Performance Measurement for Diagnosing and Debriefing Distributed Command and Control Teams

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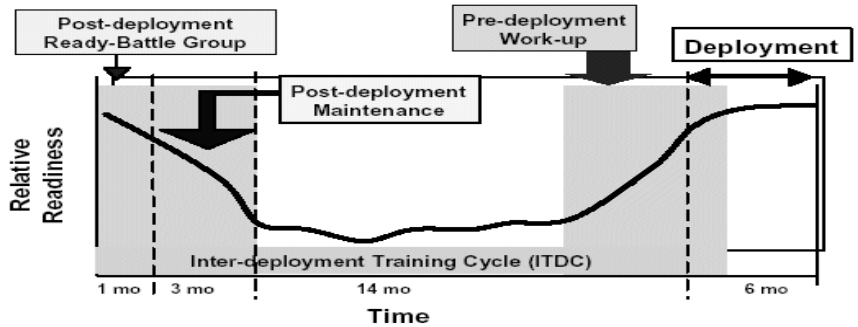
Navy Requirements

TRANSITION SPONSORS

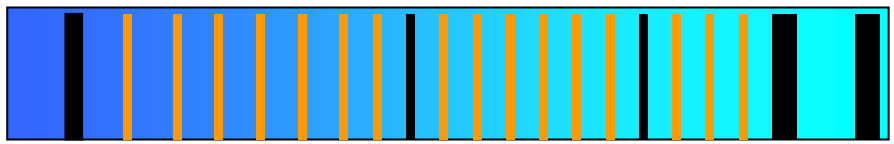
NAVAIR Navy Aviation Simulation Master Plan

NAVAIR Advanced Warfare Training Development 6.4 Program

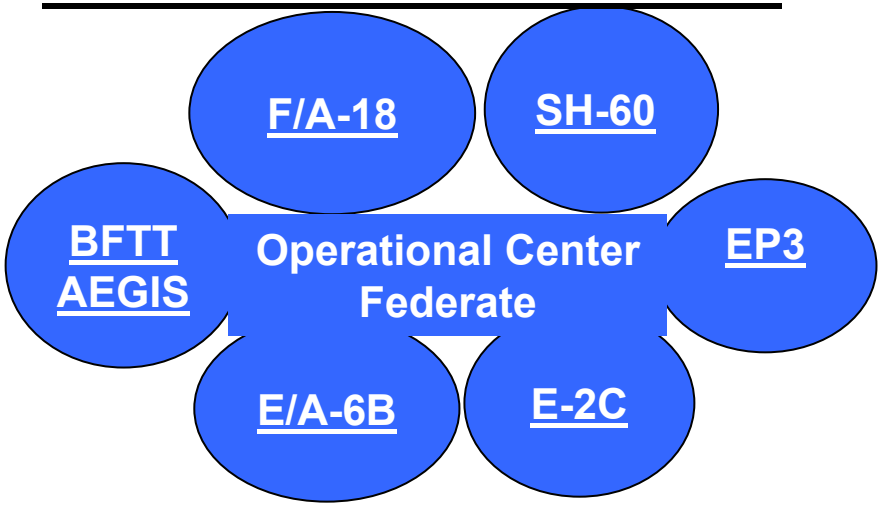
NAVSEA IWS 1E -BFTT



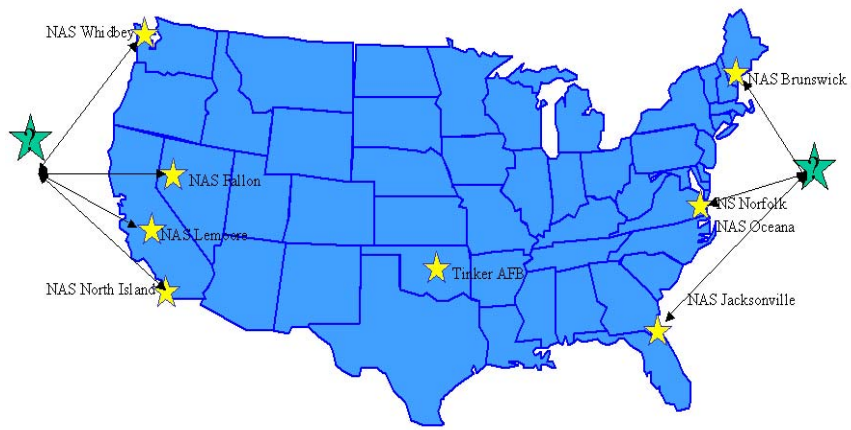
Deficiency: Just 5 Post Fleet Replacement Squadron Distributed Training Events



NASMP PLAN FY03-FY08 +→

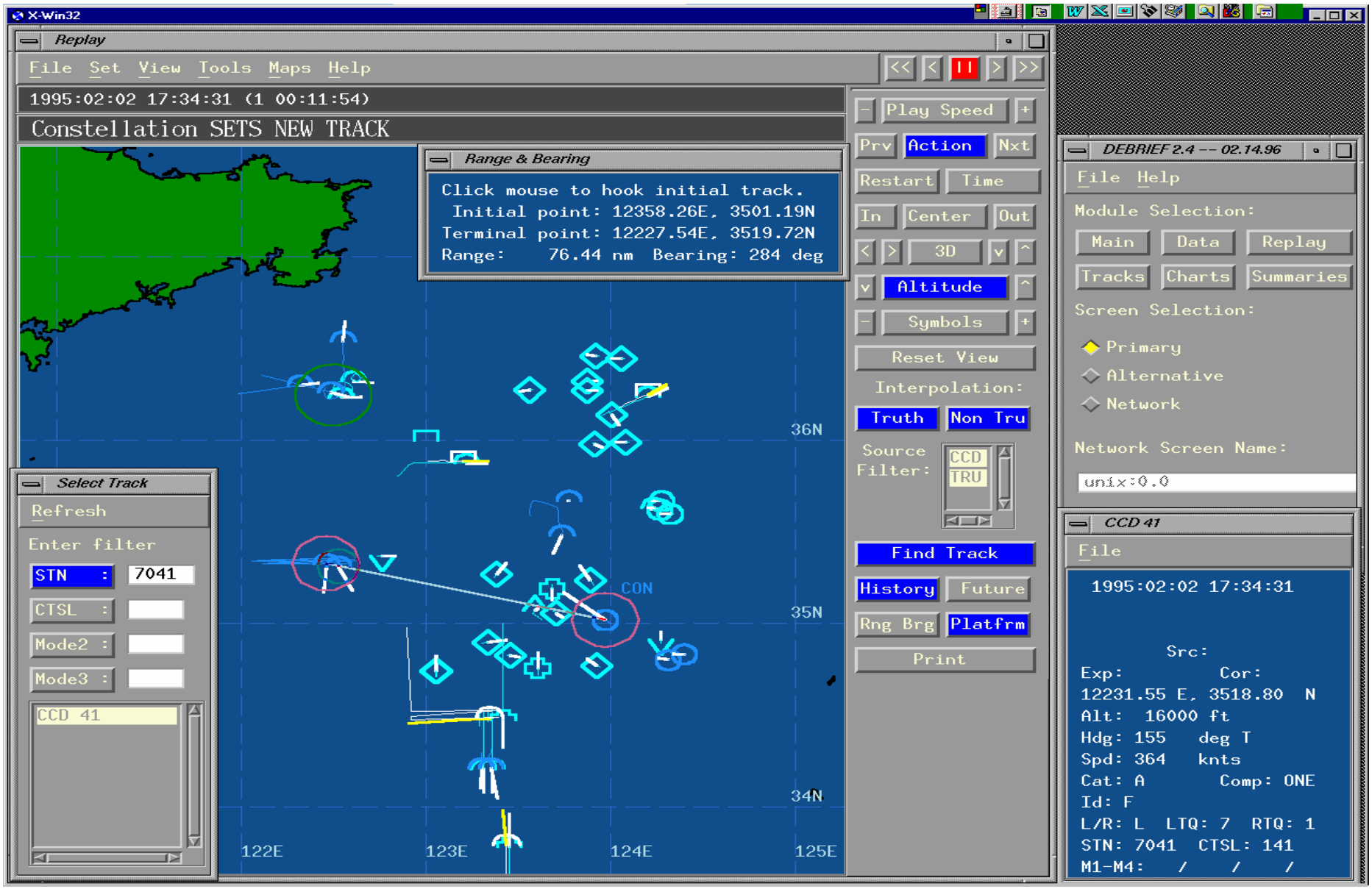


Distributed Training CONOPS

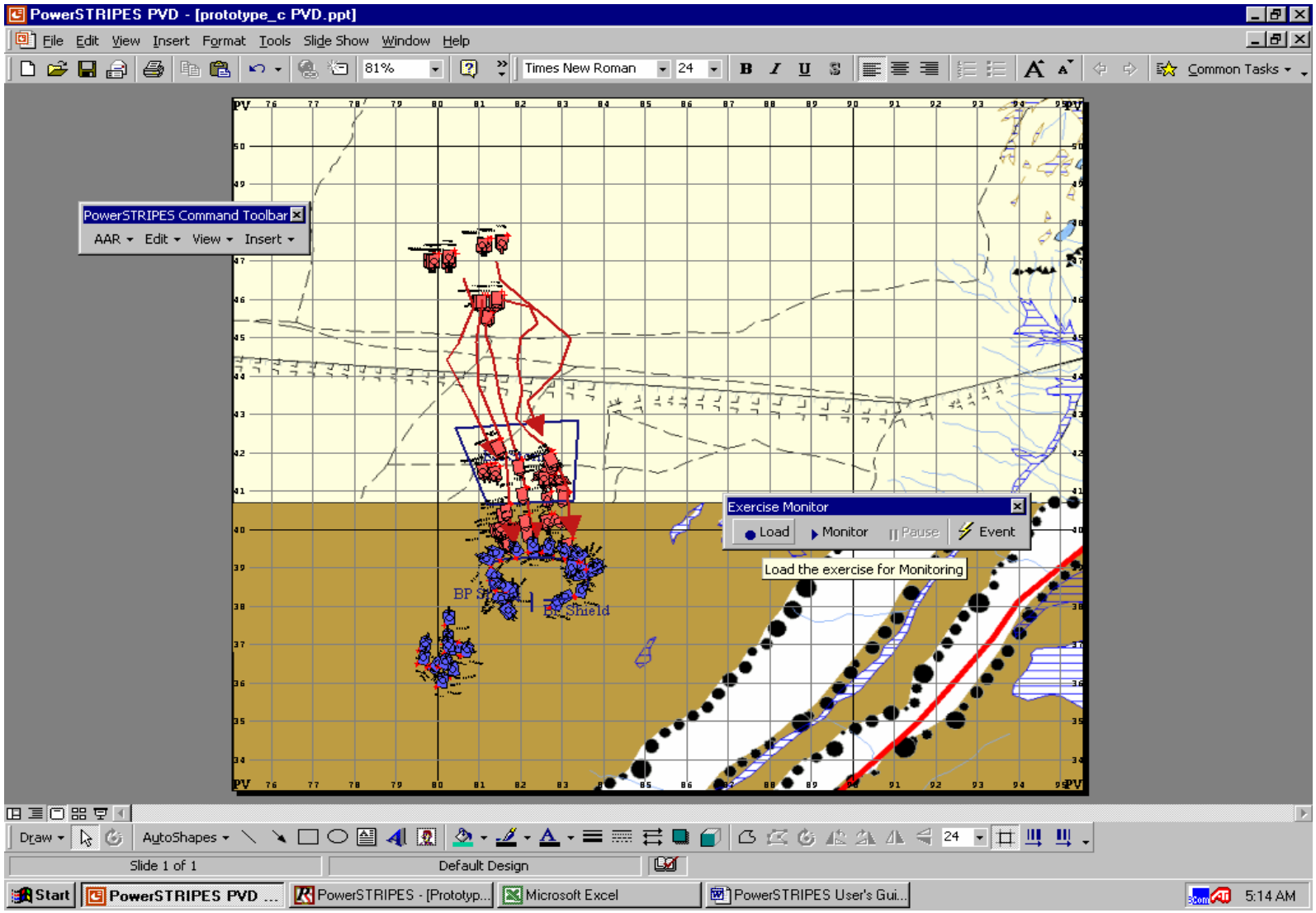


AAR System Example for Aviation Teams

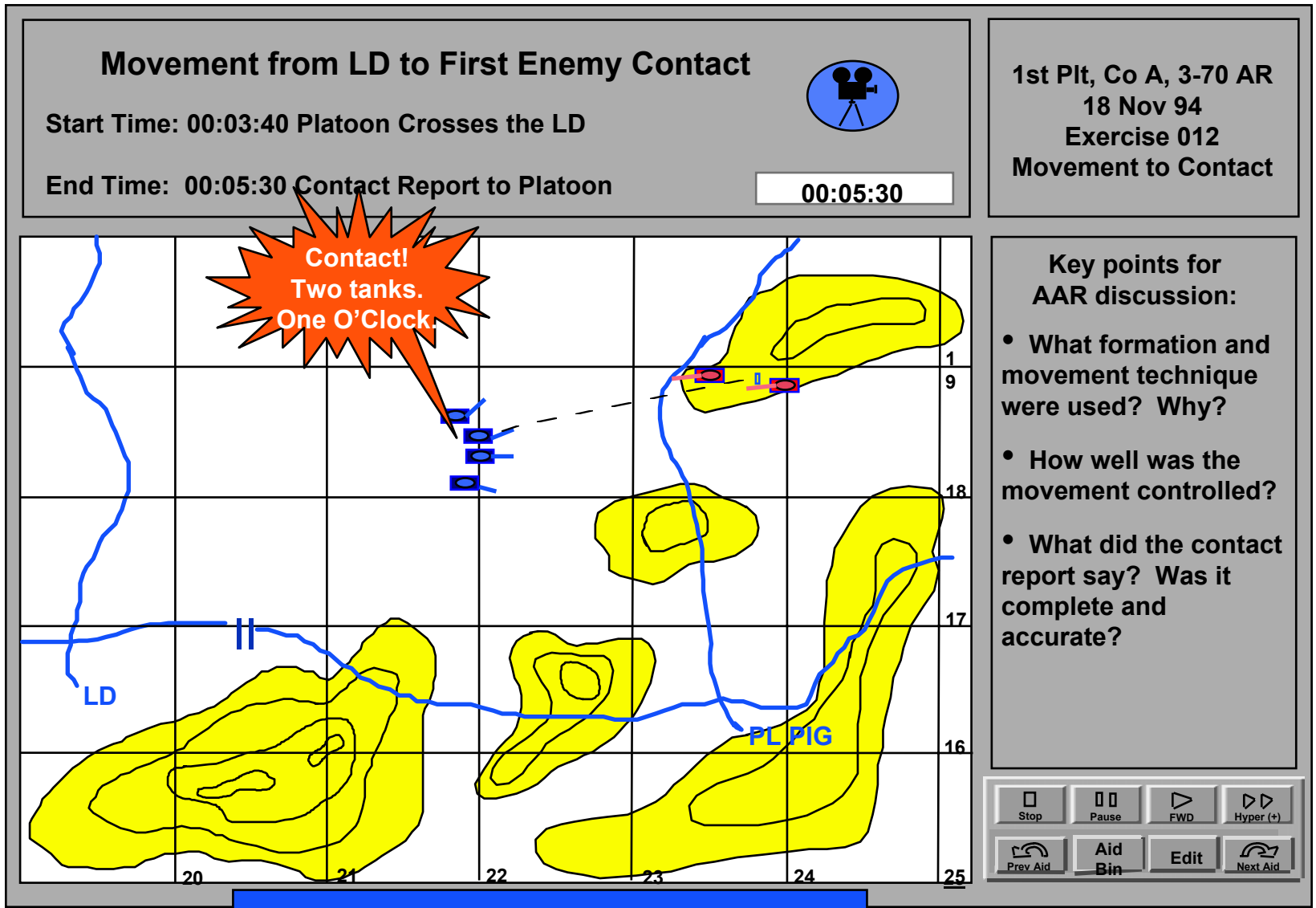
AAR System Example for Battle Group Shipboard Training: BFTT Debrief



AAR System Example for Army/USMC: PowerSTRIPES



Army Research Institute: Automated Training Analysis and Feedback System



Plan View Animation Aid

Distributed Training Challenges

- Nature of Effective Teams: Ability to Adapt Behaviors
  - Self-Correct, Compensate, Re-Allocate Functions
- Adaptation Forces Changes to Scenario Events
- Increased Workload for Instructors/Assessors
  - Distributed Teams Multiply Measurement Requirements
  - Increased Reliance on VTC/Phone Conferences and Fewer Face-to-Face Debriefs/AARs
- Need Rapid Tailoring and Debrief Based on Distributed Team Training Requirements
- Training Technology Gap: Theory- and Empirically-Based Measurement Strategies to Optimize Partitioning Debrief/AAR for Distributed Simulation-Based Exercises

Partitioning the Debrief/AAR

- NOT TRIVIAL! Additional challenges:
  - Partitions may not correspond to existing boundaries between teams or functions--They may be quite novel
  - There may be more interacting groups than there are venues (e.g., VTC facilities) and time to debrief them

- A practical balance must be struck VERSUS
  - Debriefing every interacting sub-team about every failure OR
  - The common solution: debrief everyone in intact groups (e.g., each flight element) about everything

- Partitioning Decisions
  - Identify individuals within the organization whose interactions influenced team performance
  - Set priorities
  - Bring those individuals together to critique the interactions and recommend improvements in them

Model of Organizational Behavior

- Adaptive Architectures for C2 and Team Training R&D (MacMillan et al.)

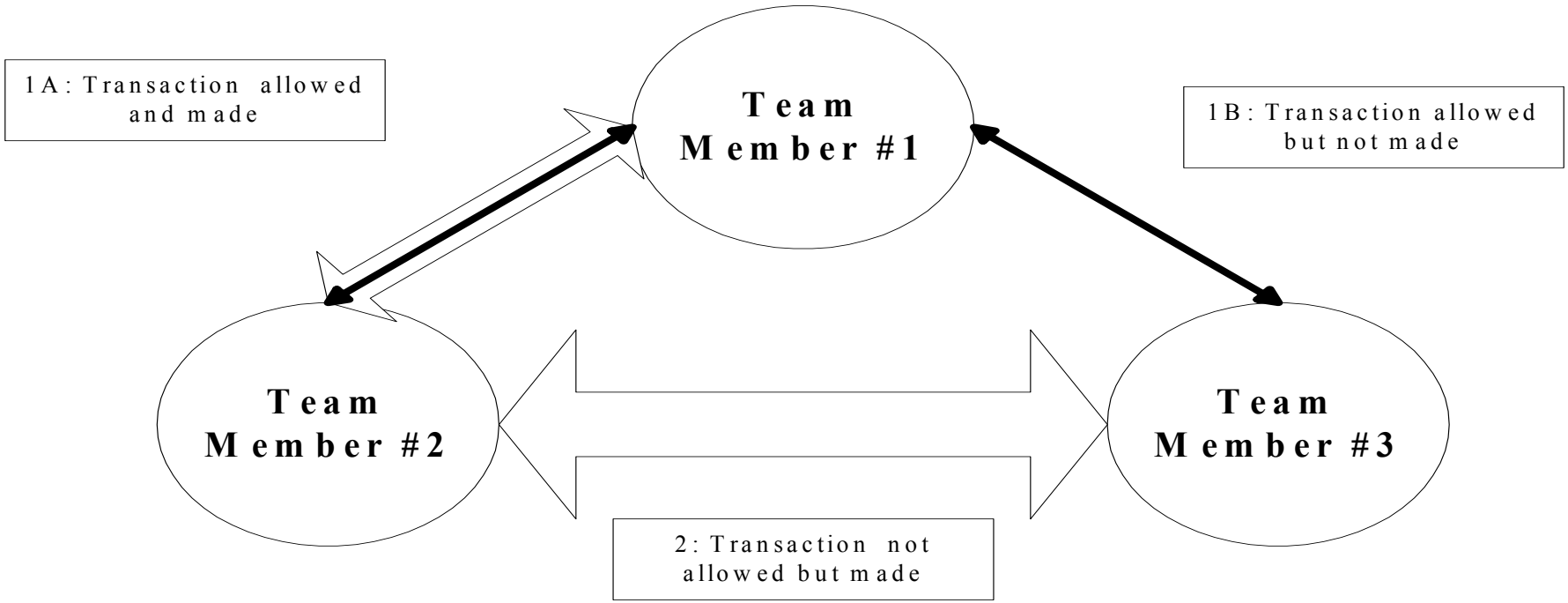
- Model of Organizational Behavior for Command and Control

- Organizational Structure

  - Static--Decision Hierarchy and Task Responsibilities
    - Who Is Subordinate to Whom Through Command Authority
    - Who Has Control of Specific Assets
    - Who Has Access to Specific Information Resources
    - Communication Rules for Passing Information
    - Distributed Expertise

  - Dynamic—Adaptive Behaviors of Team Members
    - Team Members Command, Communicate, Control Assets, Access Information, and Exercise Expertise
    - Content and Timing of Communications

Model of Organizational Behavior



Thin black lines = (official) communications transactions
Wide white lines = (actual) dynamic communication transactions

Partitioning for Feedback May Be Determined by Assessing the Transactions Made Among Team Members in Response to the Organizational Structure

Partitioning for Feedback

• Volume and criticality of behaviors (indicated by the breadth of lines in Figure 1) can guide instructors to prioritize feedback so that they give the most weight to most frequent or critical errors – whether of commission (1B) or omission (2).

• (1A)--Conforming to architectural constraints may warrant feedback that reinforces the behavior, particularly if that behavior is spotty

• (1B)--Behaviors that fail to exploit the allowances of the architecture may warrant instruction that reminds team members of this aspect of the architecture (e.g., the available communication channel or control over some asset)

• (2)--Violating architectural designs may warrant corrective instruction or organizational redesign

Partitioning the Debrief/AAR: Measurement Strategy

- Combine Team Measures to Identify Performance Patterns
  - Team Decision Making Processes
  - Team Adaptation and Coordination

- Team Decision Making Dimensions
  - (Paris et al. (1998) & Marshall (1995)
  - Identification
    - Recognizing the Problem
    - Effective use of Pattern Recognition Strategies using Track Profile Information
  - Elaboration
    - Interpreting the Situation
    - Recognizing Constraints
    - Prioritizing Threats
  - Planning
    - Knowing what to do and when to do it
  - Execution
    - Effective and Timely Implementation of Plans
    - Knowing Who Should Perform the Required Actions

Air Warfare Team Performance
Detect-to-Engage Sequence

IDENTIFICATION

- **Detect**
- **Entity Type ID**

ELABORATION

- **Threat ID**

PLANNING

- **Query**
- **Final Warning**
- **Illuminate**
- **Cover With Weapons**
- **Engage**

EXECUTION

- **Query**
- **Final Warning**
- **Illuminate**
- **Cover With Weapons**
- **Engage**

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 Comair	0 ⇐ *(2:30)* >	0 X ⇐ *(3:00)* >	0 X ⇐ *(3:00)* >	0 1 2 ⇐ *(7:00 E)* > ⇐ *(6:00 P)* >	0 X(E) X(P)	0 X(E) X(P)	0 X(E) X(P)	X(E) X(P)
1:06 – 255/36	7023 Helo	0 ⇐ *(2:30)* >	0 X ⇐ *(4:30)* >	0 X ⇐ *(15:00)* >	0 1 2 ⇐ *(6:00 E)* > ⇐ *(5:00 P)* >	0 1 2 ⇐ *(19:30 E)* > ⇐ *(18:30 P)* >	0 1 2 ⇐ *(19:30 E)* > ⇐ *(18:30 P)* >	0 1 2 ⇐ *(10:30 E)* > ⇐ *(9:30 P)* >	X(E) X(P)
2:06 – 030/76	7017 P-3	0 ⇐ *(3:30)* >	0 X ⇐ *(16:30)* >	0 X ⇐ *(16:30)* >	0 1 2 ⇐ *(15:30 E)* > ⇐ *(14:30 P)* >	0 1 2 ⇐ *(26:30 E)* > ⇐ *(25:30 P)* >	0 1 2 ⇐ *(26:30 E)* > ⇐ *(25:30 P)* >	0 1 2 ⇐ *(17:00 E)* > ⇐ *(16:00 P)* >	X(E) X(P)
6:06 – 029/76	7027 F-4 (1)	0 ⇐ *(7:30)* >	0 X ⇐ *(9:30)* >	0 X ⇐ *(11:30)* >	0 1 2 ⇐ *(17:00 E)* > ⇐ *(16:00 P)* >	0 1 2 ⇐ *(26:30 E)* > ⇐ *(25:30 P)* >	0 1 2 ⇐ *(26:30 E)* > ⇐ *(25:30 P)* >	0 1 2 ⇐ *(17:30 E)* > ⇐ *(16:30 P)* >	X(E) X(P)
6:06 – 029/76	7030 F-4 (2)	0 ⇐ *(7:30)* >	0 X ⇐ *(9:30)* >	0 X ⇐ *(11:30)* >	0 1 2 ⇐ *(23:00 E)* > ⇐ *(22:00 P)* >	0 1 2 ⇐ *(26:30 E)* > ⇐ *(25:30 P)* >	0 1 2 ⇐ *(26:30 E)* > ⇐ *(25:30 P)* >	0 1 2 ⇐ *(23:00 E)* > ⇐ *(22:00 P)* >	X(E) X(P)
12:06 – 031/78	7034 Comair	0 ⇐ *(13:30)* >	0 X ⇐ *(14:00)* >	0 X ⇐ *(14:00)* >	0 1 2 ⇐ *(18:00 E)* > ⇐ *(17:00 P)* >	0 X(E) X(P)	0 X(E) X(P)	0 X(E) X(P)	X(E) X(P)

ATPI Critical Event Clusters- Emphasis on Resource Allocation

Event 1: Begins 1 minute after scenario start and ends at 5 minutes Team Actions in Min:Sec	Made Detection	Made Platform Identification	Made Platform Threat ID And Priority
Commercial Aircraft #1 Wanders Off of COMAIR Route	1:30	2:30	3:00
Potentially Hostile Aircraft #1	2:30	4:30	5:00
Potentially Hostile Aircraft #2	3:30	4:30	5:00

Event 2: Begins 5 min after scenario start and ends at 15 minutes	Plan/Execute Query	Plan/Execute Final Warning	Plan/Execute Illuminate	Plan/Execute Cover With Weapons
COMAIR #1	6:00/7:00	N/A	N/A	N/A
Potentially Hostile A/C #1	5:30/5:30	7:30/7:30	8:00/8:30	8:00/8:30
Potentially Hostile A/C #2	6:00/7:00	7:30/8:30	8:30/8:30	14:30/15:00

% Team Actions Performed on Each Dimension for Each Event Cluster

Team A

Scenario	Identification	Elaboration	Planning	Execution
Event 1	90	90	40	40
Event 2	80	80	20	20
Event 3	80	80	0	0

Team B

Scenario	Identification	Elaboration	Planning	Execution
Event 1	60	40	99	99
Event 2	60	40	99	99
Event 3	50	30	99	99

Partitioning the Debrief/AAR: Measurement Strategy (Cont.)

- Team Adaptation and Coordination (Serfaty et al., 1998)

- Anticipation Ratio Enables Diagnosis of the Dynamic Communication Exchanges Among Team Members

- Categories
  - Type of Communication (E.G., Information Exchange, Situation Updates, Supporting Behavior, Error Correction, and Feedback)
  - Direction of the Communication in the Hierarchy (e.g., Team Member to Team Member and Team Member to Higher Authority)

- Example of A Good Anticipation Ratio
  - # of Team Member Communications to Higher Authority Greater Than # of Communications From Higher Authority to Team Members

Anticipation Ratio Assessment

TEAM ADAPTATION AND COORDINATION TRAINING MEASURE

CIC TEAM COMMUNICATION RECORDING FORM: TEAM

TEAM # ____ SITE _____ DATE ____ OBSERVER ____ SCEN # ____

PERIOD 1 2 3

TYPE & CONTENT		TIC to:		IDS to:		AAWC to:		EWS to:		Team
		TAO	Team	TAO	Team	TAO	Team	TAO	Team	Out
REQUESTS	INFOR-MATION									
	ACTION & TASK									
	PROBLEM SOLVING & PLANNING									
TRANSFERS	ACTION & TASK									
	PROBLEM SOLVING & PLANNING									
ACKNOWLEDGMENTS										

Partitioning Debrief for Teams A & B: Using ATPI With Anticipation Ratios

Team A: Was Higher Authority Asking For Information?

Scenario	Identification	Elaboration	Planning	Execution
Event 1	90	90	40	40
Event 2	80	80	20	20
Event 3	80	80	0	0

Team B: Were There Improper Team Member to Team Member Communications?

Scenario	Identification	Elaboration	Planning	Execution
Event 1	60	40	99	99
Event 2	60	40	99	99
Event 3	50	30	99	99

Sponsored Research Initiatives