



Pacific Science
& Engineering

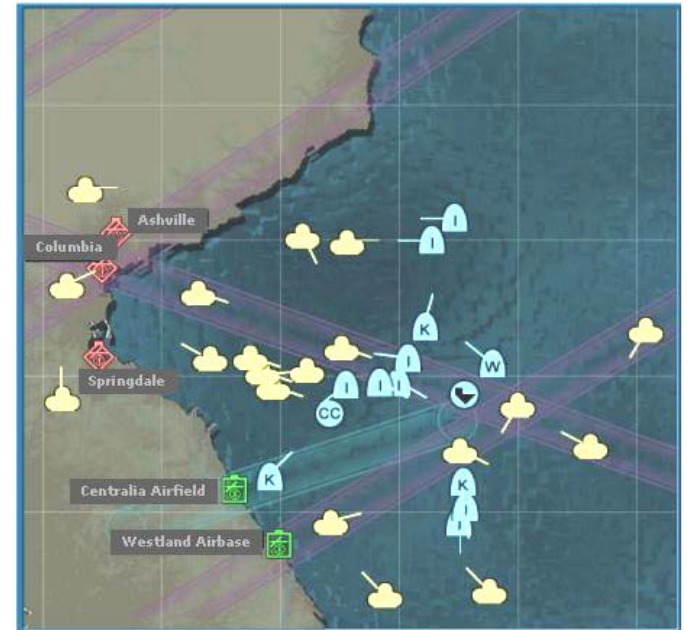
Intelligent Attention Management Tools For Tactical Situation Awareness and Supervisory Control

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Maintaining Tactical SA



Problem

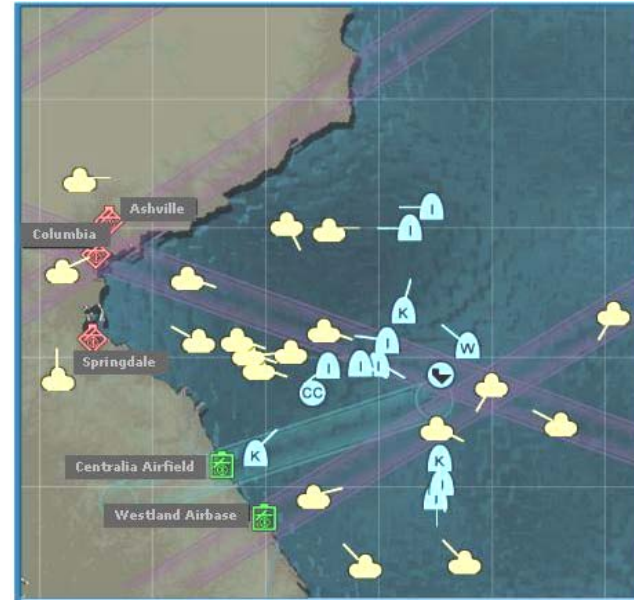
- Severe clutter from mostly low-interest tracks
- Distraction and interruption from secondary tasks
- Change blindness
- Resulting in delay and possible error

Solution: Intelligent attention management

- Assisted focus
- Change awareness

Benefits

- Better overall situation awareness
- Faster recovery from interruptions
- More timely responding to threats
- Better team coordination

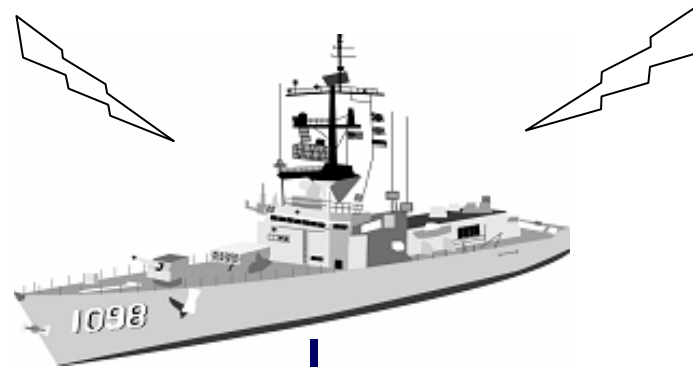


Assisted Focus

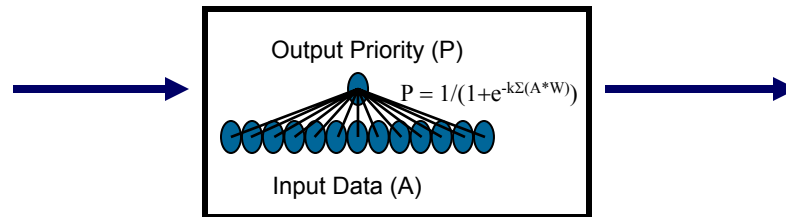
Identify and Declutter



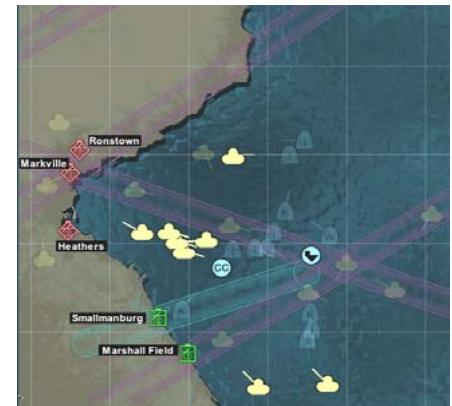
Track
Data



Expert Experience



Assisted Focus
Algorithm

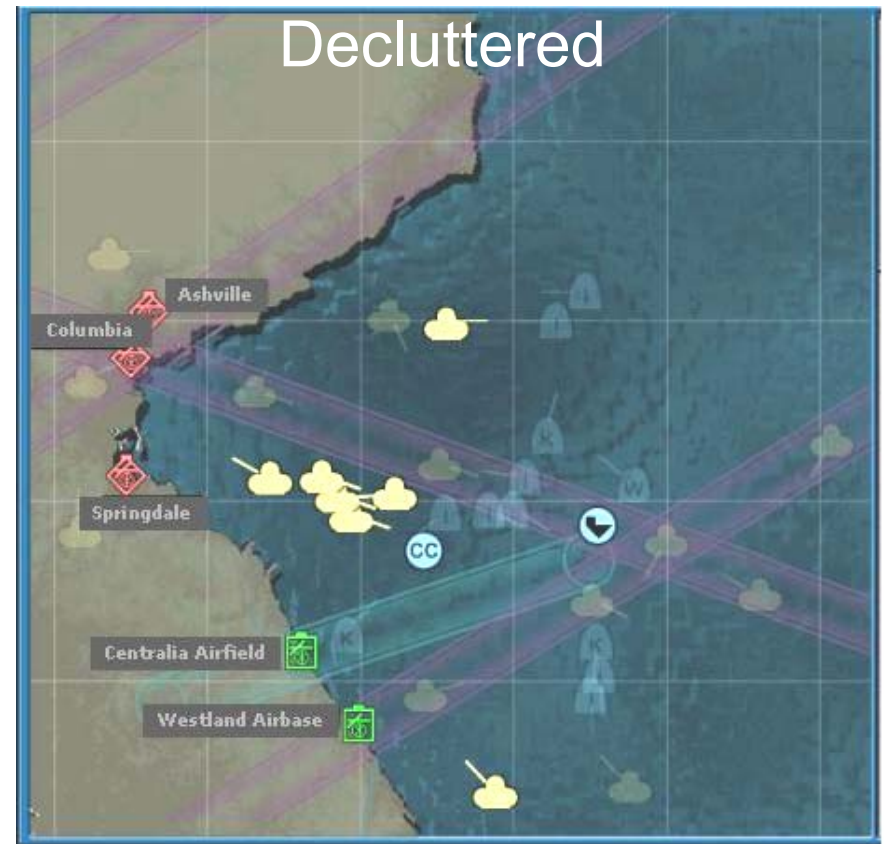
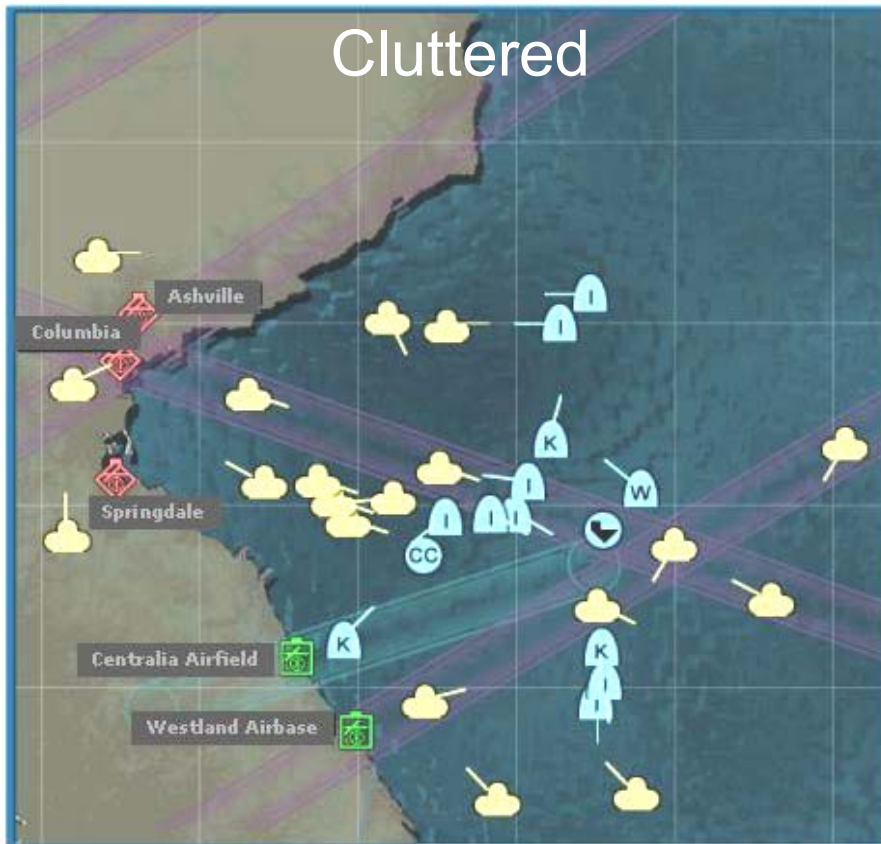


Decluttered Geoplot

Assisted Focus “Decluttering”



Allows user to focus on key tracks.



FY03 – Empirical Test

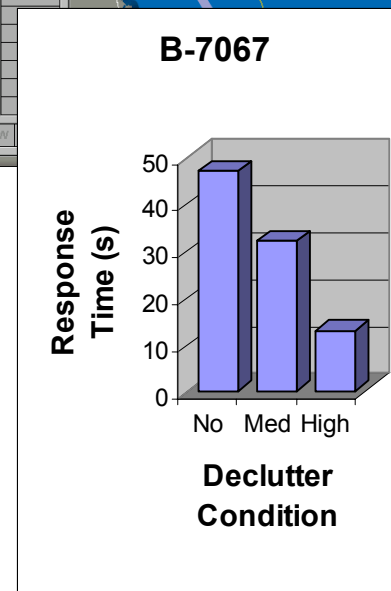
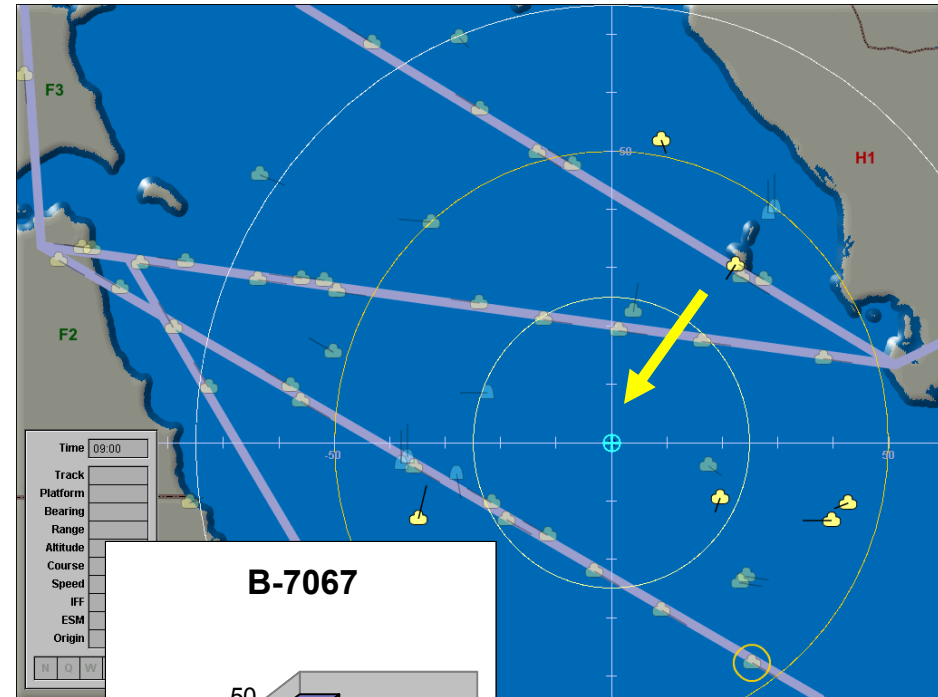


Does Assisted Focus enhance air warfare performance?

- 27 Navy air warfare experts
- Realistic air warfare tasking (single user)

Findings

- More timely responses
 - » 28% faster response times to threats
 - » 44% faster for peripheral threats
- Better situation awareness
 - » 23% more attention to threats



Faster responding to threats.

93% Preferred Decluttering



“I didn’t have to waste time on low threat tracks.”

“I actually had more time to spend scanning the display because I could see where the high threats were.”

“Decluttering allowed me to get ahead in my ROE – instead of behind it, when mistakes are more likely to happen.”

Publications

- St. John, M., Smallman, H. S., Manes, D. I., Feher, B. A., & Morrison, J. G. (2005). Heuristic automation for decluttering tactical displays. *Human Factors*. In press.
- St. John, M. & Manes, D. I. (2002). Making unreliable automation useful. In *Proceedings of the Human Factors and Ergonomics Society 46th Annual Meeting* (pp. 332-336). Santa Monica, CA: Human Factors and Ergonomics Society.
- St. John, M., Oonk, H. M., & Osga, G. A. (2000). Designing displays for command and control supervision: Contextualizing alerts and “trust but verify” automation. In *Proceedings of the Human Factors and Ergonomics Society 44th Annual Meeting* (pp. 646-649). Santa Monica, CA: Human Factors and Ergonomics Society.

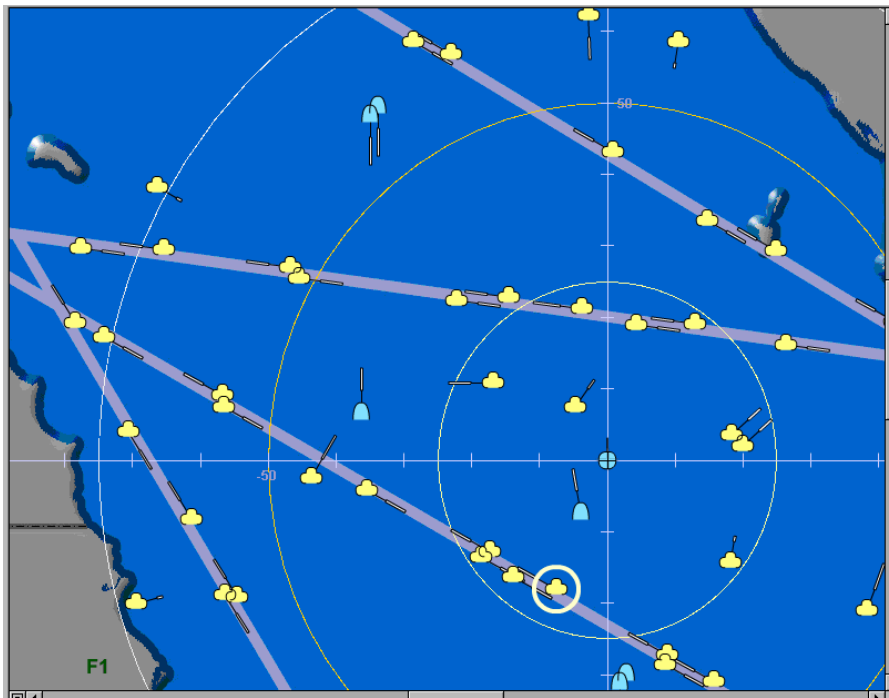
Change Blindness



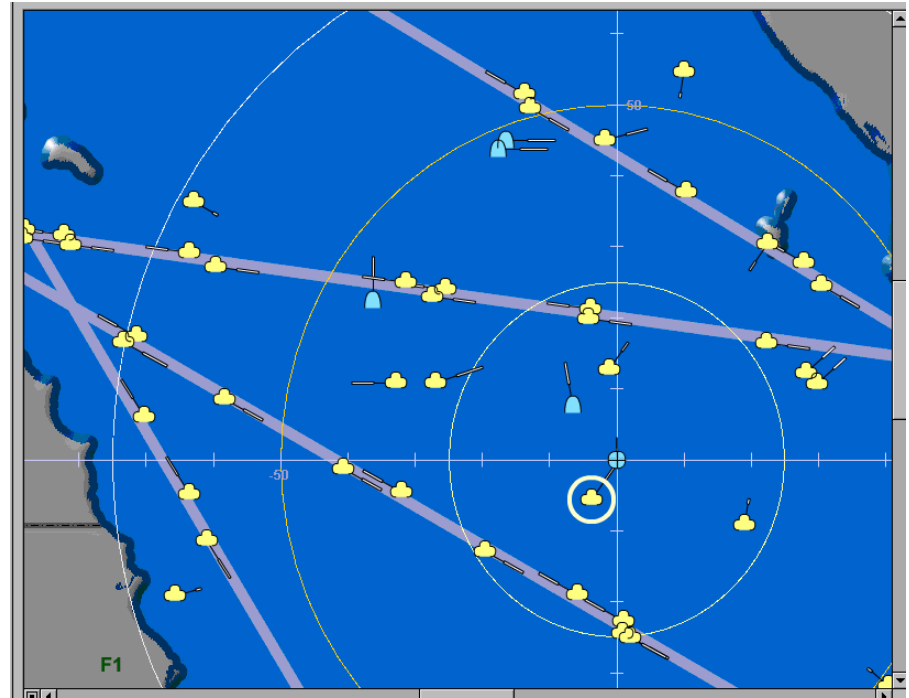
What are the significant changes?

- Even momentary attentional lapses cause problems
- Longer lapses and interruptions pose greater problems

Time 1



Time 2 (2.5 minutes later)



Design Alternatives



The image shows a cockpit display interface. The top part is a blue screen with several aircraft icons. Some icons are circled in red, indicating alerts. Below the screen is a grey panel with a 'Replay' button and a red arrow icon. To the right of the screen is a 'Change History' table.

Change History		
Time	Track	Change
04:00	7021	Accelerate
04:00	7021	Begin Descent
02:53	7060	Cross Warn
02:46	7034	Cross Warn
02:04	7059	Cross Warn
01:30	7052	Leave Airplane
01:24	7021	Cross Notify
01:10	7056	Cross Warn
00:45	7021	Detect Track
00:34	7050	Cross Warn
00:10	7060	Cross Query
00:04	7034	Cross Query

Naïve Realism Hypothesis

- Naive faith in human perception and its ability to acquire information from realistic displays
- E.g. Instant replay

Alert circles

- Change alerts without integrated explanation

CHEX (Change History) table

- Change alert plus linked explanation

Automated Change Detection

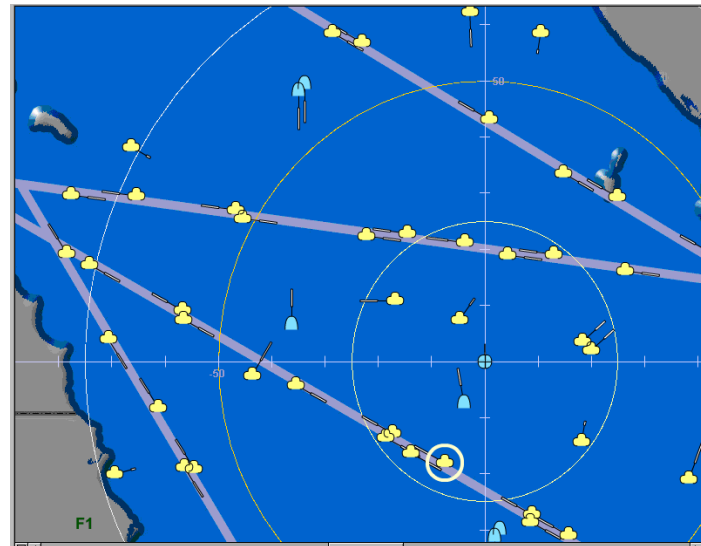


Aircraft are automatically monitored for changes

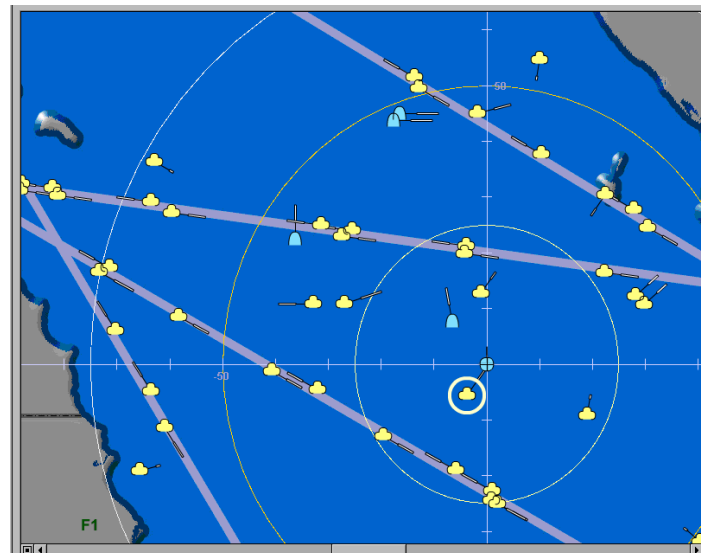
- Attributes
 - » Speed
 - » Course
 - » Altitude
 - » Emissions
- Thresholds

Algorithm is simple and clear

- Few trust issues
- More simple than threat assessment



Time 1



Time 2

CHEX Interruption Recovery Tool

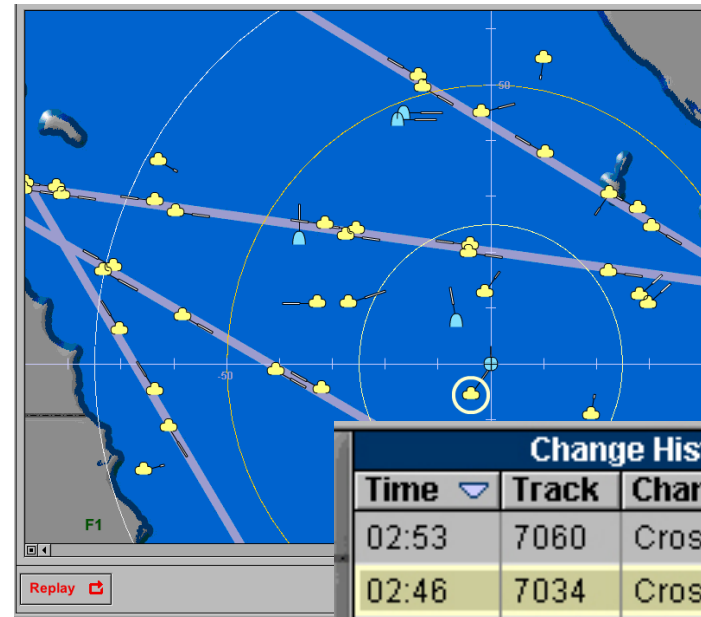


Explicit, automated presentation

- Automated notification and logging
- Simple trustworthy automated algorithm

Information access

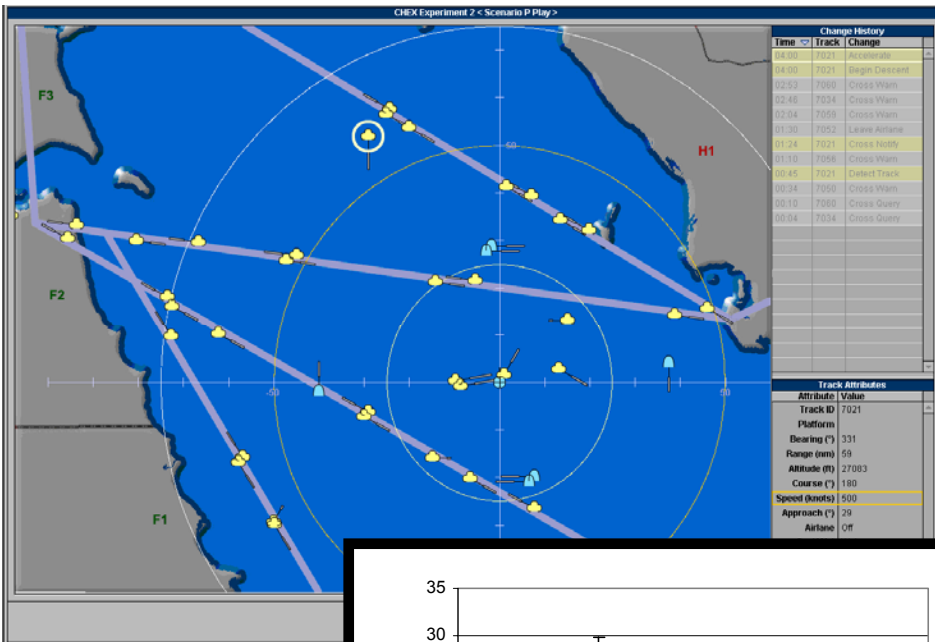
- Low clutter
- Unobtrusive
 - » Less obtrusive than alerts
- Separated
 - » But linked



Change History		
Time	Track	Change
02:53	7060	Cross Warn
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CHEX
tool

FY03 & 04 Empirical Studies



Task

- Quasi-realistic AW scenarios
- Detect and report significant changes

Participants

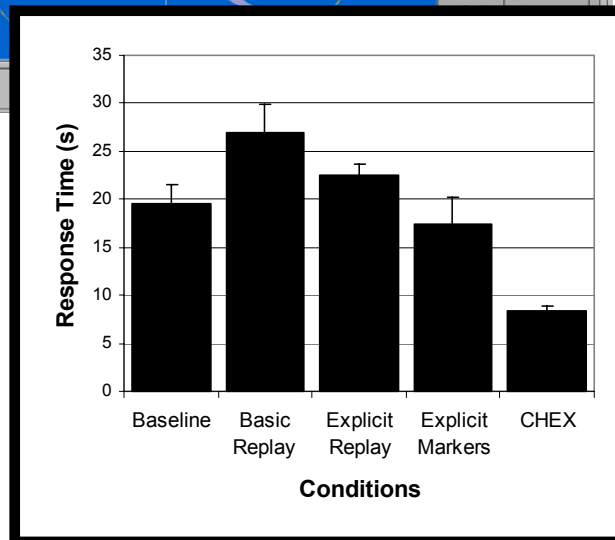
- Drawn from the general public

Results

- Change alerts, by themselves are uninformative and inferior to linked CHEX table (FY03)
- Instant replay is also uninformative and worse than nothing (FY04)
- CHEX table is fast and accurate (FY03, FY04)

Publications

- St. John, M., Smallman, H. S., & Manes, D. I. (2005). *HFES*
- Smallman, H. S., & St. John, M. (2003). *HFES*



CHEX 57%
faster than
Baseline

Assisted Focus Tool Suite

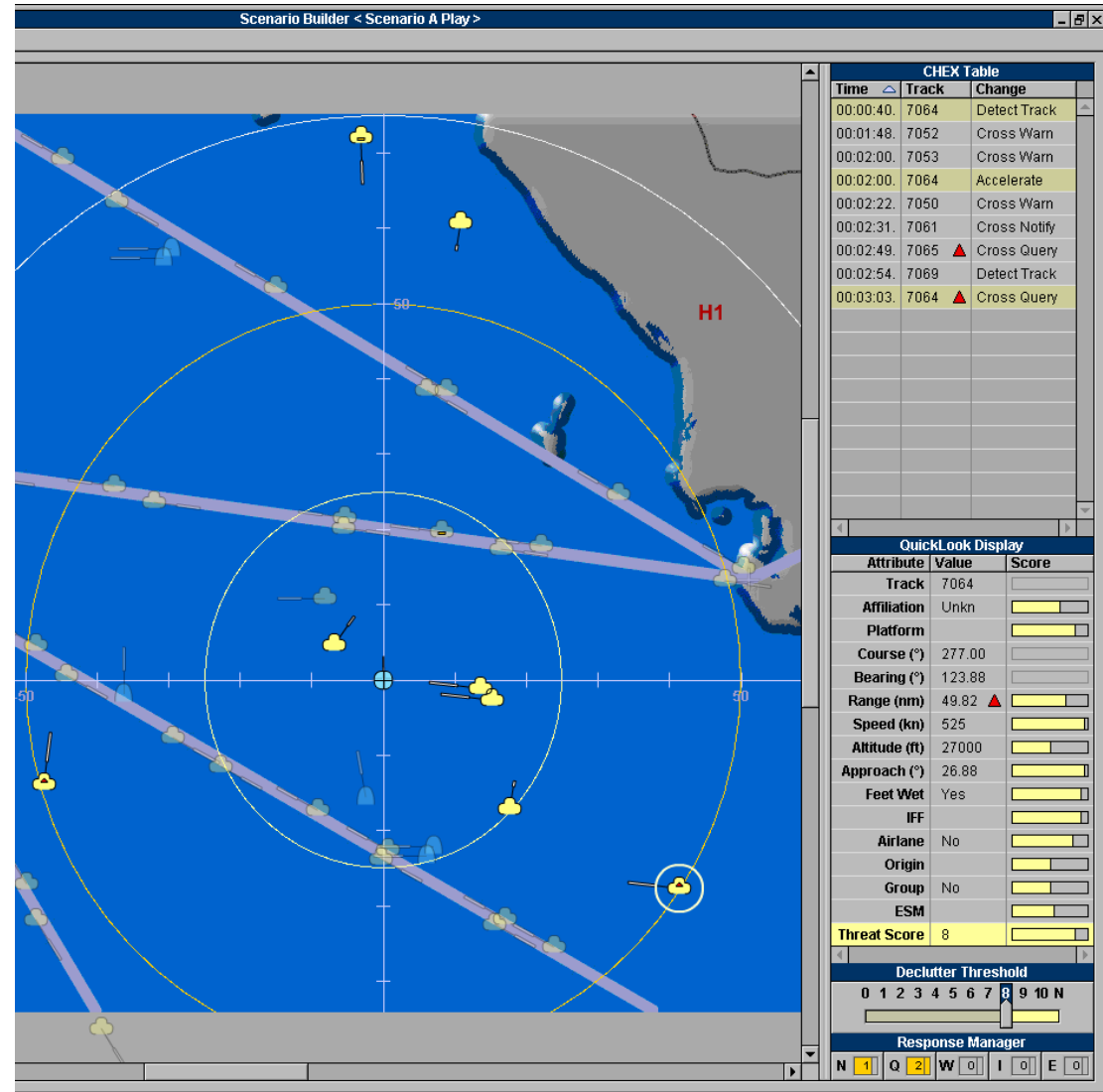


Declutter

- Assessment and
- Visual salience

Plus

1. Change history tool
2. Status change notification
3. Status re-assignment
4. Threshold adjustment
5. Response manager
6. Quick-Look threat assessment



Analysis and Evaluation Methods



A. Human Factors analysis of designs

- Analyze designed based on HF principles, and choose most promising design

B. Usability evaluation

- Expert air warfare personnel from Aegis Training and Readiness Center, Detachment San Diego
- Procedure
 - » Exposure to decluttering and all tools, 15 minute scenario-based “test drive,” usability interview about each tool

C. Experimental evaluation

- Aspects of the CHEX tool and the Quick Look tools have been researched using formal experimental studies
 - » Members of the general public
 - » Aegis Training and Readiness Center, Detachment San Diego
 - » Tactical Training Group, Pacific
 - » Airborne Early Warning Wing, Pacific

Maintaining Tactical SA



Problem

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Solution: Intelligent attention management



For more information, please contact:

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FY04 – Tool Suite



Additional, complementary tools suggested by analyses and expert users from the FY03 experiment

1. Status change notification for maintaining SA on threats
 - » Alert user to tracks that change from decluttered to fully visible
2. Status re-assignment for tailoring threat assessment
 - » Given that the heuristic automation will occasionally mis-categorized tracks as high and low threats; users need manual method for re-assignment
3. Threshold adjustment for tailoring declutter threshold
 - » Situation or user may call for raising or lowering the declutter threshold
4. Response manager for book-keeping responses
 - » Which actions are most appropriate for a track, which have been taken, how many times?
5. Quick-Look tool for scanning threats rapidly
 - » Users need tool for very quickly scanning entire display for threats
6. Change history tool for automatically logging and alerting user to critical track changes

Assisted Focus Summary



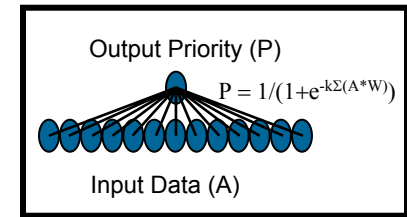
Assisted Focusing consists of two parts:

– Automation

- » Fusion of individually ambiguous data
- » Task-relevant assessment and prioritization of threats
- » Rules of thumb are sufficient – the assessment does not need to be perfect – users continue to “hook and look”

– Attention management

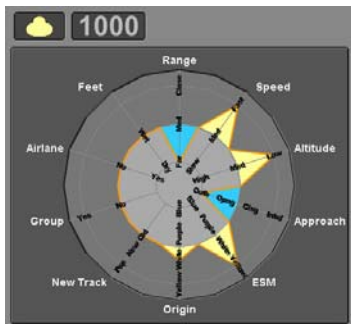
- » Visual salience: highlighting and dimming
- » Reduced and prioritized search space - “critical contacts of interest”
- » User adjustment and tailoring is easy



FY02 Lessons Learned



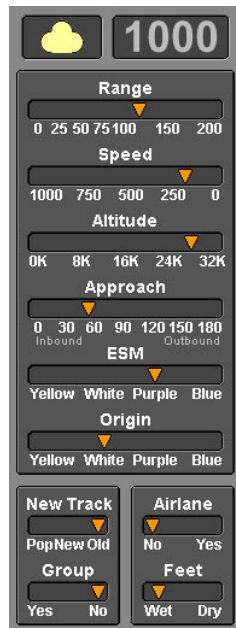
1.



2.



3.



4.



Star Diagram (1)

- Color coding of threat level was a key benefit
- Poor for legibility

Icon (2)

- Good for memory but poor for reminding user of all attributes



Analog (3)

- Qualitative values
- Emergent feature for threat
 - » Arrowheads line up toward left side for threat
- Emergent feature for threatening attributes
 - » Longest bars are most threatening
- Lists are good for explicitly reminding user of all attributes

Digital (4)

- Poor for quick look, but good for precise values – deep look

Response Manager



Basic.



Business rules

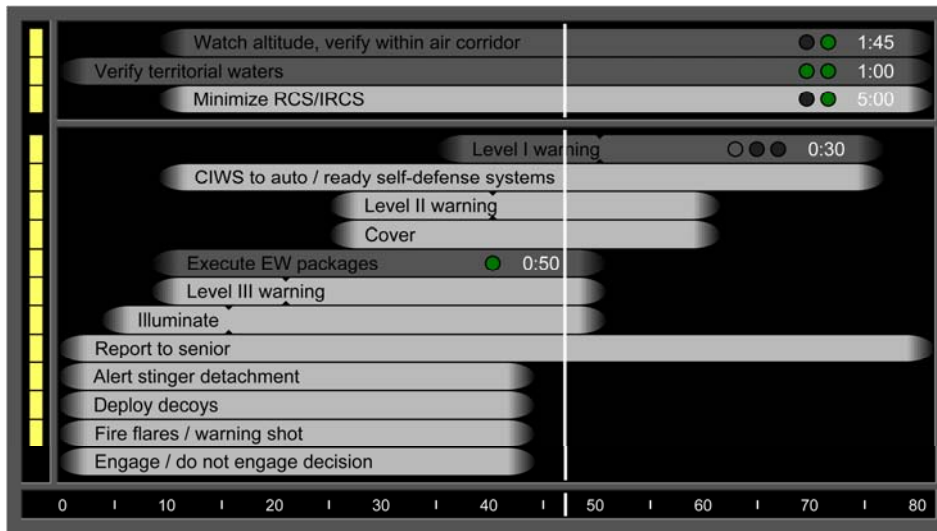
– A) Basic

1. Basic contact responses only
2. Indication of which have been taken and how many times
3. Indication of range appropriateness (ROE only)

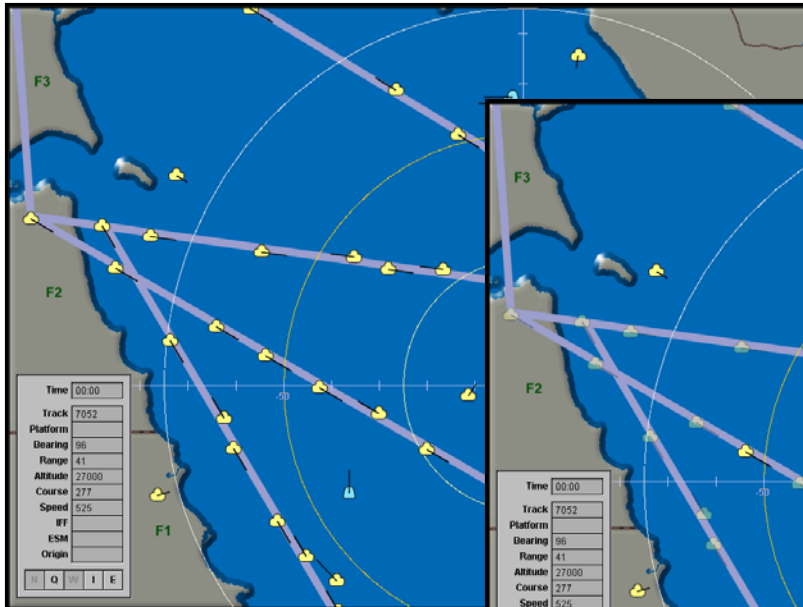
– B) Upgraded

1. Full battle orders
2. Indication of which have been taken and how many times
3. Indication of range appropriateness (both ROE and "offensive")

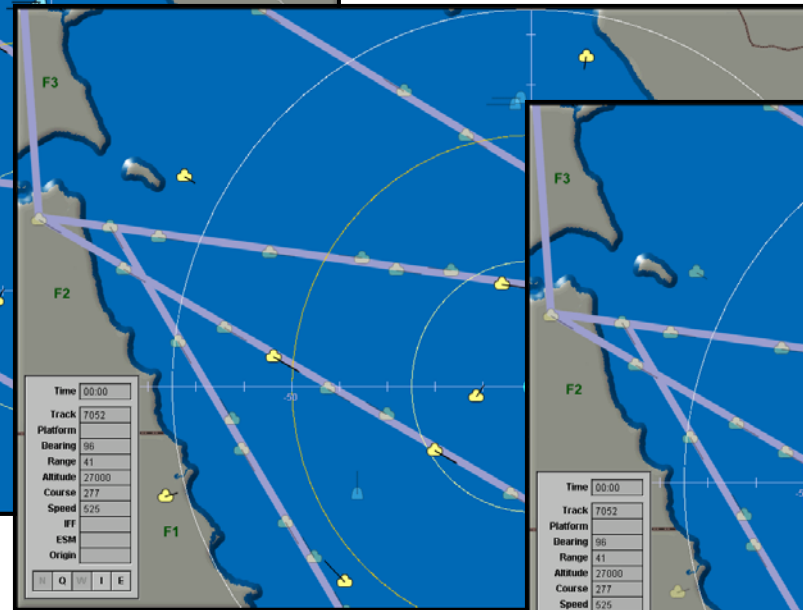
Upgraded.



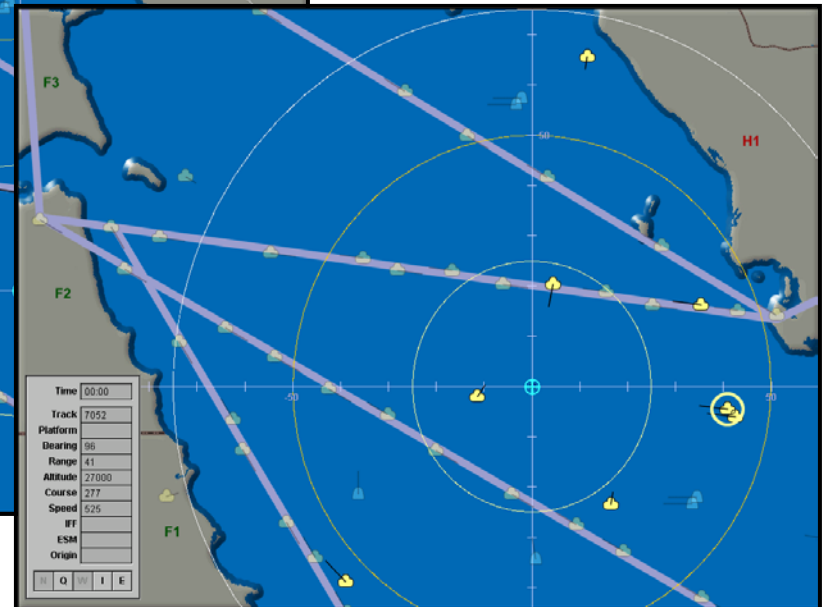
3. Threshold Adjustment



Threshold at 0
No declutter

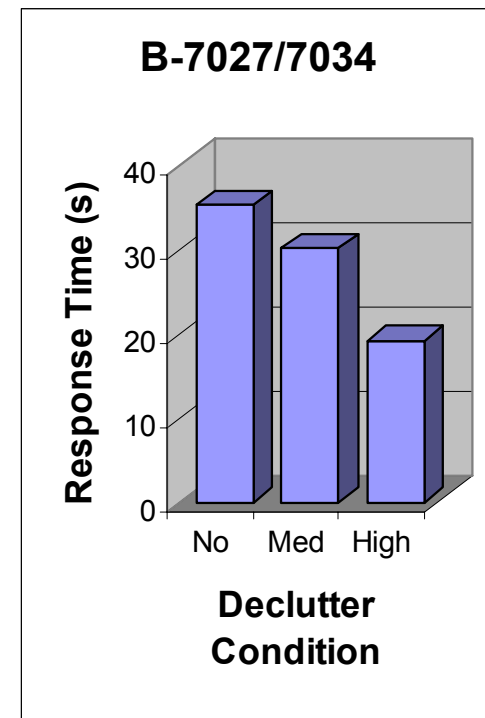
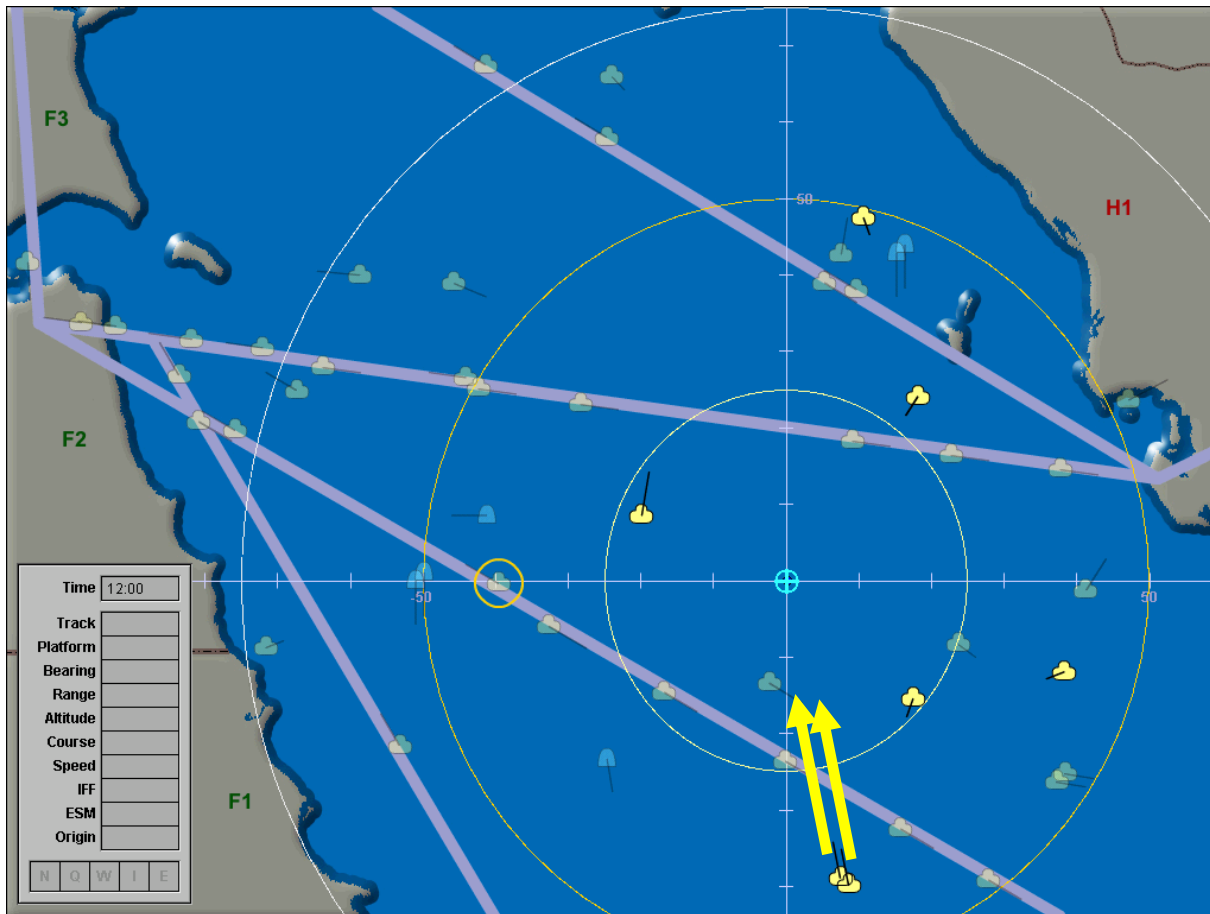


Threshold at 6
~60% decluttered



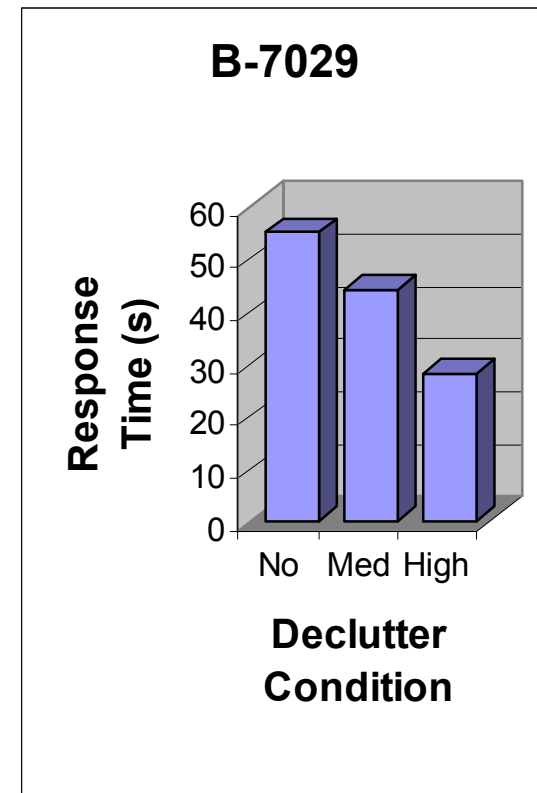
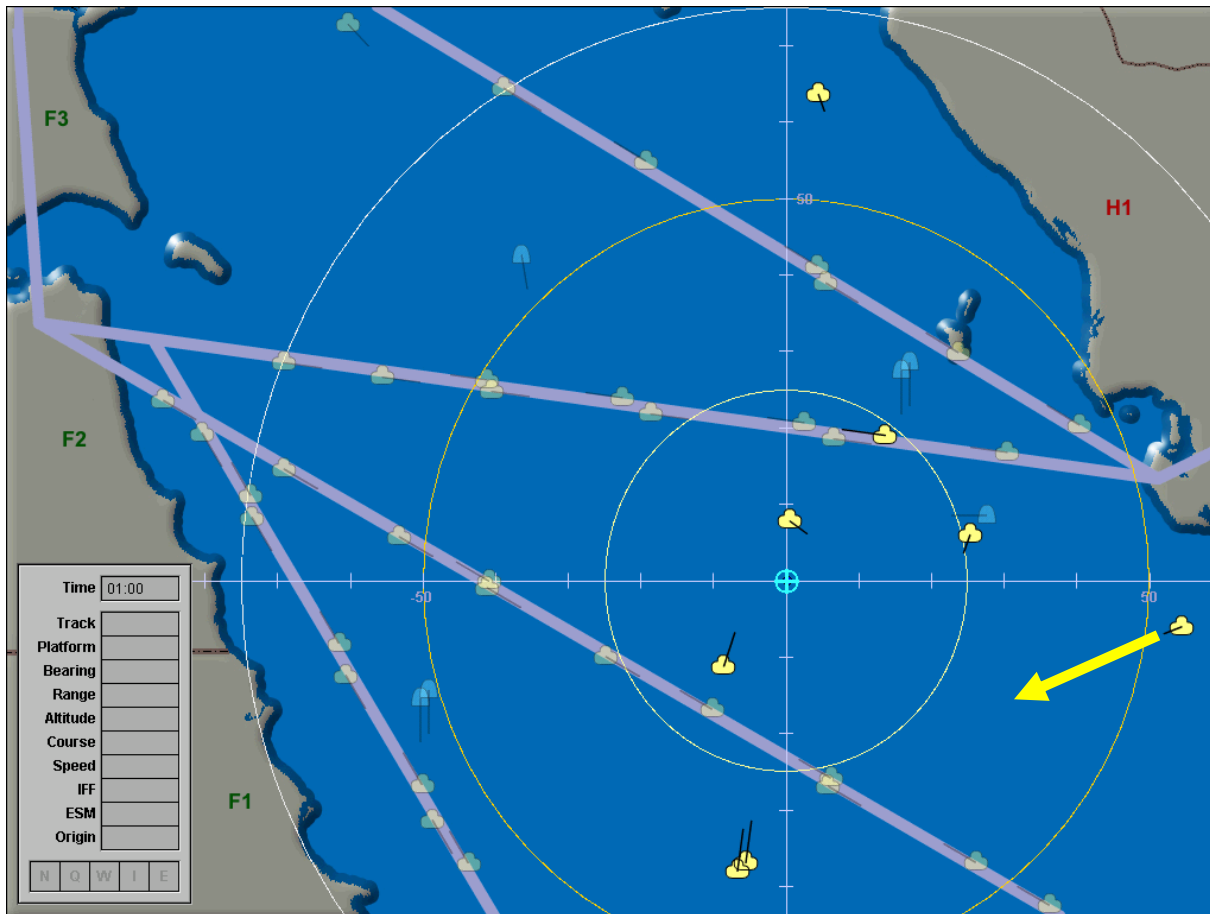
Threshold at 8
~85% decluttered

Fast Pair From Periphery



Faster responding to threats.

Slow Threat From Periphery



Faster responding to threats.

