12TH INTERNATIONAL COMMAND AND CONTROL RESEARCH AND TECHNOLOGY SYMPOSIUM

"Adapting C2 to the 21st Century"

On Regarding 21st Century C2 Systems and their Users as Fallible ePartners

Topics: C2 Concepts, Theory & Policy; Cognitive & Social issues; C2 Technologies & Systems

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The first two tenets of Network-Centric Warfare (NCW) – known in The Netherlands as Network Enabled Capabilities (NEC) – state that a robustly networked force improves information sharing, and that information sharing and collaboration lead to shared situation awareness (Alberts & Hayes, 2003, Fig. 12). The danger is that the information being shared may be erroneous. Moreover, the comprehension that should lead to situation awareness (Endsley, 2000) may be flawed, and collaboration can fall prey to groupthink (Janus, 1983).

Helmreich (2000) shows that in the benign, shirt-sleeved domain of commercial aviation an average of two safety threats occur per flight. In addition, experienced crews frequently make errors, 54% of which are caused by a conscious failure to adhere to regulations, 29% by wrongly executed procedures, 6% by poor communication, 5% by lack of knowledge or skill, and 7% by decisions that unnecessarily increase risk. It is reasonable to expect that the equivalent rates for military C2 - where decision makers are subjected to factors such as excessive task demand, cognitive overload, emotion, and poor working environments – are likely to be still higher.

At present, the nodes in a 21st century C2 network are platforms (i.e. fighting vehicles, ships, or aircraft) or military units. In the not-too-distant future, warfighters will form teams with autonomous platforms, working together in hostile environments for long durations while coping with complex, unexpected, and hazardous situations. For example, soldiers will cooperate with unmanned land vehicles, and pilots of manned aircraft will work together with unmanned air vehicles. Information will come from networks of battlefield sensors. Adding such autonomous platforms to the C2 network will bring with it still more modes of failure and error generation.

In this paper we argue that research is needed into the relationship between C2 systems and their human and machine users, given that both C2 systems and users are

fallible. We believe that C2 systems will have to be increasingly designed to minimize, identify and mitigate user errors. Likewise, users will need to minimize, identify and mitigate C2 system errors. In essence, the C2 system and its users will have to become *e*Partners (Neerincx, 2003), with cognitive engineering techniques (Van Maanen et al, 2005) being used to design the interfaces between them. This approach is currently being demonstrated in a European Space Agency project to prototype a networked C2 system to support astronaut-rover teams in exploring Mars (Neerincx et al, 2006).

The paper opens by reviewing NEC / NCW research. It shows that the emphasis has been on the changing organizational relationship between the users of the network, rather than on the interfaces between the information and the physical, cognitive and social domains. Both C2 systems and users are shown to be fallible, with the respective sources of error being identified. It is argued that C2 systems and their users need to partner one another by minimizing, identifying and mitigating the other's errors. Finally, the paper proposes a research program based on cognitive engineering and drawing on results from the European Space Agency project.

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