



Human Factors: Conducting Over the Shoulder Assessment for Military Exercises and Experiments

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3-5 October 2006

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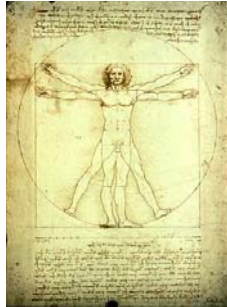
Exercise and JEFX Experience



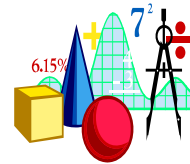
- JEFX 1999 AFRL/HEA
 - Warfighter Operations Centers
- JEFX 2000, AFRL HEA & AFEO Assessment Team
 - CAOC Time Sensitive Targeting
- JEFX 2000, AFEO Assessment Team
 - JAOC Time Sensitive Targeting
 - Human Factors & Opns Effectiveness
- Schreiber I and II (Capt Del Vecchio)
 - SWC and SMC/XR (Transformation Div)
 - Weapon System Effectiveness
- Virtual Flags, AFRL-HEA
 - BCC-X Training Requirements
 - Operator Effectiveness
- JEFX 2004, ESC & AFEO Assessment Team
 - Battle Control Center-Experimental
 - Tactical Battle Management Command & Control
 - Human Factors/Ops Utility Assessments

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- Introduction
- Human Factors Concepts
- Understanding Control



- JEFX Overview
- HF Assessment JEFX 02
- HF Assessment JEFX 04



- Nuclear power plant operators have to periodically go to simulator and pass a certification test
- Assessors evaluate performance to ensure that operators have the expertise that is required to operate the plant safely and effectively

A Story from the Field



- Frustrated by repeated “write-ups” for failure to comply with established procedure they decided to perform next simulation strictly “by the book”
- Un-amused, the assessors cited the operators for “*malicious compliance with procedures*”

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Role of Human Operator



The role of the *human operator* in today’s complex socio-technical systems is to *adapt* to the unanticipated variability inherent in a dynamic *operational environment*



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The role of the **technology** in these systems it so **support** the development and deployment of operators' **adaptive strategies** in the face a dynamic task environment

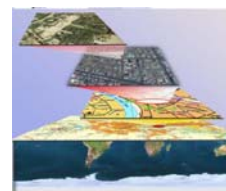
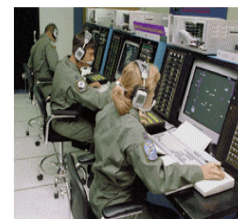


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● A OTS assessment is rigorous to the extent that it

- provides analysts with **insight** into and **understanding** of the mechanisms and strategies of human operators to **adaptively cope** with the complexities of a **dynamic, uncertain, and high consequence** operational environment.
- demonstrates the extent to which technology, in all its forms, **supports** the **coping strategies** of human operators and enhances overall system performance.



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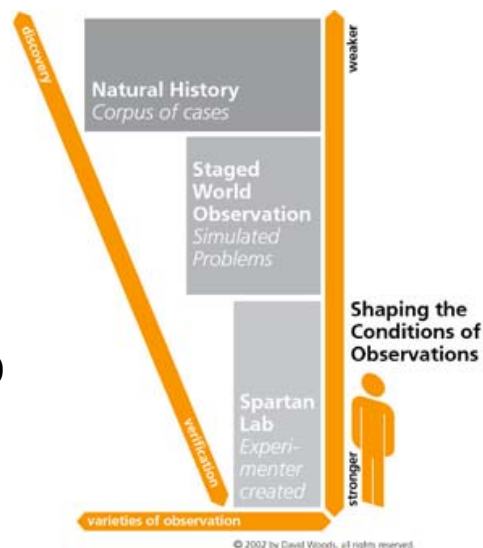


- Accept reduced performance – all tasks will be performed but at lower performance levels
- Shed load – prioritize across tasks and activities, dropping out those considered low priority
- Redistribute work demands – shift work to other local/distributed operators or automated agents
- Reduce Operational Tempo – manage the processing tempo resulting in less work per unit time



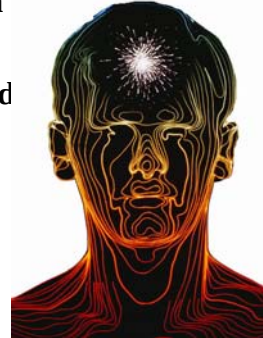
“There is a need to orchestrate varieties of observation that are diverse in how they shape (and therefore distort) the processes we wish to observe and understand”

Woods & Hollnagel (2006)





- **Complexity of Operations: What do you look for?**
- **Context sensitivity: Every instance is different**
- **Goal conflicts: Avoiding goal fixation**
- **Distributed nature of work**
- **Observability: Getting inside the head**
- **Operator variability**
- **Process vs Product**
- **Plans vs Situated Action**
- **Metrics and measures**



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- **Explain and substantiate (not just “what” but also “how” and “why”)**
- **Avoid premature narrowing (iterative process of broadening and focusing)**
- **Exploit the dual status of prototypes**
 - Tools for discovering new aspects of dynamic demands and constraints of operational domains (test our assumptions)
 - Hypotheses of what will be useful. Refined product to support operators in the pursuit of operational goals and objectives.

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Lessons Learned from the Field: Best Practices for OTS Assessment



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Preparation: Building Expectations



- **Literature Review**
 - Doctrine
 - Test and Field Reports
 - Experimentation Plans
 - Concepts of Operations
- **Technology CONOPS development**
 - What purpose does technology serve (design intent)
 - Anticipate consequences of technology change
 - Establish expected outcomes
 - Develop conceptual model of the work system
- **Scenario Generation**
 - Participation in development of MSEL to enable anticipation of interesting situations and opportunities for data collection

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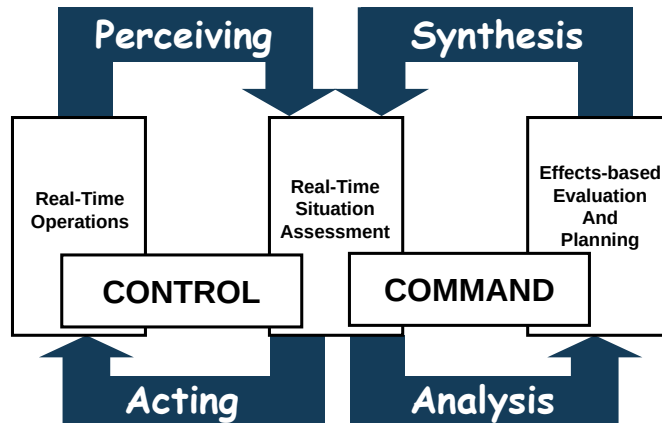
- **Surveys**
 - Use surveys to guide and direct observation
 - Identify specific challenging activities or things that will likely prove problematic
 - Leverage operational patterns seen across domains
 - Generate survey questions that will expose problem areas and unique challenges
- **Observation**
 - Capture unique aspects of operator behavior
 - Look for variations in strategies across operators
 - Record operators to extent possible to support follow-up sessions with operators
 - Think Aloud techniques
- **Interviews**
 - Follow-up sessions with operators to review critical incidence, provide more in-depth understanding of performance and task strategies

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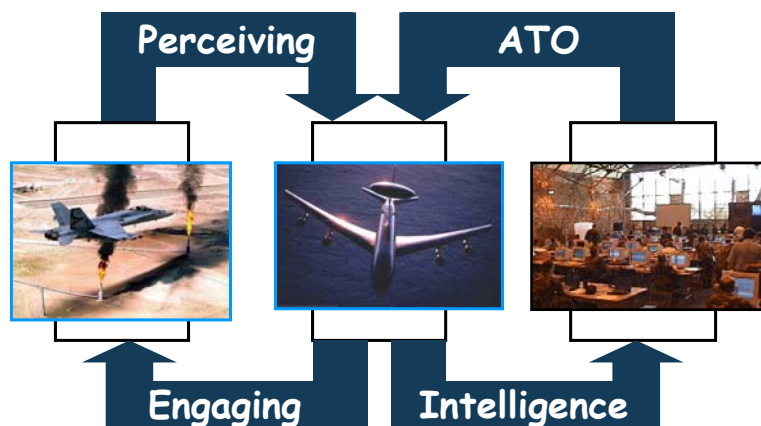


- **Pursuing causal explanations**
 - Interpretation of data, why did we see what we saw
 - What was impact
- **Identify how technology changes work**
 - Mapping observation to expectations
 - In response to mission events
 - In response to technology
 - Identify unintended consequences of technology
- **Refining models and assumptions**
 - How did observation change expectations

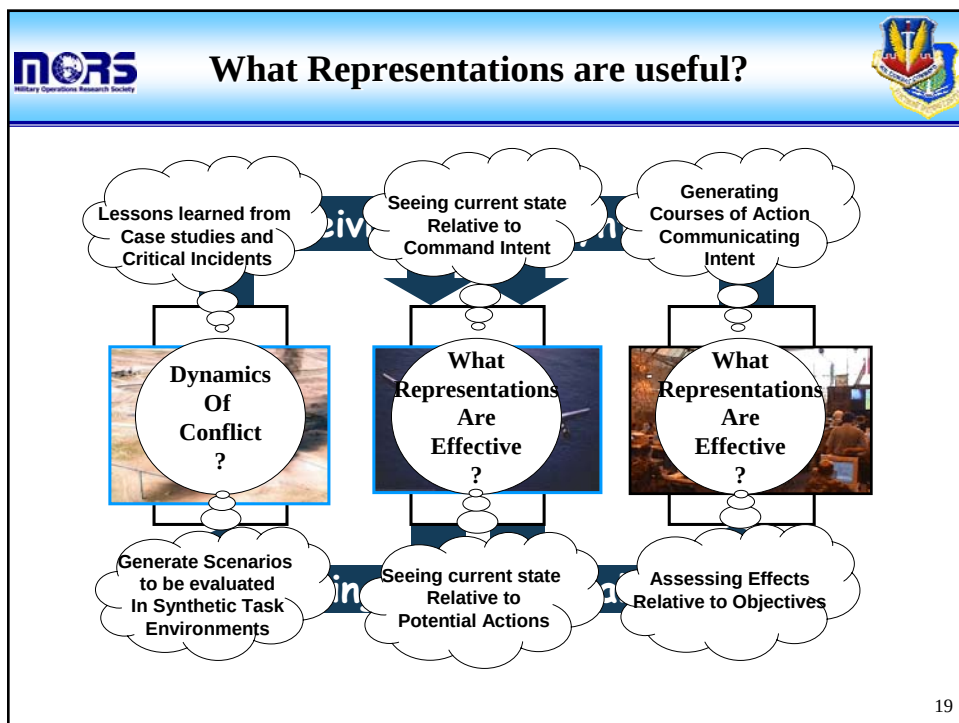
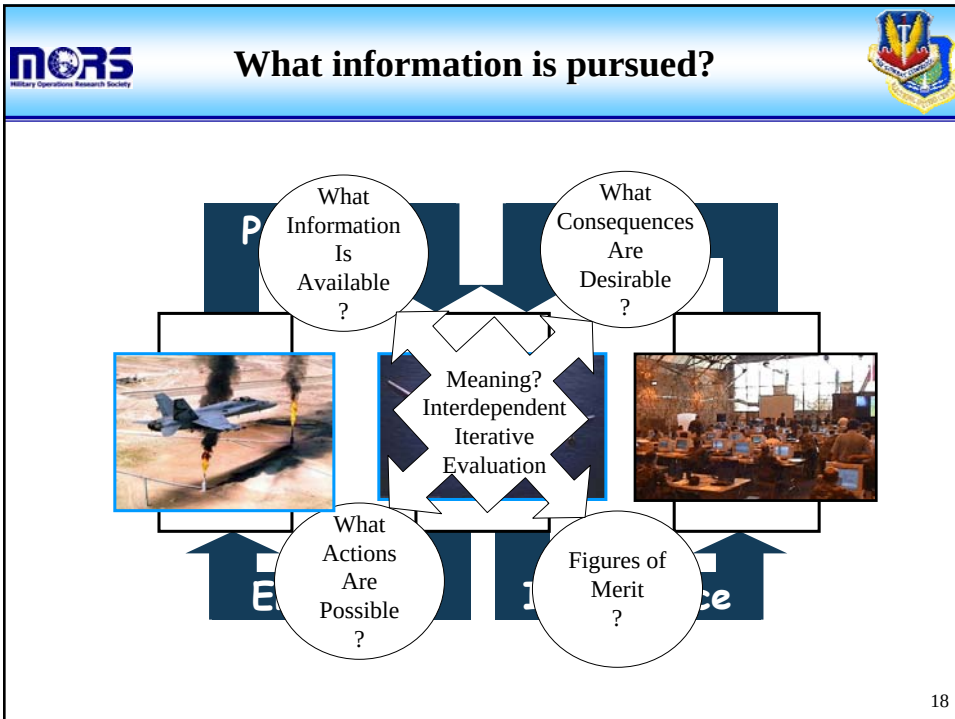
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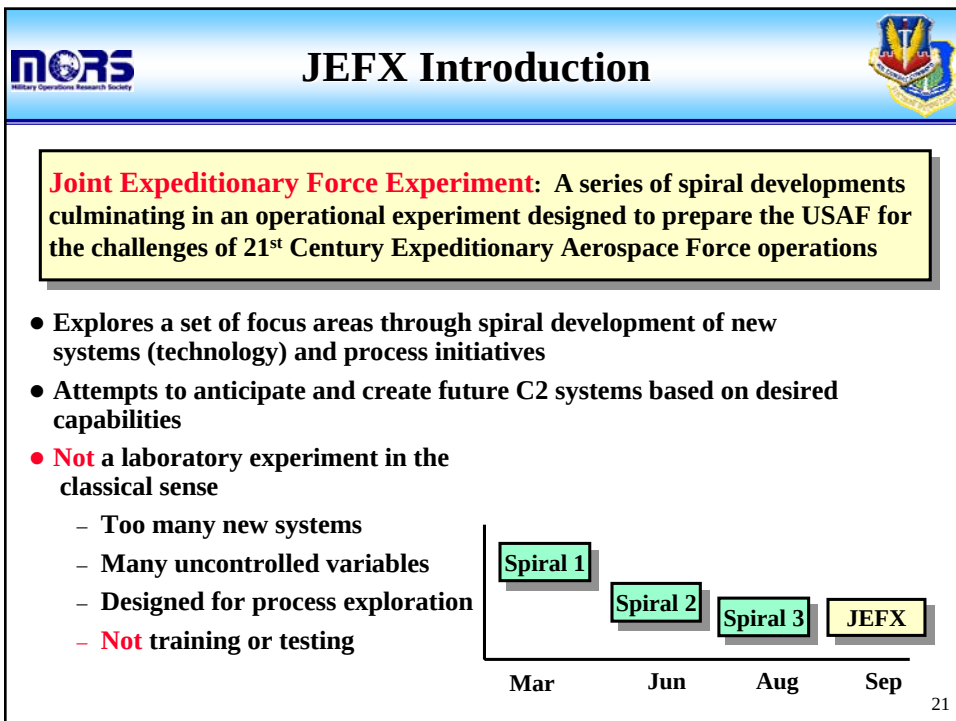
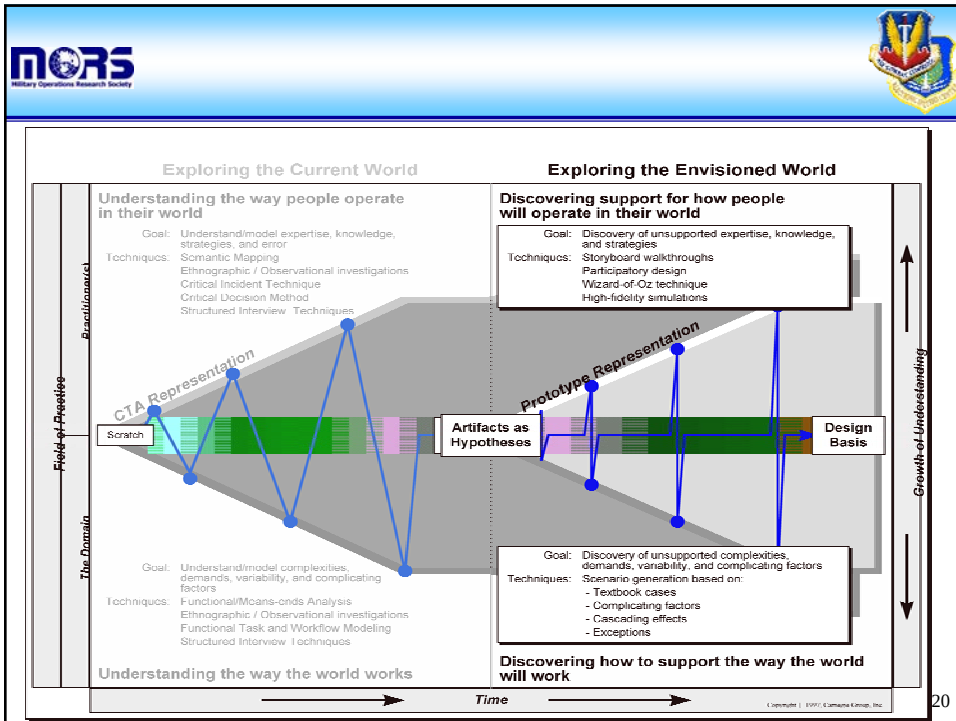


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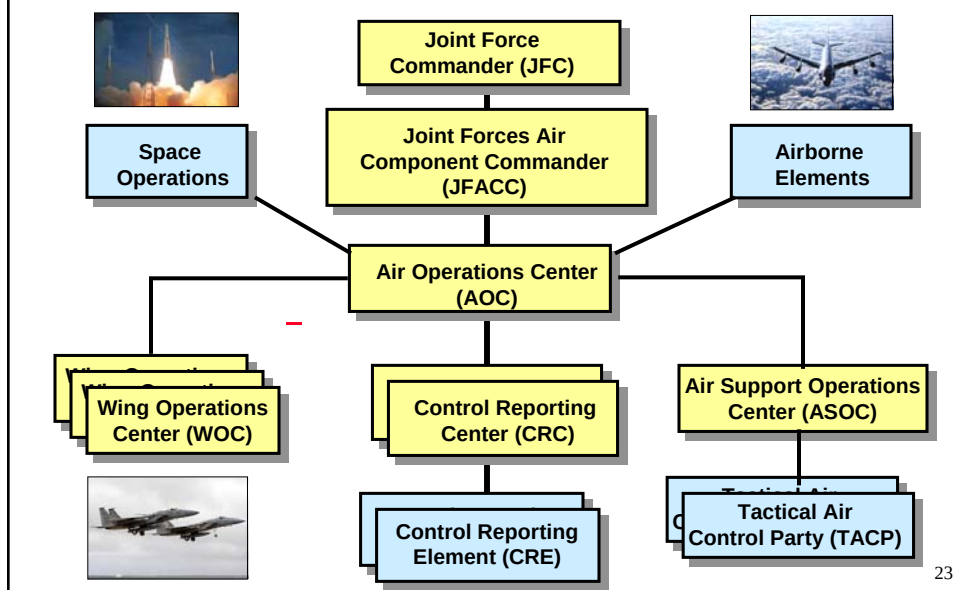




Initial Perspective

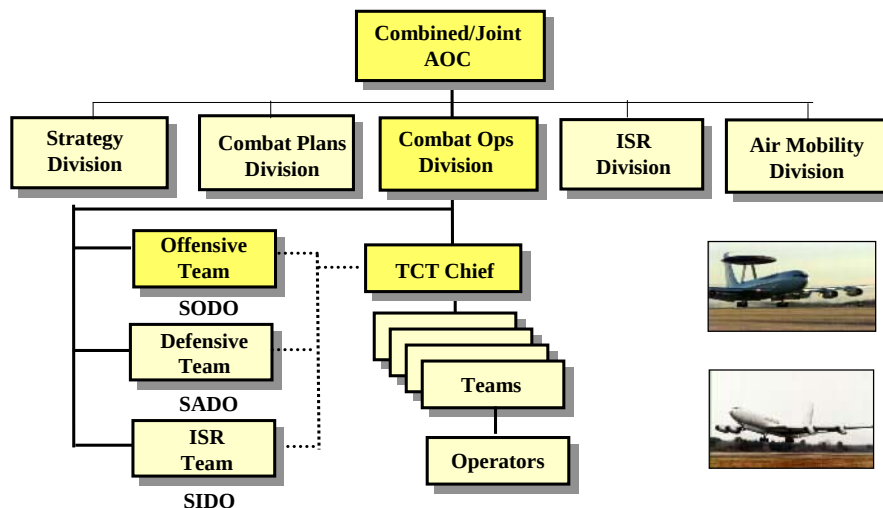
- Over 2200 Participants at 8 primary locations
- 35 Computer Models/Simulations injecting from different locations
 - Approximately 1200 Sorties/day, 250 messages/hour
 - 241 M&S support & 56 scenario controllers
- Virtual Cockpits (Weapon System Simulators)
 - F-15C/E, F16C, Rivet Joint, JSF, ABL, AWACS
- 77 Aircraft in “live-fly” at Nellis
- 60+ System/Process initiatives

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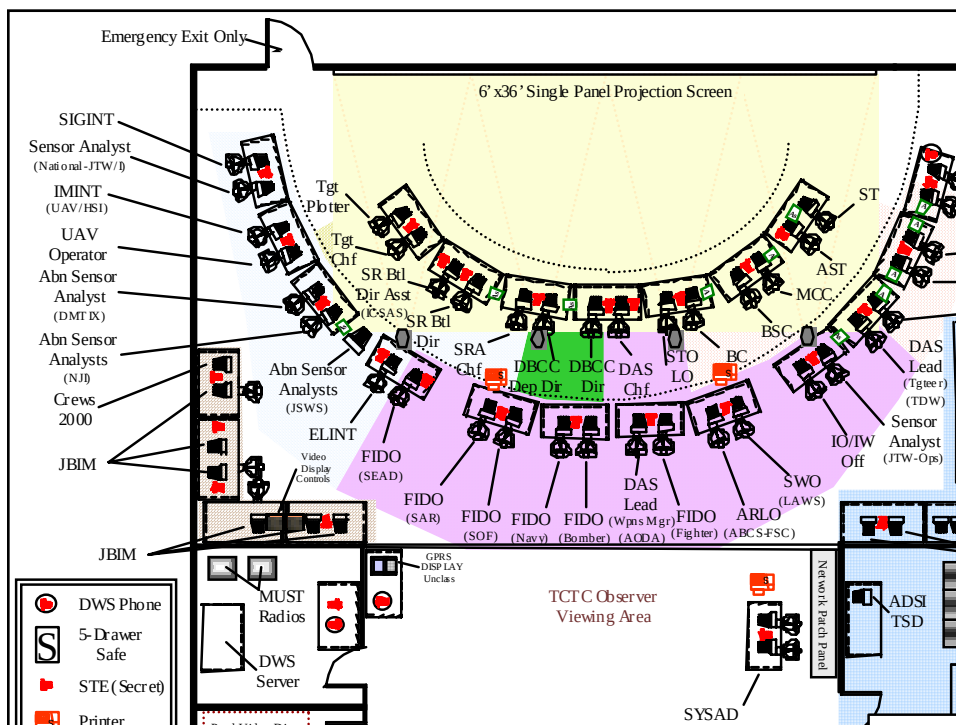


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Organizational Relationships



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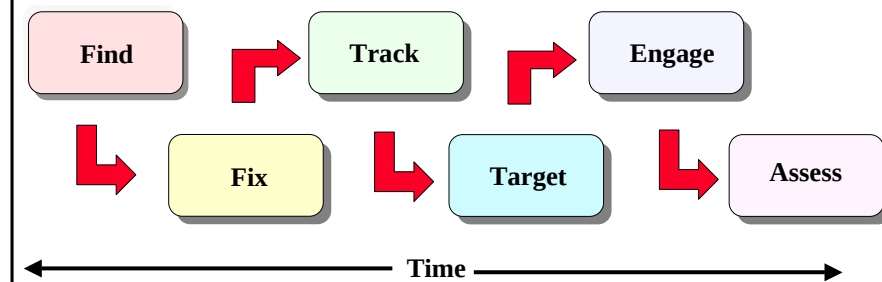




Organized operations to anticipate TCTs not in the ATO and orchestrate operations to negate mobile surface targets within their operating cycles

Prosecution of Time Critical Targets

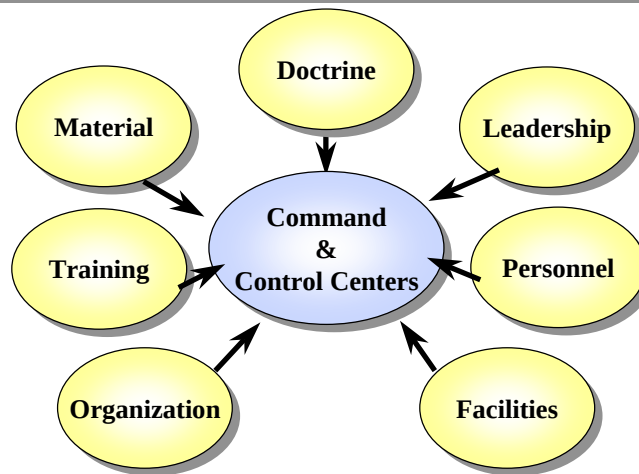
(F2T2EA)



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Identify DOTMLPF recommendations that will improve operational warfighter capabilities



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TCT Thread



TCT Thread: A group of processes & systems initiatives that work together to support **execution** of Time Critical Targets

- **Process Initiatives (6)** --New ways of doing business (Doctrine, Organization, Training, Materiel, Leadership & People)

- Battle Control Center (BCC) JEFX 99 Carryover
- Intelligence, Surveillance Reconnaissance (ISR)

- **Time Critical Targeting (TCT)**



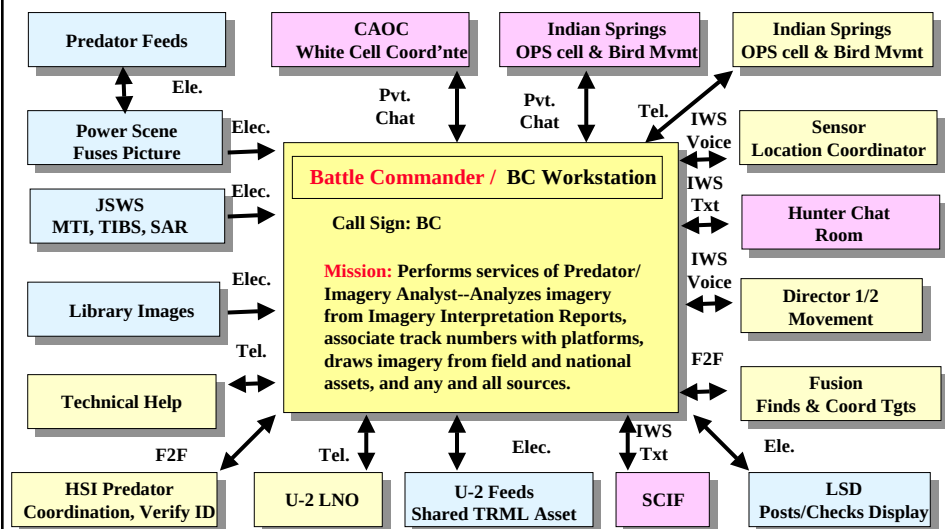
- **System (Technology) Initiatives (70)** --New, existing, or commercial systems to determine operational capability

- **TCT Technology Initiatives**

- Talon Gateway
- Mission Analysis Tracking (MATTS/ITE)
- Bomber Enhanced Tactical Interface (BETI)
- Project Suter
- Panther Den
- Attack Ops Decision Aid (AODA)
- TBMCS/Army BCS Interoperability

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Battle Commander Workstation Connectivity



- Directs movement of the predator by positioning pointer, Has 15 Input/output commo ports

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Example AFRL/HEAI Message Transmission Capture Form



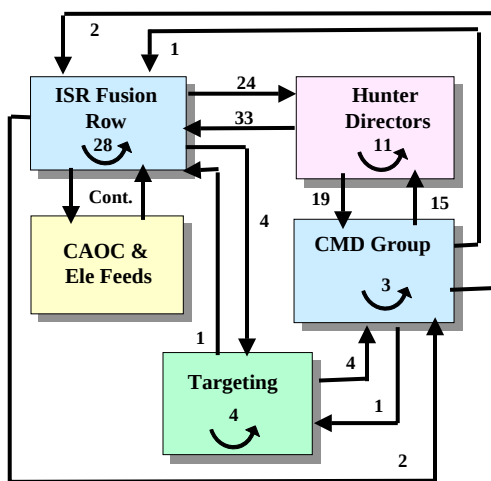
Collector: Garrambone Date 6 Sep 2000 Start 1759 End 2200 Page 1 of 8
Cell/Section Hunter Physical Location Director 1 corner Episode Day 3

	Time Zulu	Mode Type	From	To	MSG Gist	RFI	Coor	Ord	Un Date	Res/ Conf
1.	1757	C	HL	All	Radio Check (All come up)	x				
2.		C	D2	All	Set up map—prepare symbology			x		
3.		C	HL	Tgt	Is your radio working					x
4.	1800	C	D1	SCIF	Is your radio working					x
5.		C	D2	All	Reporting downed crew member—CSAR Mission					x
6.	1801	C	Rvn	All	ISTAR in AO		x			
7.		C	D1	All	Focus on two possible targets			x		
8.	1802	C	D2	Sen	Provide ISR asset status check	x				
9.		C	JBIM	D1	Radio check		x			
10.	1803	F	HL	BD A	Coordination		x			
11.		F	D2	D1	Note 4 targets on screen—remove these two				x	
12.	1804	C	D1	Img	Are these tgts from yesterday?	x				
13.		F	HL	TCTC	Coordination					
14.		F	D2	D1	Showing too much detail in grid box		x			
15.	1807	C	D1	HL	Too much detail and indistinguishable colors		x			
16.		C	Rvn	D2	I've determined tracks on two tgts				x	
17.	1808	C	Fus	D2	Screen clears when transition takes place		x			
18.	1809	C	Sen	HL	Provide information	x				
19.		F	HL	Sen	Coordinating information		x			
20.		C	D2	D1	Status of SA-10 in listing column of data?	x				

R = Radio Trans/Rec B = IWS BBS F = Face-to-Face Ord = Order
L = Large Screen Display A = IWS Audio P = Person-to-Person Res/Conf = Response/Confirmation
D = DIS Net T = IWX Text S = Sneaker Net RFI = Req for Information
T = Telephone C = 16 channel phone PA = Public Address CB = Crib sheet

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Example Hunter Section Voice/Visual Message Traffic



Direction	Number
CAOC-ISR	Cont
ISR-CAOC	Cont
ISR-CMD	3
CMD-ISR	2
ISR-Hunt	24
Hunt-ISR	33
ISR-TGT	1
TGT-ISR	4

	ISR	Hunt	TGT	CAOC	CMD
ISR	28	24	1	C	2
Hunt	33	11	6	2	15
TGT	4	10	4	0	1
CAOC	C	2	0	?	?
CMD	2	19	4	?	?
Total	67	66	15	2	18

Note. 168 messages caught

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System Feeds

- JSTARS
- VSTARS
- JTIDS
- Predator Images
- Predator Library

Audio Products

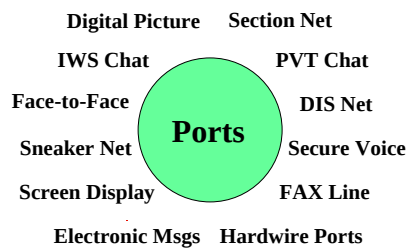
- 16 Pipe DIS Net
- IWS Audio
- Public Addr Sys
- Telephone
- ACCESS Comm
- Sneaker Net
- Secure Telephone
- Face-to-Face

Electronic Products

- TBMCS SAA/ATT
- SPINS & IPB
- SAA Display
- SOLIPSIS Display
- TG / RPTS
- Section Chats
- AODA

Paper Products

- Smart Pack 1
- Smart Pack 2
- Smart Pack 3
- Operator Checklist
- Threat Sys Hndbk
- Operation Hndbk
- Written Msgs
- Coord Cheat Sheets



Special Products

- Large Screen Display
- Private Chat Rooms
- Secure FAX
- OPS Briefings
- SA Briefings
- Pilot Debriefings
- Tools/Apps Briefings
- On-call support
- Computer Crossovers

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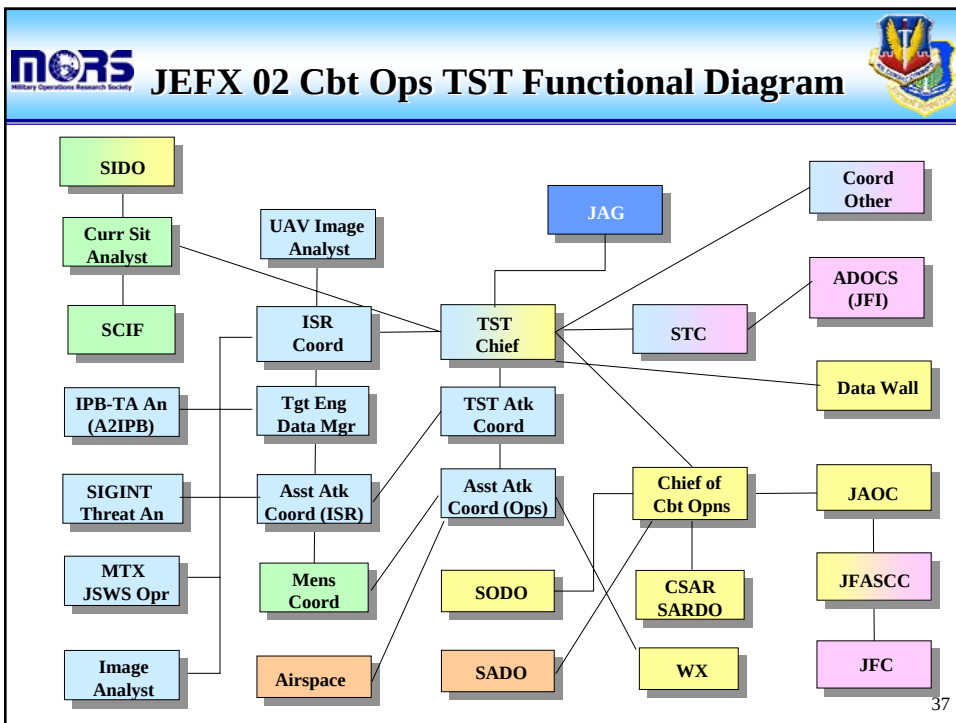
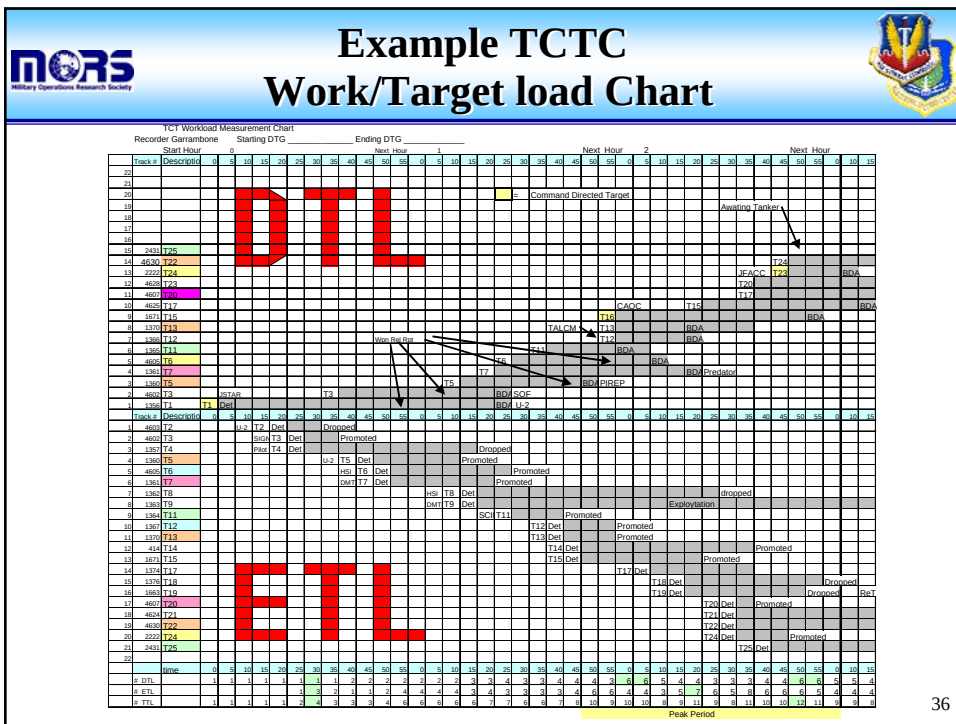
- TCT Cell Ops
- Section Reviews



- Internal Process Review
- Shortfall Analysis
- Operational Discussion
- Team Innovation
- Process Adaptation

- Cross-talk
- Sneaker-net
- Display alerts
- Fusion Nodes
- Task partitioning
- Task sharing
- Info pull/push
- Cohesion meetings
- Definitions
- Documentation
- Questions/agreements

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- Evolving C2 Centers present dynamic challenges
- JEFX - good venue to gain Human Factors insights
- New technology / forms of automation - pros & cons
 - Operators reverting to “tried” and “true” when automation failed
- New technologies and processes necessitate new methodologies and processes for operator training
 - New mindset
 - Big picture, consequences, multiple qualifications, etc
- Individual operator and team development implications
- No more pick up teams - well honed and integrated
- **Human element** requires at least equivalent **attention** / **emphasis** as technology and process acquisitions
- Lots of unmade charts (time sensitive to CSAF De-briefings)

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- JEFX participants recognized the **need for more, better training**
- Operational training on new systems was critical to the success of TCTC
- **Training shortfalls generated need for numerous workarounds**
- New-essential **training** took place every day
- It **was requested** by operators, was formal and informal, and practiced as a result of the **pressure** of the operations
- **Combat operations require C2 training on numerous subjects** to provide error free rapid performance at critical times
- Training has to create the image of **“doing it right”** in the mind of the operator

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C2ISR at the tactical level

The work of the Air Control Squadron

40

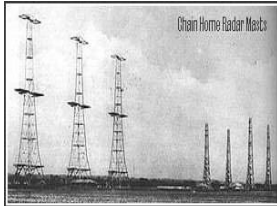
**Warfighter
Training
Research**



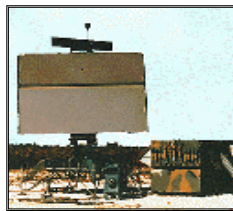
**Warfighter
Mission
Training**

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Missions of the Air Control Squadron (ACS)



“Battle Management Command and Control”



- Air Battle Management
- Surveillance
- Combat Identification
- Weapons Control
- Data Link Management
- Theater Missile Defense



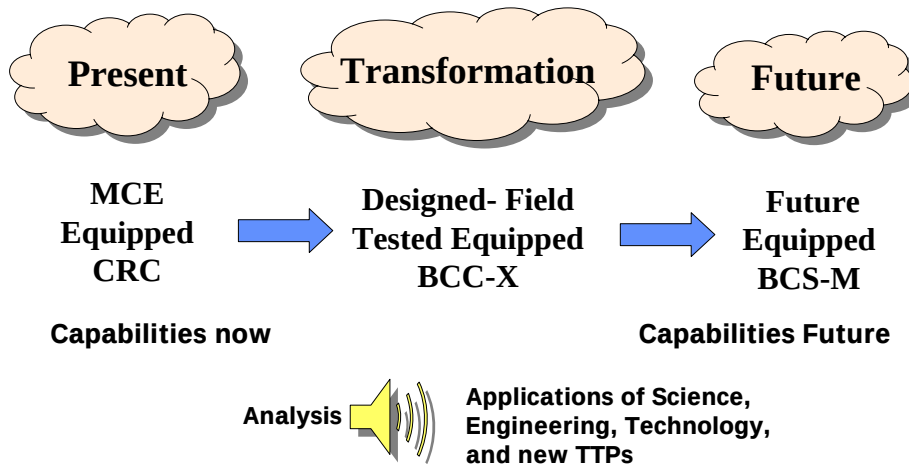
“Centralized Control and Decentralized Execution”

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Premise for BCC-X



The Transformation of CRC (MCE-Equipped) to BCS (Future-Equipped)

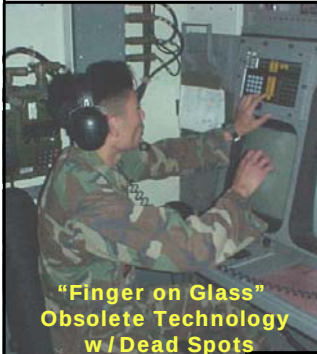


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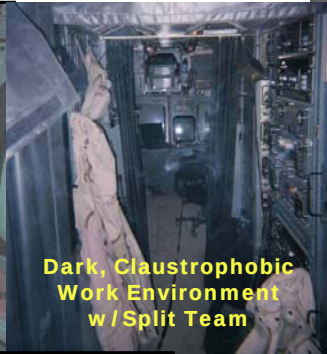


Reasons for Transformation





"Finger on Glass"
Obsolete Technology
w/ Dead Spots



Dark, Claustrophobic
Work Environment
w/ Split Team



Operators must find
a way to satisfy
mission requirements



4 "Box"
Operation



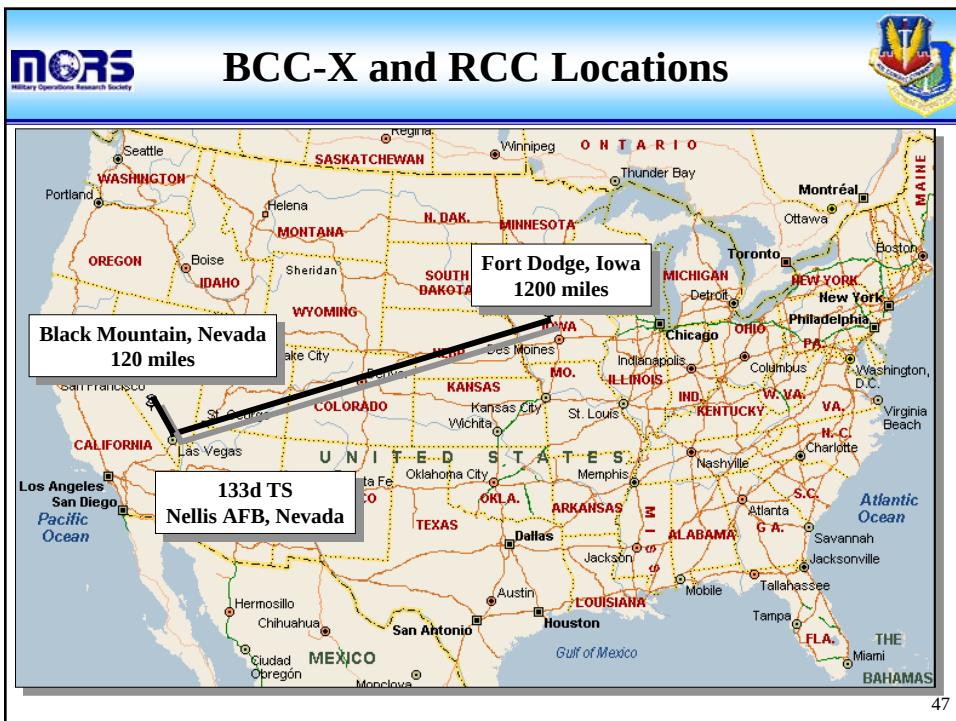
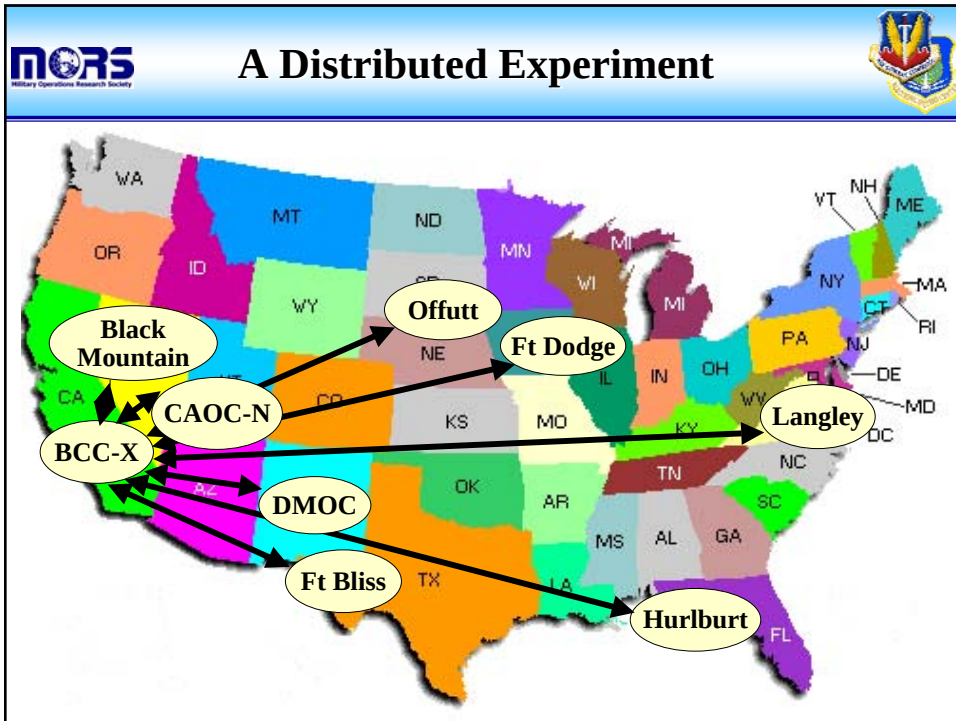
Labor Intensive
to Mobilize



Frontline operations means you
bring support infrastructure with you

 Defining the BCC-X New Systems 	
Generic System	Some Example Systems
Situational Awareness System	TDF-like, Thales/Raytheon-like, X-like
Intelligence Information Fuser	Multi-Source Correlator Tracker, other correlators-fusers
Mobile Operations Facility	OMs, GP Med Tent, 3-in-1 Shelter, Temper Tent
Environmental Control Units	600 BTU, 660 BTU, etc.
Communications Radio Systems	AVTEC, ASTI, others
Air Defense Warning/track Sys	TAD MTS, ADSI, SIS
Data Links, Networks, Flows	SATCOMs, Remote Radio, Satellite, BUG-E
Mobility Systems	Mobilizers, M913 Bridge Trucks, S&T Trailers
Robotics Sensors	UCAV, Predator Feeds, GH, SWARM

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Types of Analyses for Assessment

- System Analysis of BCC-X Systems
- Operations Analysis of Processes
- Operational Assessment
- Operational Utility Assessment
- Engineering Technical Assessments
- Performance Measurement
- Human Factors Assessment

Target of Analyses

Devices/systems

Operators

Mission

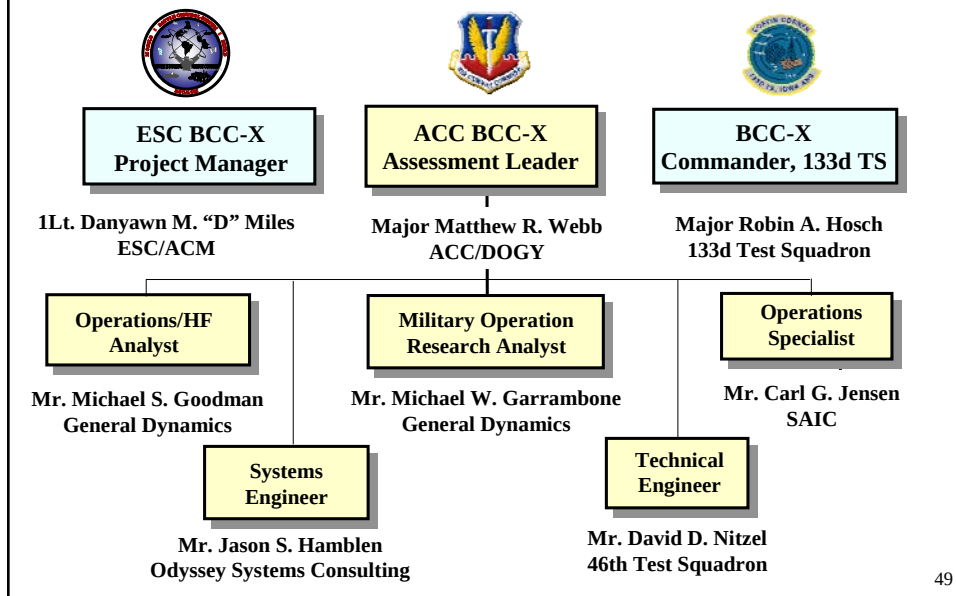
Warfighter value

Specifications

Baselines

HF Operations

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Operational Equipment Comparisons



Four Operations Modules



WT. 18K Lbs x 4 = **72,000** Lbs
 SF. 4 sections + **4** Mobilizers
16 Operations Consoles
8 ECUs 600 Lbs = **4800** Lbs
 SF 2x3x8 = **48** SF Area

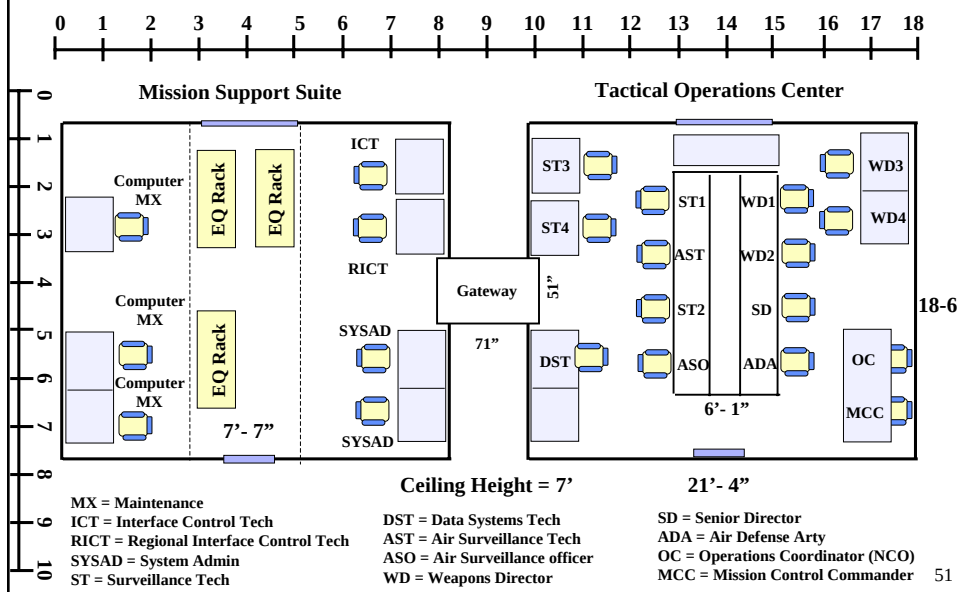
Two 3-in-1 Shelters



WT. 15K lbs x 2 = **30,000** Lbs
 SF. 2 sections + **2** Mobilizers
16 Operations Consoles
4 ECUs 700 Lbs = **2800** Lbs
 SF 3x5x2 (stacked) = **30** SF Area

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JEFX04 BCC-X 3-n-1 Shelter Configuration



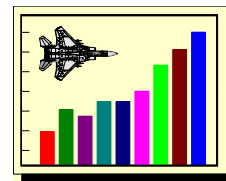
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- Literature & documentation reviews
- Structured interviews
- Operator daily surveys
- Spot and activity reports
- Player's general observations
- Ops planning meeting extracts
- Solicit thoughts, ideas, & opinions
- De-brief, hot wash & post-ops results
- Electronic data capture (some)
- On-station observations
- Reviews and final comments



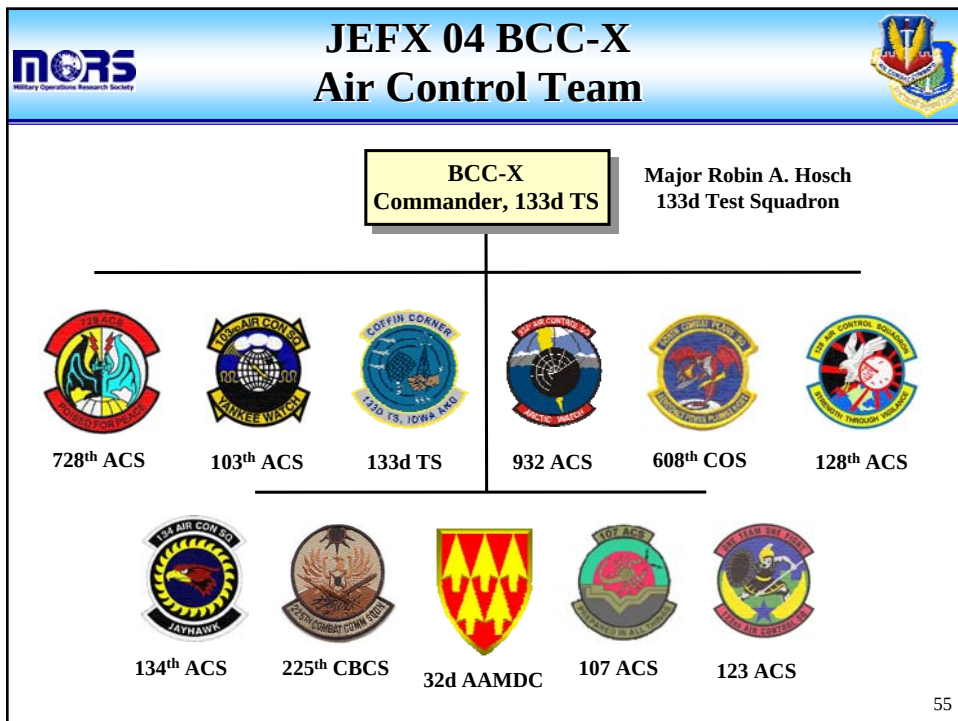
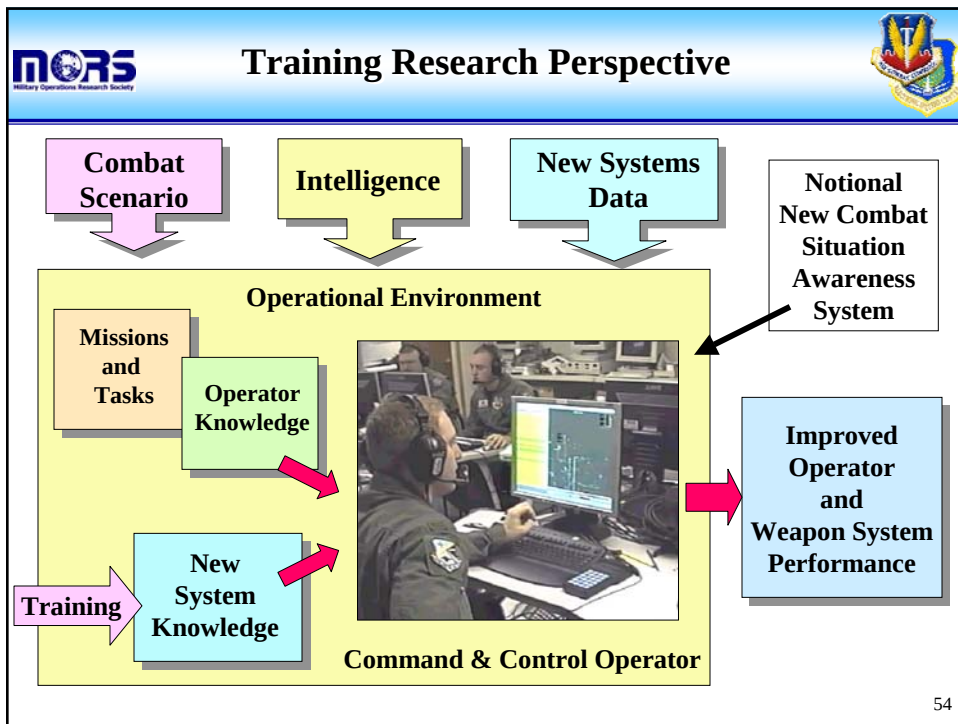
Tactical Command and Control
Over Time

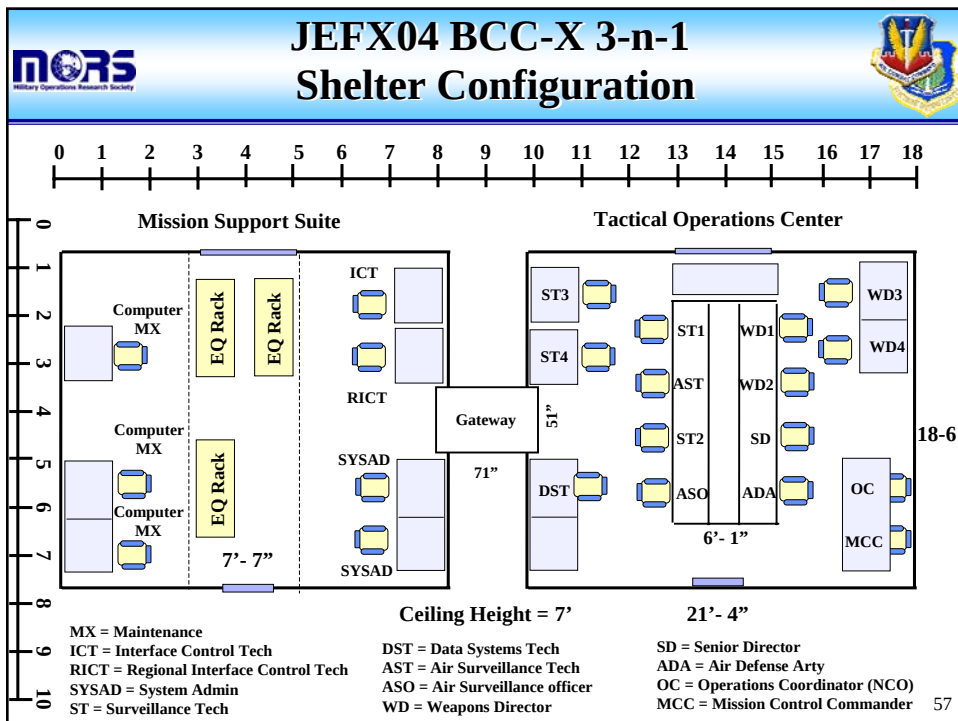
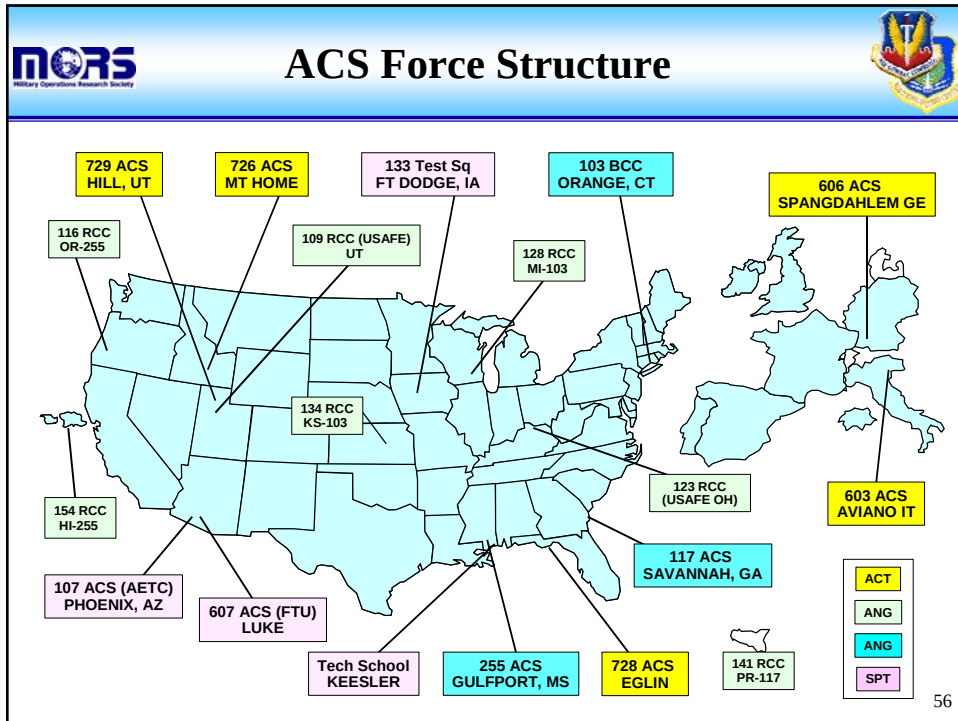


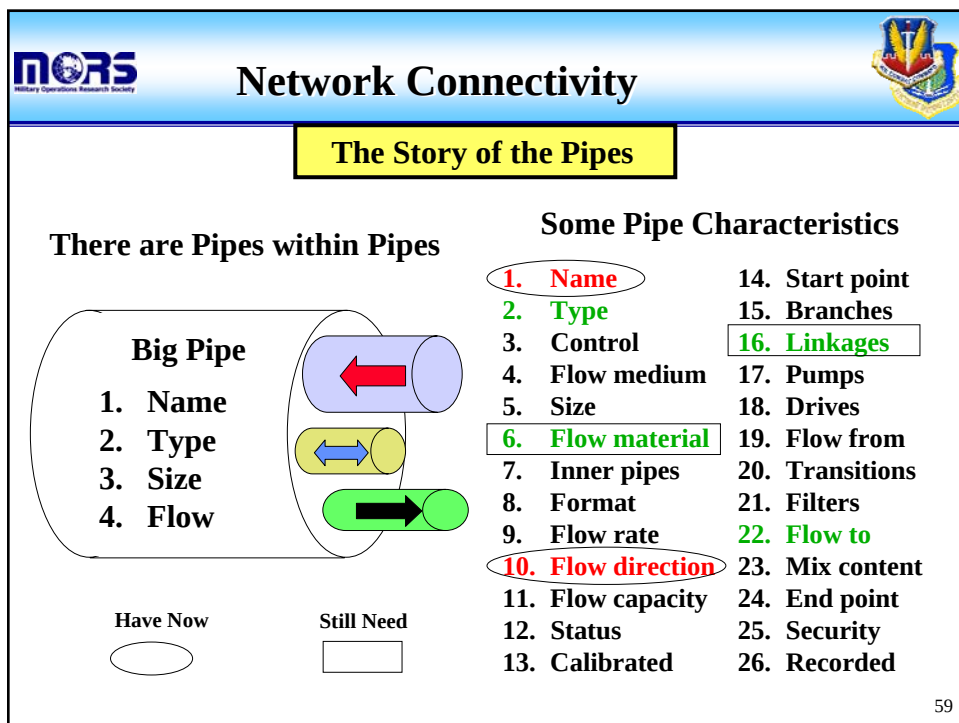
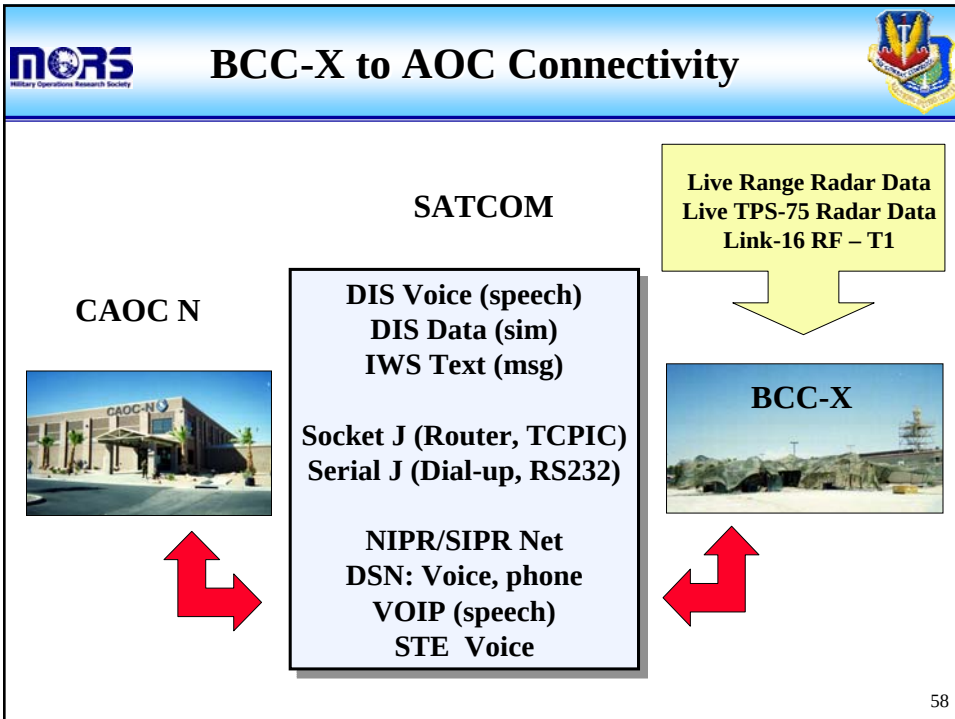
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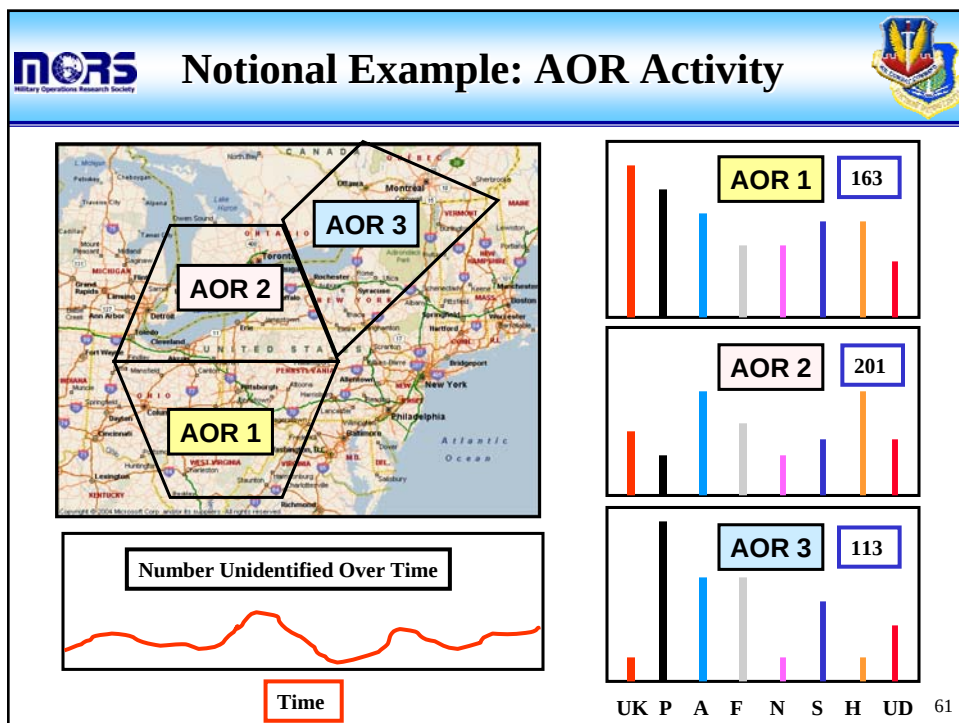
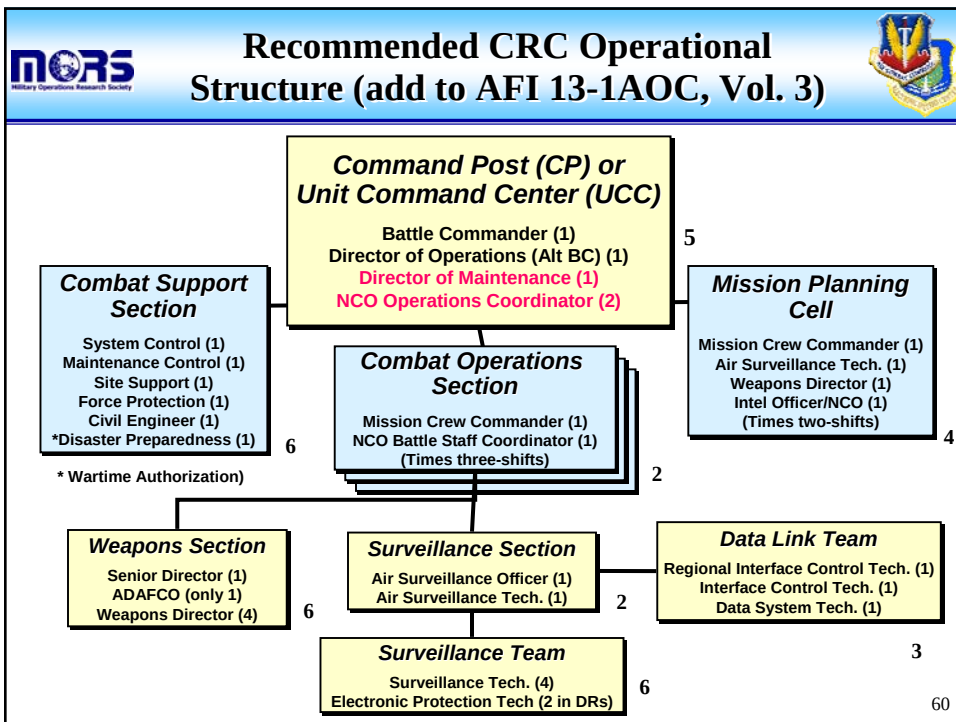


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Some JEFX 2004 Products



Providing a scientific approach & quantitative response to the assessment process

- Designed schema and definitions for BCC-X processes
- **Measures of merit, and data collection forms** for information
- **Communication diagrams** (paths, patterns, message types, rates) outlining internal & external relationships of section/individual station operators
- **Operator communications**, RFI, coordination, directive orders, information updates, and **decision making responsibilities**
- Warfighter information, **“workload”** rates, targets prosecuted, command interest operational displays
- AFEO assessment **reports**, numerous observations, and comments on operations and leadership
- 325 plus page **BCC-X at JEFX 04 Report**

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Lessons Learned JEFX 04 Assessments

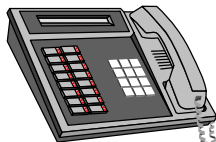


- | | |
|-----------------------------------|---|
| • They are optimistic warriors | • Operators suffice (good enough) |
| • They are loyal to a fault | • They are “minimize” learners |
| • They don’t know “how much” | • They use old process w/new tool |
| • They don’t know “how long” | • They circumvent the tools |
| • Learn mostly from OJT | • All Info has a quality index |
| • They use rules of thumb | • They might talk, but don’t write |
| • They are weakly trained | • Experience counts most |
| • No automated data capture tools | • They can’t type very fast |
| • No bench marks on performance | • They don’t recognize “tired” |
| • Need technical SMEs to assess | • Units need to experience experiments |

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