

Framing the Functions: Towards a Taxonomy of Command and Control

by C. Donald Means and Kevin Burns

The design of Command and Control systems is often characterized as either “system” centered or “human” centered. We believe that a better approach is “function” centered because the basic problem is to allocate/coordinate functions (often dynamically) between systems and humans in order to accomplish missions. To this end, we are performing a function-centered analysis of three major functions/systems in the domain of Air Force Command and Control, namely: Time Critical Targeting Functionality (TCTF), Joint Surveillance and Target Attack Radar System (JSTARS) and Airborne Warning And Control System (AWACS). Our poster presents some preliminary results from this effort aimed towards developing a “taxonomy” of Command and Control decisions.

Our analysis extends previous work on Time Critical Targeting [1] by using the methods of Applied Cognitive Work Analysis [2] to create “Functional Decomposition Diagrams” (FDD), which are similar to Rasmussen’s theory of an abstraction hierarchy [3]. We apply this approach to TCTF, JSTARS and AWACS to develop a comparable picture of three functions/systems. This allows us to identify fundamental similarities and differences in goals, decisions and information requirements between these functions/systems. For example, at the highest level of abstraction, we show that TCTF, JSTARS and AWACS all involve the fundamental functions of “Risk Assessment” (i.e., making determinations based on uncertain information) and “Resource Allocation” (i.e., deciding between competing options influenced by the current situation). Such comparisons are useful because they can inform the design of new systems like the Multisensor Command and Control Aircraft (MC2A), which seeks to blend the functions of JSTARS, AWACS and Rivet Joint Systems into a single battlespace management system [4]. The eventual product of our effort will be a set of FDDs at various levels of abstraction, which will offer a rudimentary taxonomy of Command and Control.

Also at the highest level of abstraction, our FDDs show that the “real world” decision making challenges of Air Force missions are similar to the “micro world” [5] decision making challenges of a card game called “Poker TRACS” [6] that we are using to perform laboratory experiments on cognitive strategies. Here our objective is to use FDDs to formalize the analogy between decision making in poker and warfare [7], in order to help bridge the gap between micro world research and real world applications. On the one hand, the FDDs show how our micro world experiments (with card games) can be informed by the relevance of real world situations (in warfare). On the other hand, the FDDs show where real world applications (in warfare) can be informed by the rigors of micro world experiments (with card games).

References

- [1] MITRE (1999). Center for Air Force Command and Control Systems. Decision Support System Engineering for Time Critical Targeting. *Command & Control Research & Technology Symposium* (Naval War College, Newport, RI).
http://www.mitre.org/support/papers/tech_papers99_00/pedersen_decision/pedersen.pdf
- [2] Elm, W. C., Potter, S. S., Gualtieri, J. W., & Roth, E. M. (in press). Applied Cognitive Work Analysis: A Pragmatic Methodology for Designing Revolutionary Cognitive Affordances. In Hollnagel, E., & Dobson, D. L., Eds. *Handbook of Cognitive Task Design: Human Factors and Ergonomics* (Mahwah, NJ: Lawrence Erlbaum).
- [3] Rasmussen, J. (1986). *Information Processing and Human-Machine Interaction: An Approach to Cognitive Engineering* (New York: North-Holland).
- [4] Journal of the Air Force Association, Vol. 85, No. 11. Seeking a Triple-Threat Sensor.
<http://www.afa.org/magazine/Nov2002/1102threat.asp>

[5] Gray, W. (2002). Simulated task environments: The role of high-fidelity simulations, scaled worlds, synthetic environments and micro worlds in basic and applied research. *Cognitive Science Quarterly*, 2(2), 205-227.

[6] MITRE (2003). Center for Air Force Command and Control Systems. Mental Models in Naturalistic Decision Making. <http://mentalmodels.mitre.org>

[7] McManus, J. (2003). The poker of war: How military strategy was born at the gaming tables. *The Boston Globe*, March 30, 2003, page D2.
http://www.boston.com/dailyglobe2/089/focus/The_poker_of_war+.shtml