotheses:
  - Less Perceived Stress
  - Better Teamwork Performance
  - Better Critical Thinking Skills
  - Better Tactical Performance
  - *Teamwork is Related to Tactical Performance*
- *Integrated Training Approach Via Scenario-Based Training*
  - *Individual Skills Training*
    - Critical Thinking Skills Training (PC-Based)
    - Decision Support System (DSS) Tutorial
  - *Team Skills Training*
    - Team Dimensional Training (TDT):
      - + Facilitated Team Self-Correction with Event-Based Scenarios
    - Cross Training:
      - + Utilized DSS for AAR to Facilitate Discussion of Decision Making Processes

# TADMUS Final Demonstration Approach

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- Participants: Total of 16 Six-Person Teams (Surface Warfare Officer's School Department Head Classes) in control (8) and in experimental (8) conditions
- Design: Multiple Post-Test (Arabian Gulf Event-Based Scenarios) Counterbalanced
- Task: Air Defense Warfare (Decision Making Evaluation Facility for Tactical Teams)
- Individual and Team Measures
  - Stress: NASA TLX
  - Teamwork: ATOM
  - Team Tactical Decision Making (ATPI)
  - TAO Decision Making Priorities
  - Critical Thinking Indicators (under development)
- Recorded Team Voice Comms, Created Transcripts

# DEFTT Lab at SWOS

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# Debrief/AAR Using the DSS



# Research Problem: Need Diagnostic Team Performance Assessment Tools to Identify Critical Team Knowledge and Skill Deficits

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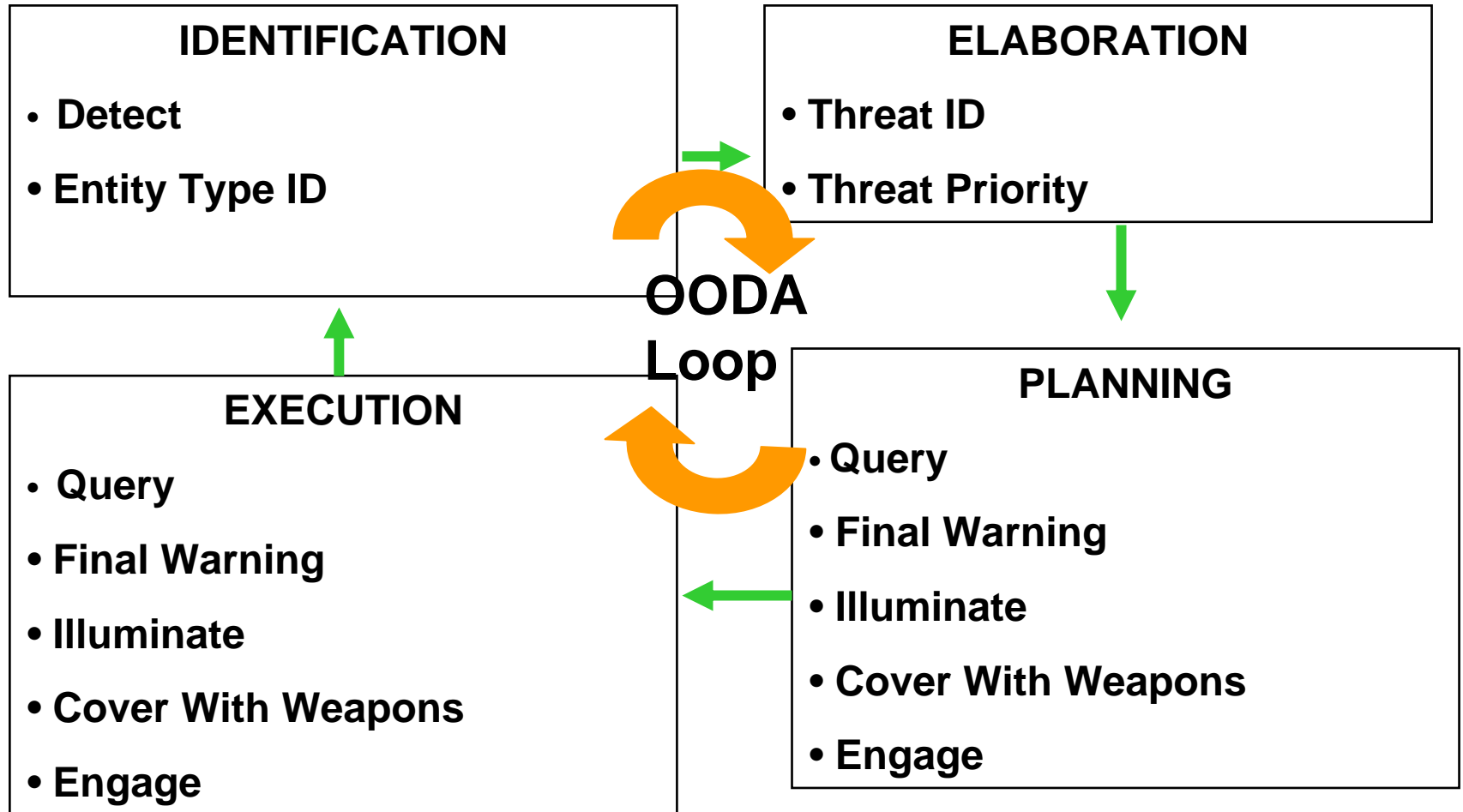
## Hypotheses:

Measure of Team Taskwork, based on Marshall et al. model, will increase diagnosticity of team tactical decision making performance (Paris et al., 2001)

Using Taskwork & Teamwork measures will increase the diagnosticity of team performance for AAR (Johnston, Freeman, & Serfaty, 2003)

ID & Prioritization Actions	Planning & Execution Actions	Plan to Engage/Engage (What is typically discussed)
<ul style="list-style-type: none"> <li>● Recognizing the Problem (ID)</li> <li>● Effective use of Pattern Recognition Strategies using Track Profile Information (ID)</li> <li>● Interpreting the Situation (ELAB)</li> <li>● Recognizing Constraints (ELAB)</li> <li>● Prioritizing Threats (ELAB)</li> </ul>	<ul style="list-style-type: none"> <li>● Knowing What to Do and When To Do It (Planning)</li> <li>● Effective and Timely Implementation of Plans (Execution)</li> <li>● <b><u>Knowing Who Should Perform the Required Actions (Execution)</u></b></li> </ul>	<ul style="list-style-type: none"> <li>● NMETLs</li> <li>● e.g., Proper Weapons Employment</li> <li>● Using proper weapons engagement procedures</li> </ul>

# Team Task Work: Detect-to-Engage Sequence (Paris, Johnston, & Reeves, 1998)



# Air Warfare Team Performance Index

IDENTIFICATION				ELABORATION	EXECUTION					
					PLANNING					
Acq. Time Detec. Lost Brg/Rge	Track No. Craft Type	Detect	Entity Type ID	Threat ID /Threat Prioritization	Query	Final Warning	Illuminate	Cover w/ Weapons	Engage	
1:06 -- 030/77	7024	0  ⇐ (2:30) >	0 X  ⇐ (3:00) >	0 X  ⇐ (3:00) >	0 1 2	0	0	0	X(E)  X(P)	
	⇐ (7:00 E) >				X(E)	X(E)	X(E)			
	⇐ (6:00 P) >				X(P)	X(P)	X(P)			
1:06 -- 255/36	7023	0  ⇐ (2:30) >	0 X  ⇐ (4:30) >	0 X  ⇐ (15:00) >	0 1 2	0 1 2	0 1 2	0 1 2	X(E)  X(P)	
	⇐ (6:00 E) >				⇐ (19:30 E) >	⇐ (19:30 E) >	⇐ (10:30 E) >			
	⇐ (5:00 P) >				⇐ (18:30 P) >	⇐ (18:30 P) >	⇐ (9:30 P) >			
2:06 -- 030/76	7017	0  ⇐ (3:30) >	0 X  ⇐ (16:30) >	0 X  ⇐ (16:30) >	0 1 2	0 1 2	0 1 2	0 1 2	X(E)  X(P)	
	⇐ (15:30 E) >				⇐ (26:30 E) >	⇐ (26:30 E) >	⇐ (17:00 E) >			
	⇐ (14:30 P) >				⇐ (25:30 P) >	⇐ (25:30 P) >	⇐ (16:00 P) >			
6:06 -- 029/76	7027	0  ⇐ (7:30) >	0 X  ⇐ (9:30) >	0 X  ⇐ (11:30) >	0 1 2	0 1 2	0 1 2	0 1 2	X(E)  X(P)	
	⇐ (17:00 E) >				⇐ (26:30 E) >	⇐ (26:30 E) >	⇐ (17:30 E) >			
	⇐ (16:00 P) >				⇐ (25:30 P) >	⇐ (25:30 P) >	⇐ (16:30 P) >			
6:06 -- 029/76	7030	0  ⇐ (7:30) >	0 X  ⇐ (9:30) >	0 X  ⇐ (11:30) >	0 1 2	0 1 2	0 1 2	0 1 2	X(E)  X(P)	
	⇐ (23:00 E) >				⇐ (26:30 E) >	⇐ (26:30 E) >	⇐ (23:00 E) >			
	⇐ (22:00 P) >				⇐ (25:30 P) >	⇐ (25:30 P) >	⇐ (22:00 P) >			
12:06 -- 031/78	7034	0  ⇐ (13:30) >	0 X  ⇐ (14:00) >	0 X  ⇐ (14:00) >	0 1 2	0	0	0	X(E)  X(P)	
	⇐ (18:00 E) >				X(E)	X(E)	X(E)			
	⇐ (17:00 P) >				X(P)	X(P)	X(P)			

# ATPI Analysis

- Created 6 ATPIs
  - Alpha &Tango training scenarios
  - Bravo, Charlie, Delta, India Experiment Scenarios
- Two SMEs used transcripts of team communications (obtained very close agreement)

<i>Summed Instances of Actions Across 4 Test Scenarios</i>	Summed ID & Elaboration Actions	Summed Planning & Execution Actions	Plan to Engage and Engage Actions
Tactical A/C	<ul style="list-style-type: none"> <li>• Correct</li> <li>• Correct, But Late</li> <li>• Incorrect (Wrong/Missing)</li> </ul>	<ul style="list-style-type: none"> <li>• Correct</li> <li>• Correct, But Late</li> <li>• Incorrect (Wrong/Missing)</li> </ul>	<ul style="list-style-type: none"> <li>• Correct</li> <li>• Correct, But Late</li> <li>• Incorrect (Wrong/Missing)</li> </ul>
Commercial A/C	<ul style="list-style-type: none"> <li>• Correct</li> <li>• Correct, But Late</li> <li>• Incorrect (Wrong/Missing)</li> </ul>	<ul style="list-style-type: none"> <li>• Correct</li> <li>• Correct, But Late</li> <li>• Incorrect (Wrong/Missing)</li> </ul>	Incorrect

# TEAMWORK DIMENSIONS: PROCESSES

## (Smith-Jentsch et al., 1998)

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### **INFO EXCHANGE**

- *Communication that promotes a team awareness of the surrounding environment, both internal and external to the team.*
- *Timely and accurate reporting of deviations and/or potential problems*

### **COMMUNICATION**

- Clear and efficient exchange of relevant information.
- Using proper terminology, standard procedures for external communications, and an appropriate tone of voice.

### **SUPPORTING BEHAVIOR**

- Monitoring the activities of other team members, taking action to correct errors, giving and receiving feedback in a nondefensive manner
- Providing and seeking assistance or backup when needed.

### **INITIATIVE/LEADERSHIP**

- Providing needed guidance to other team members; helping team members focus their activities appropriately and anticipate tasks that should be performed;
- Providing instruction to other team members to enable team to perform or complete their tasks. Any team member can perform initiative / leadership functions.

## **Air Warfare Team Observation Measure (ATOM)**

### ***Example of Information Exchange for Evaluation***

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**Frequency of Seeking sources - How many times did the team members proactively ask for information from multiple sources in order to establish an accurate assessment of the situation. These sources may be internal or external to the team and may include written documentation.**

None = Seeking information is a real weakness for this team

1-2 times= Seeking Info is adequate for this team

3 or more times= Seeking Information is a Strength for this team

# Air Warfare Team Observation Measure (ATOM)

## *Example of Information Exchange for Training*

---

**Anchored Scale for Seeking sources - Proactively asking for information from multiple sources in order to establish an accurate assessment of the situation. These sources may be internal or external to the team and may include written documentation.**

**1**

**2**

**3**

**4**

**5**

Seeking information  
a real weakness  
for this team.

Seeking information is  
is a real strength for  
this team.

# ATPI Outcomes

Number of Tactical Engagements	Correct Plan to Engage IAW ROE	Correct Engage IAW ROE	Plan to Engage not IAW ROE	Engage not IAW ROE
<u>Control</u> Tactical Commercial	<ul style="list-style-type: none"> <li>• 7</li> <li>• N/A</li> </ul>	<ul style="list-style-type: none"> <li>• 6</li> <li>• N/A</li> </ul>	<ul style="list-style-type: none"> <li>• 10 (9 teams)</li> <li>• 1</li> </ul>	<ul style="list-style-type: none"> <li>• 7 (6 teams)</li> <li>• 0</li> </ul>
<u>Expt'l</u> Tactical Commercial	<ul style="list-style-type: none"> <li>• 7</li> <li>• N/A</li> </ul>	<ul style="list-style-type: none"> <li>• 6</li> <li>• N/A</li> </ul>	<ul style="list-style-type: none"> <li>• 8 (7 teams)</li> <li>• 0</li> </ul>	<ul style="list-style-type: none"> <li>• 6 (5 teams)</li> <li>• 0</li> </ul>

# ATPI: Team Task Processes

	<b>ID &amp; Elaboration Tactical Actions IAW ROE Percent of Possible Correct + Correct, But Late</b>	<b>Planning &amp; Execution Actions IAW ROE Percent of Possible Correct + Correct, But Late</b>	Number of Instances of Incorrect Planning & Execution Actions
<u>Control</u> Tactical	<ul style="list-style-type: none"> <li>• 83 (range 78-89)</li> </ul>	<ul style="list-style-type: none"> <li>• 30 (range 25-41)*</li> </ul>	<ul style="list-style-type: none"> <li>• 0</li> </ul>
Commercial	<ul style="list-style-type: none"> <li>• 68 (range 48-83)</li> </ul>	<ul style="list-style-type: none"> <li>• 19 (range 0-45)</li> </ul>	<ul style="list-style-type: none"> <li>• 16 (6 teams)</li> </ul>
<u>Expt'l</u> Tactical	<ul style="list-style-type: none"> <li>• 85 (range 80-88)</li> </ul>	<ul style="list-style-type: none"> <li>• 36 (range 22-47)*</li> </ul>	<ul style="list-style-type: none"> <li>• 9 (6 teams)</li> </ul>
Commercial	<ul style="list-style-type: none"> <li>• 54 (range 29-71)</li> </ul>	<ul style="list-style-type: none"> <li>• 22 (range 5-45)</li> </ul>	<ul style="list-style-type: none"> <li>• 11 (4 teams)</li> </ul>

\* Problem appears to be NOT taking action

# Initial Results:

## Relationship of Teamwork and Taskwork

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- DSS/Trained Teams Achieved Significantly Better ( $p < .001$ ) Teamwork Performance (about 11% better after each scenario), than teams in the control condition
  - In Preparation For Potentially Hostile Tactical Aircraft, DSS/Trained Teams
    - Showed a trend in performing more correct actions across ID/ELAB/Planning/Exec ( $p = .07$ ), but no correlation with teamwork ( $r = .260$ , n.s.) +
    - Showed a trend in waiting longer (a few seconds) across ID/ELAB/Planning/Exec, but performed more correct actions (much greater variability in performance than control condition) ( $p < .1$ ). Correlation with teamwork was  $.418$ , but n.s.+
    - Waited longer (a few seconds), but performed *significantly* more correct planning/execution actions ( $p < .005$ ). *Significant* correlation with teamwork performance ( $r = .532^*$ )+
- + Pooled Within Groups Correlation (Across Both Conditions) b/w Teamwork and ATPI metrics ( $.426^*$ ,  $p < .05$ ,  $df = 14$ )

# After Action Review

ID & Prioritization Actions	Planning & Execution Actions	Plan to Engage/Engage (Currently what gets discussed)
<ul style="list-style-type: none"> <li>• Recognizing the Problem</li> <li>• Effective use of Pattern Recognition Strategies using Track Profile Information</li> <li>• Interpreting the Situation</li> <li>• Recognizing Constraints</li> <li>• Prioritizing Threats</li> </ul>	<ul style="list-style-type: none"> <li>• Knowing What to Do and When To Do It</li> <li>• Effective and Timely Implementation of Plans</li> <li>• <b>Knowing Who Should Perform the Required Actions—Teamwork Implicated Here</b></li> </ul>	<ul style="list-style-type: none"> <li>• NMETLs</li> <li>• e.g., Proper Weapons Employment</li> <li>• e.g., Using proper weapons engagement procedures</li> <li>• Proper Operation of Radar System</li> </ul>

Team Self Correction in AAR Can Focus on Planning & Execution Actions, to Rapidly Narrowing the Focus on Specific Knowledge and Skill Deficiencies

- GUI Concepts for AAR on Team Decision Making
  - Replay of Training Ground Truth
  - Expected Team Performance Compared with Actual Team Performance
  - Voice Reports and Watchstander Actions Incorporated Into Replay
  - Review of Events Walk Through to Address:
    - Team ID/ELAB Processes
      - + Basis for Assessment
      - + Track Priorities
    - Team Planning/Execution Processes Based on Task Manager Results

The screenshot displays a complex military simulation interface. On the left, a map shows the Persian Gulf region with labels for Iraq, Kuwait, Saudi Arabia, and Iran. A track for '7037' is highlighted. The top-left panel contains view and display settings. The top-right panel shows track details for '7037', including its type (Super Puma Helo), status (THREAT), and various parameters like range and speed. The bottom section features a task manager with a list of tracks and a central area with action buttons such as 'Verify airspace', 'Execute EW packages', and 'Engage / Do not Engage decision'.

Track ID	Type	Altitude	Speed	Status
7013	La Combatante	079°/15.2	Surface	Castor II
7037	Super Puma Helo	161°/27	→ 3000	Primus-40
7001	Unknown	190°/8.9	Surface	Decoa-1226
7023	P-3	075°/23	→ 5000	APS-115
7020	Helo/Lt Air	041°/34	→ 3000	No ES
7036	F-4	065°/54	→ 2400	APQ-120
7034	Unknown	121°/88	→ 15000	No ES
7035	Unknown	121°/87	→ 15000	No ES
7007	Unknown	277°/5.8	Surface	Don-2
7025	Unknown	001°/7	Surface	No ES
7010	Unknown	171°/8.1	Surface	Don-2
7026	Unknown	062°/9	Surface	No ES
7027	Unknown	064°/9	Surface	No ES
7005	Unknown	262°/12.7	Surface	LN-66
7006	Unknown	264°/12.7	Surface	No ES
7004	Unknown	256°/15.5	Surface	No ES

# Selected References

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