

# Human Supervisory Control Issues in Network Centric Operations

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# Humans & Automation Lab





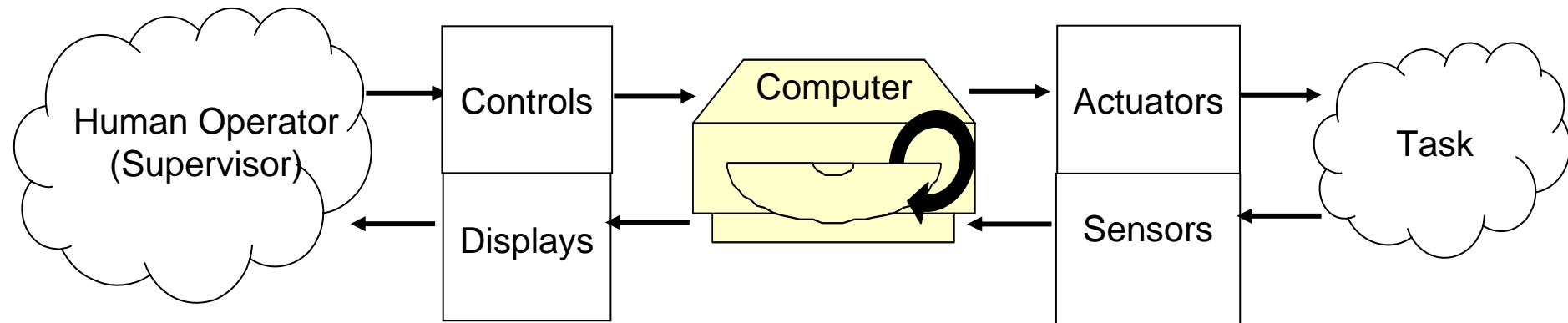
# HAL Director

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- **Former U.S. Navy officer and pilot**
- **Systems engineer with a cognitive focus**
- **Research Interests: Human supervisory control, decision support design, human interaction with autonomous systems, design of experiments technology development, social impact of technology**

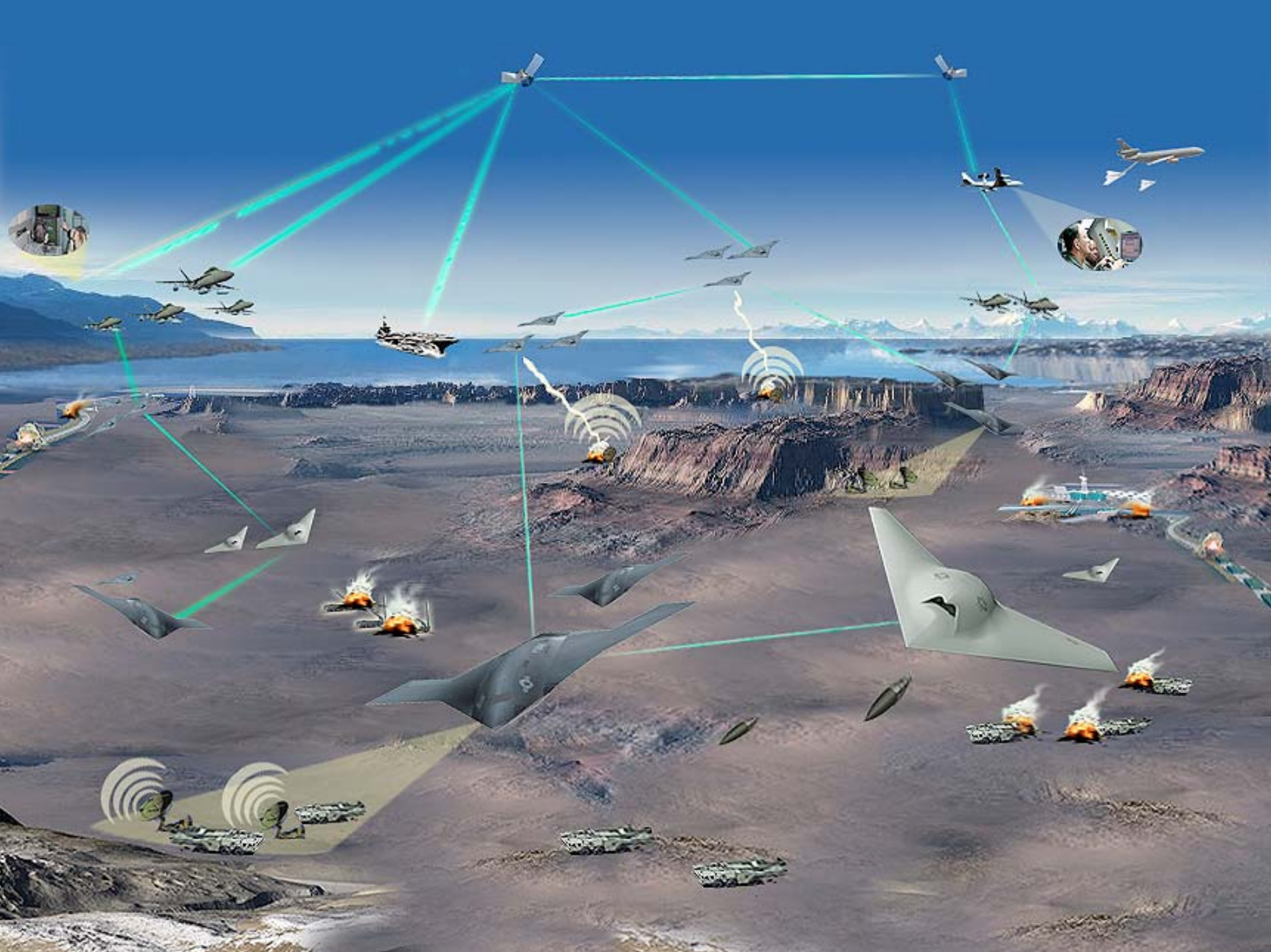


# Human Supervisory Control



- Humans on the loop vs. in the loop
- Supporting knowledge-based versus skill-based tasks
- Network-centric operations & cognitive saturation
  - Information representation is critical







# Areas of Concern

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- Information overload
- Attention allocation
- Decision biases
- Distributed decision-making through team coordination
- Complexity
- Supervisory monitoring of operators
- Trust and reliability



# Information Overload

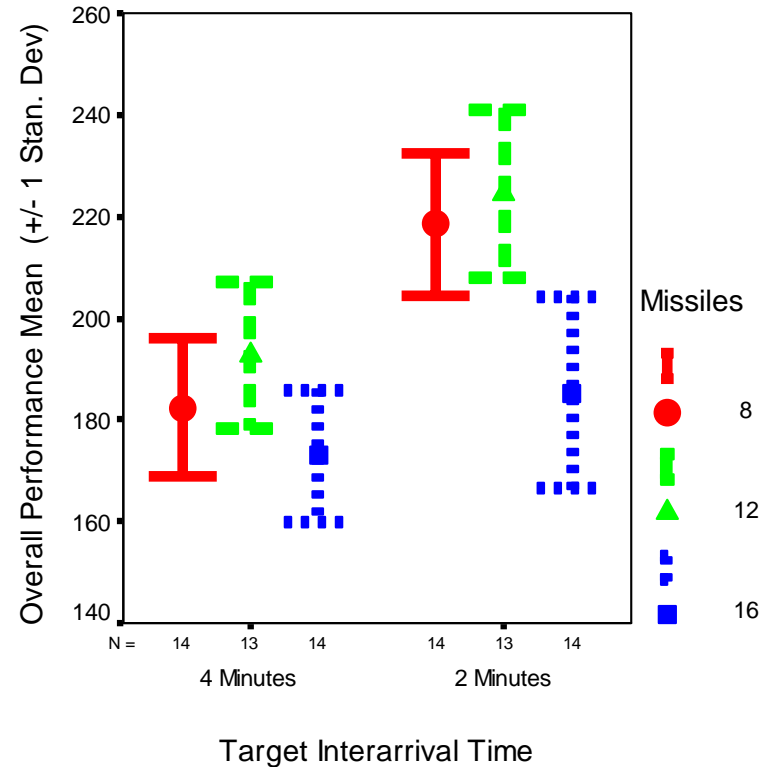
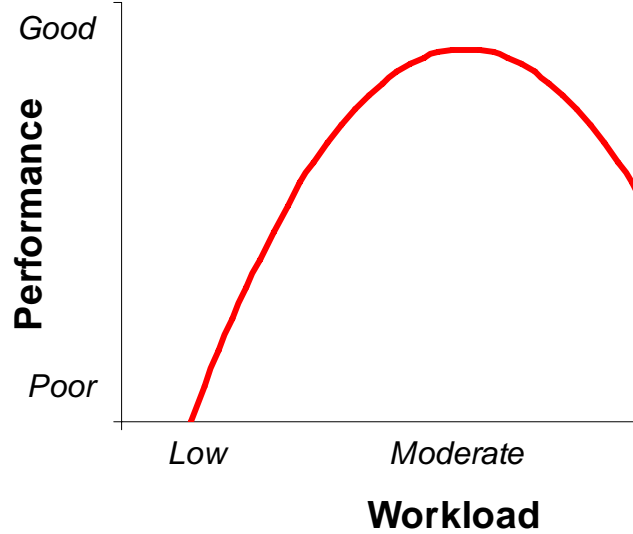
Full Spectrum Dominance

Decision Superiority

Information Superiority

Network-Centric Warfare

Global Information Superiority







# Attention Allocation

- Multiple HSC tasks = Divided attention problem
- Information uncertainties & time latencies
- Preview times & stopping rules
- Primary task disruption by secondary task
  - Chat

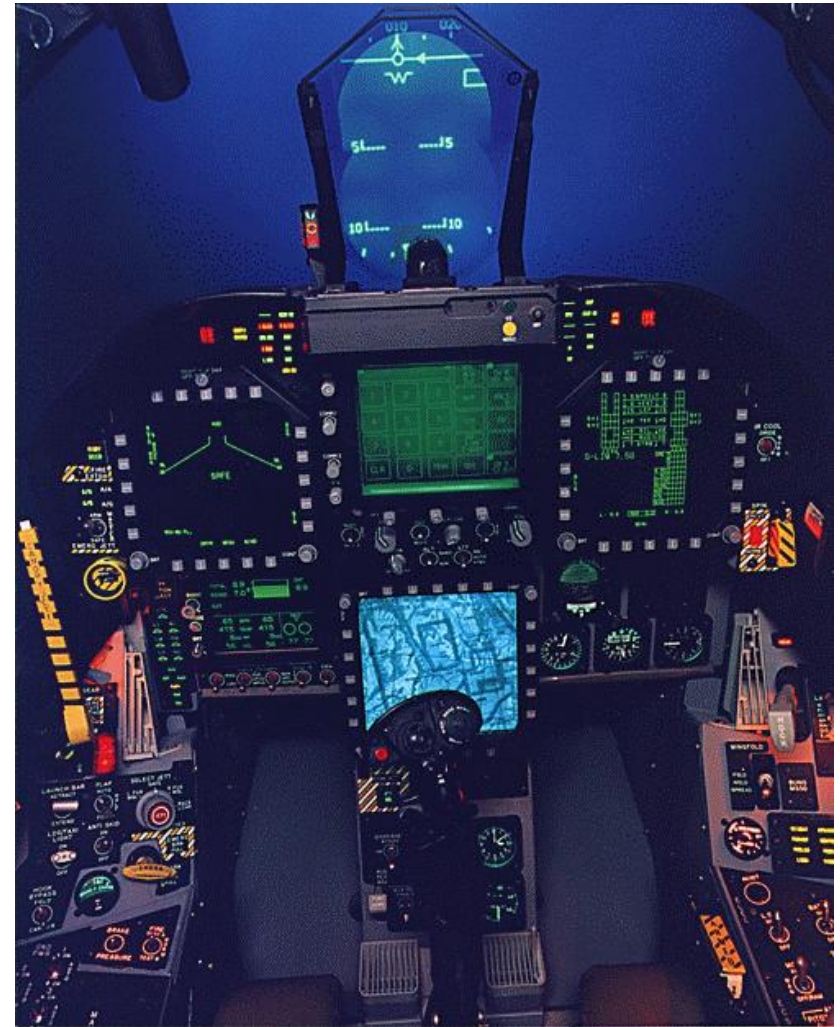






# Decision Biases

- Naturalistic Decision Making
  - Dynamic ill-structured problems with shifting goals (i.e., NCW)
  - Heuristics good & bad
- Biases
  - Confirmation
  - Recency
  - Automation





# Distributed Decision-making & Team Coordination

- The move from hierarchical, centralized to decentralized control
- Team mental models & shared situation awareness (SA)
- Decision support
  - Automated agents as team members
- Not just an issue for human teams
  - Swarming UAVs

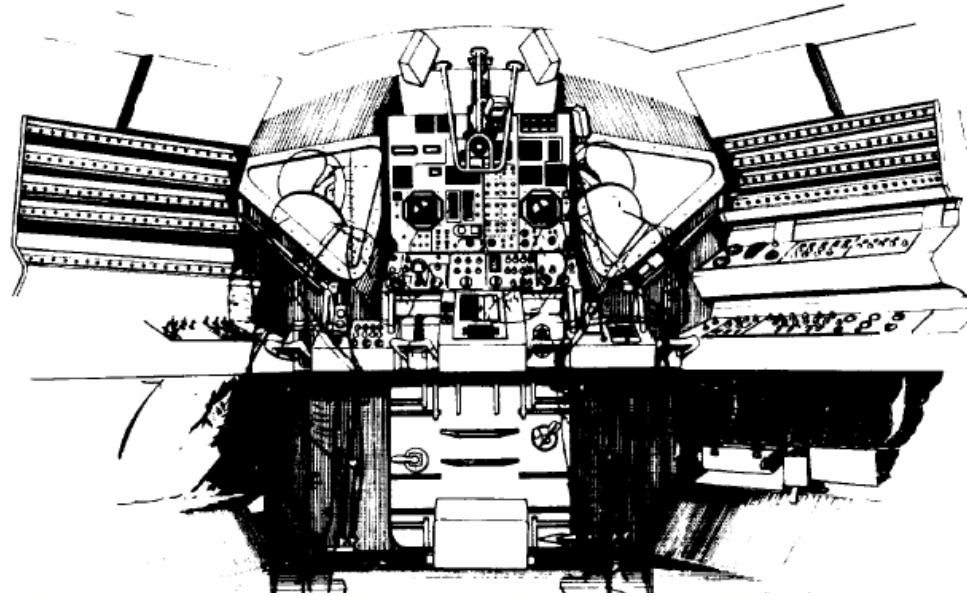




# Complexity

NASA-S-66-6140 JUN

## LM FLIGHT CONFIGURATION

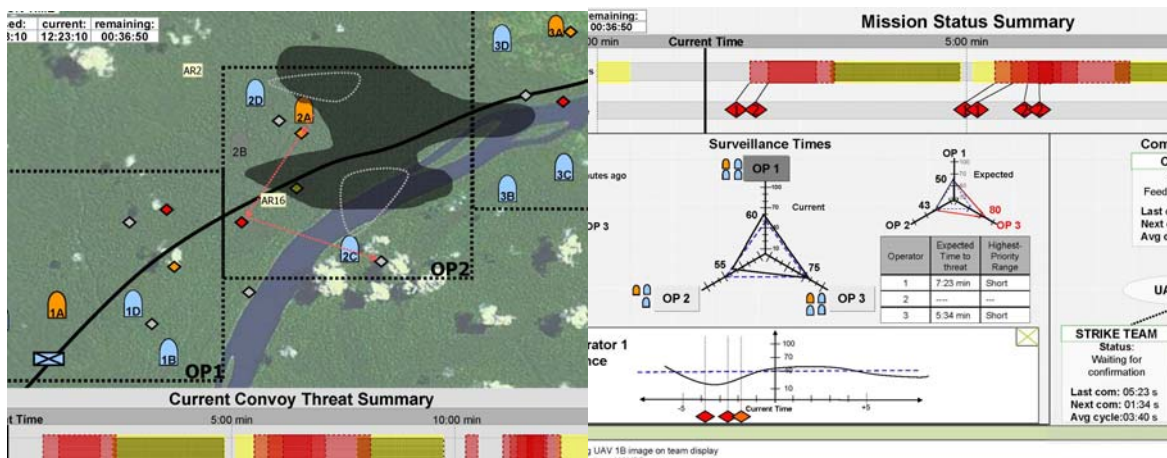






# Supervisory Monitoring

- Nested supervisory control
- Two basic issues: Recognizing & intervening
- Interventions
  - Redistribute workload
  - Adding team members (both human & computer)
  - Modify mission objectives







# Trust & Reliability

**Mission Table**

| Target    | Route     | Launch Bsk. | Nav. Equip. | Priority | Warhead     | Missile Req. |
|-----------|-----------|-------------|-------------|----------|-------------|--------------|
| TARGET 3  | LOTER NO. | LB 1        | GPS only    | low      | penetrating | 1            |
| TARGET 1  | ROUTE1    | LB 2        | GPS only    | low      | submunition | 1            |
| TARGET 18 | ROUTE18   | LB 2        | GPS only    | medium   | submunition | 1            |
| TARGET 19 | ROUTE11   | LB 2        | GPS & DSM   | medium   | penetrating | 1            |
| TARGET 2  | ROUTE12   | LB 2        | GPS only    | low      | airburst    | 1            |
| TARGET 20 | ROUTE13   | LB 3        | DSMAC only  | high     | submunition | 1            |
| TARGET 7  | ROUTE14   | LB 3        | GPS & DSM   | medium   | submunition | 2            |
| TARGET 8  | ROUTE15   | LB 1        | GPS only    | high     | penetrating | 3            |
| TARGET 4  | ROUTE16   | LB 3        | GPS & DSM   | high     | submunition | 2            |
| TARGET 20 | ROUTE17   | LB 1        | GPS & DSM   | high     | submunition | 1            |

**Missile Table**

| Missile    | Ship        | Launch Basket | Nav. Equip. | Warhead     |
|------------|-------------|---------------|-------------|-------------|
| Missile 1  | USS Dallas  | LB 1          | GPS only    | submunition |
| Missile 10 | USS Boston  | LB 3          | GPS & DSMAC | airburst    |
| Missile 11 | USS Dallas  | LB 1          | GPS only    | airburst    |
| Missile 12 | USS Chicago | LB 2          | GPS only    | penetrating |
| Missile 13 | USS Chicago | LB 2          | GPS only    | airburst    |
| Missile 14 | USS Boston  | LB 3          | GPS & DSMAC | penetrating |
| Missile 15 | USS Chicago | LB 2          | DSMAC only  | airburst    |
| Missile 16 | USS Dallas  | LB 1          | DSMAC only  | submunition |
| Missile 17 | USS Boston  | LB 3          | GPS & DSMAC | airburst    |
| Missile 18 | USS Chicago | LB 2          | GPS & DSMAC | submunition |
| Missile 19 | USS Dallas  | LB 1          | GPS & DSMAC | airburst    |

**CURRENT ASSIGNMENT**

Buttons: Add Match, Delete Match, Clear Matches

| Missile    | Route     | Launch Bsk. | Nav. Equip. | Warhead     | Priority  | Tar. | Missile Req. |
|------------|-----------|-------------|-------------|-------------|-----------|------|--------------|
| Missile 1  | ROUTE1    | LB 1        | GPS only    | submunition | TARGET 1  | 1    |              |
| Missile 12 | ROUTE20   | LB 2        | GPS only    | submunition | TARGET 10 | 2    |              |
| Missile 16 | LOTER NO. | LB 2        | GPS only    | submunition | TARGET 11 | 1    |              |
| Missile 20 | ROUTE20   | LB 1        | DSMAC only  | submunition | TARGET 10 | 2    |              |
| Missile 21 | ROUTE18   | LB 2        | GPS only    | penetrating | TARGET 8  | 3    |              |
| Missile 22 | ROUTE18   | LB 3        | GPS only    | penetrating | TARGET 16 | 1    |              |
| Missile 25 | ROUTE15   | LB 1        | GPS only    | penetrating | TARGET 8  | 3    |              |
| Missile 27 | ROUTE16   | LB 1        | GPS & DSM   | airburst    | TARGET 14 | 1    |              |
| Missile 28 | LOTER NO. | LB 3        | GPS only    | submunition | TARGET 1  | 1    |              |

Criteria

Days to Port

Number of Loiter

Number of High Priority

Number of Med. Priority

Number of Low Priority

Ordered Criteria

Total Number of Missions

Firing Rate

Automatch

Total Targets Assigned: 10 of 1

High Priority Targets Assigned: 2 of 4

Medium Priority Targets Assigned: 5 of 7

Low Priority Targets Assigned: 3 of 4

25 # MISSILES

19 Missiles    12 Missiles    25 Missiles

USG Boston    USG Dallas    USG Chicago

100 FIRING RATE

MISSILES

DAYS TO PORT

SAVE CURRENT    RETRIEVE SAVED    EXECUTE CURRENT

**SAVED ASSIGNMENT**

Total Targets Assigned: 10 of 1

High Priority Targets Assigned: 2 of 4

Medium Priority Targets Assigned: 5 of 7

Low Priority Targets Assigned: 3 of 4

25 # MISSILES

19 Missiles    12 Missiles    25 Missiles

USG Boston    USG Dallas    USG Chicago

100 FIRING RATE

MISSILES

DAYS TO PORT

Automatch
Execute

50% Loiter

|     |      |      |      |
|-----|------|------|------|
| All | P    | U    | S    |
| 0%  | 100% | 100% | 100% |

80% High Priority

|     |      |      |      |
|-----|------|------|------|
| All | P    | U    | S    |
| 0%  | 100% | 100% | 100% |

Days to Port

Firing Rate

0% Low Priority

|      |    |    |    |
|------|----|----|----|
| All  | P  | U  | S  |
| 100% | 0% | 0% | 0% |

50% Medium Priority

|      |    |    |    |
|------|----|----|----|
| All  | P  | U  | S  |
| 100% | 0% | 0% | 0% |

**SAVED ASSIGNMENT**

Total Targets Assigned: 10 of 1

High Priority Targets Assigned: 2 of 4

Medium Priority Targets Assigned: 5 of 7

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25 # MISSILES

19 Missiles    12 Missiles    25 Missiles

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100 FIRING RATE

MISSILES

DAYS TO PORT



# The Future of NCO

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- Information representation is critical to mitigate cognitive workload
- Human-centered design vs. mission-centered design
  - The systems engineering process must consider humans early
  - Robust systems are needed for both human and automation brittleness considerations
    - Information access & time-pressured situations



# Contact Information

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