



Lessons Learned from Application of Software Agent and
Decision Support Technologies to Operator and Operational
Effectiveness

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Overview

- Tasks and role of naval operators in traditional system
- Tasks and role of operators in system employing automated detection and tracking and MSDF
- Impact of change on operator and operational effectiveness
 - based on research with other systems
 - based on observation of performance with real systems
- Integration of DCIEM research with existing knowledge base
- Conclusions

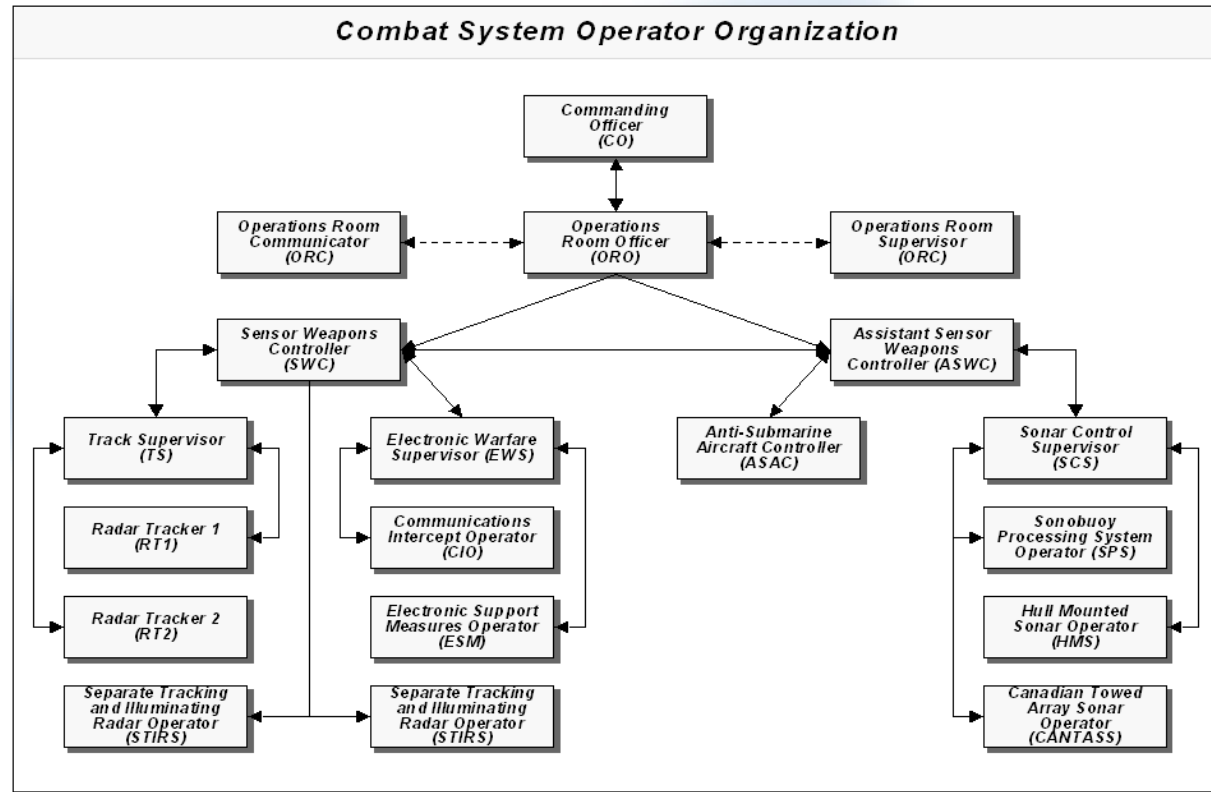
Traditional system

- Sensor Operator

- searches incoming data for possible targets
- detects, tracks and analyses possible targets
- passes on reports of possible targets

- Track Supervisor

- adds new contacts to tactical display
- updates position of existing contacts
- correlates contacts



Traditional system (2)

- Warfare Director
 - coordinates tactical picture
 - recommends classification
 - provides command with update of tactical picture



Why introduce automation

- More sensitive sensors and increased computing power
 - amount of data increased substantively
- Increase in number and type of sources of information
- New concept of operations
 - littoral versus deep water - more contacts, more noise
- Reduced manning
 - fewer operators to interrogate data
- It is possible



New concept ?

- Sensor Operator
 - monitors output of automated system that detects, tracks and does preliminary classification of contacts
 - compares automated system's decisions with current tactical and environmental picture
 - interrogates data if necessary
 - removes false alarms and passes on possible contacts



New concept ? (2)

- Track Supervisor
 - monitors output of combat data fusion system that fuses output of sensors with information from other sources
 - queries system as to status of contacts, sources etc.
- Warfare Director
 - monitors output of multi-sensor data fusion system
 - recommends classification
 - provides command with update of tactical picture



Research on use of automated systems

- Humans tend not to use automated systems if they perceive them as unreliable
- Even if they are perceived as reliable, humans may not use the system in order to maintain control
- If system is reliable and used, the human often fails to monitor it adequately
- Use of automated systems can lead to loss of skills so operator unable to intervene
- Automation errors often difficult to detect because of inadequate feedback



Caveat

- Most of the research on human use of automation centered on cockpit automation and process control
- Frequently automated tasks can be carried out manually
- Automation introduced to
 - reduce workload
 - reduce error rate
 - increase number of tasks that a single operator can monitor



Review by Klein Associates Inc.

- Looked specifically at potential impact of Multi-Sensor Data Fusion (MSDF)
- Reviewed in context of Naturalistic Decision Making
- Based on:
 - literature discussed previously
 - experience with wide range of U.S. military systems
- Focus critical



Potential problems with MSDF

- Interferes with application of expertise
 - Reduces evaluation of data when integration of sources automatic
 - see what system found and not what missed
- Interferes with expertise of team
 - verbal or written communication shared by everyone
- Slows rate of learning of novices
 - less requirement to deal with data
 - less capability to handle task if automation fails
 - less capability to detect anomalies



DCIEM research

- Initiated because of observed operator dissatisfaction with automated detection and tracking systems
- Generic target tracking task
 - later added automated detection capability
- Details of studies reported in series of presentations and papers
- Compare findings with other research and concerns of Klein



Automated tracking

- Use of moderately reliable tracker depended on:
 - number of targets that had to be tracked
 - capability of individual to do task manually
 - experience with automated tracker
- Even moderately reliable tracker:
 - perceived as reducing workload
 - reduced time on task
- As reliability increased:
 - detection of low strength targets increased
 - detection of automation errors appeared to decrease



Automated tracking (2)

- Initial experience with manual task:
 - did not result in better system performance
 - delayed learning how to find low strength targets
- Detection of automation errors:
 - little evidence that it was due to complacency
 - poorest when busy handling other tasks such as target detection
 - suggests due to relatively low visibility of those type of errors



Automated detection and tracking

- Varied detection threshold and tracking reliability
- Little variation in performance across conditions
- Best performance with low detection threshold and moderate reliability
 - less time to remove false alarms - more likely that low strength targets added by ADT
 - targets not updated as consistently - automation errors corrected
- No improvement in detection of automation errors under high reliability tracker



Automated detection and tracking (2)

- Provided capability to adjust detection threshold and tracking reliability
- Most users:
 - chose a detection threshold that minimized false alarms
 - tracker parameters that resulted in tracks being consistently updated
- Performance similar to high reliability, high threshold condition in previous study
 - preferred to let automation handle standard tracks and search for low strength targets manually



Conclusion

- Automation does allow operators to handle higher workload
 - performance likely to be higher than if tried to do task manually but will likely miss anomalies
- Most users make maximum use of automation unless seen as increasing workload
 - Any efforts to increase operator involvement has to be perceived as beneficial in short term
 - Need to force interaction with system in intelligent manner

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