

PROFILES IN PRACTICE: CMC Electronics

By Gerard Torenvliet, Dave McKay, and Shelley Roberts, CMC Electronics

Organization of Human Factors at CMC

CMC Electronics (CMC) is a Canadian aerospace company that designs and manufactures electronics for aviation and global positioning markets. CMC has a broad product portfolio for commercial and military applications, including:

- full cockpits and cockpit integration services,
- flight management systems,
- communication and navigation system control and display units,
- head-up displays,
- enhanced vision systems, and
- electronic flight bags.

The CMC Human Factors Engineering (HFE) team was assembled in 1986 to support the HFE aspects of a large military procurement program. It currently has fourteen members: half human factors engineers, and half HFE-knowledgeable software engineers that provide our modeling and simulation capability. The core of the HFE team has always been retired military personnel from the Canadian Air Force and Navy who were sensitized to human factors concerns during their time in the military. They help our team to remain grounded in the concerns of actual operators. This core has been bolstered by a contingent of academically-trained human factors staff. We also maintain strong relationships with a large number of consultants in North America, so we can access specialized expertise required by many of our projects.

It is not unusual for a large company to have an HFE team, but the way that our team has been inserted into our company makes it unique in

Canada, and perhaps even in North America and the world. In addition to a significant role in our company's core programs, half or more of our HFE business comes from providing research and applied HFE services to defence research organizations and militaries around the world. Our unique business mix benefits all of our customers: our internal customers benefit from the ideas and approaches learned from our external consulting, and our external customers benefit from the pragmatism that we've learned from applying human factors properly and efficiently in a product-development environment. Further, our work mix affords our team-members the flexibility to fulfill individual career interests, keep one foot in research and the other in a much more applied setting.

The dual roles of our team – external and internal – make us unique in a company where all the other groups face inward. While this arrangement is beneficial, it also makes for some unusual challenges. Most significantly, when allocating our time and effort we need to be careful to properly balance our team's objectives against those of the overall organization. This is a difficult balancing act, especially when loaded with work for both types of customers. But on the bright side, our team-members develop skills in project and customer management that might otherwise be difficult to learn!

Internal and External CMC HFE Projects

If human factors work is viewed along a continuum that ranges from basic research to product development (see Figure 1, below), the work that we perform for our external customers typically ranges from basic research to the early phases of product development (e.g., research and development of a CEDM toolset for use by the Canadian Forces, research to flesh out the techniques of Cognitive Work Analysis and Hierarchical Goal analysis).

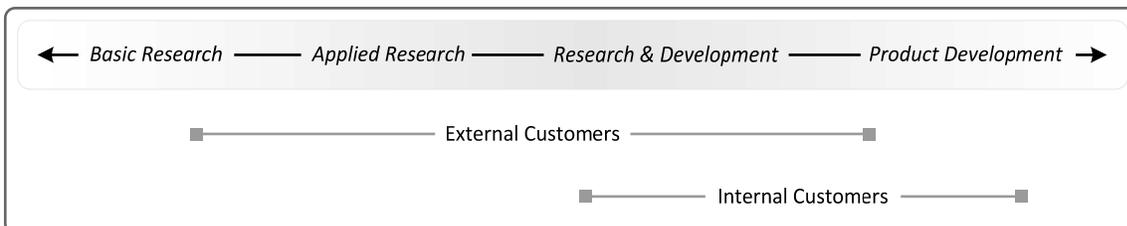


Figure 1. The range of human factors work performed by the HFE team at CMC Electronics.



The work that we perform for our internal customers ranges from research and development for new products and applications to the detailed human factors concerns involved in producing and evaluating new designs for customers (e.g. concept development for a new flight deck system, simulator studies to assess usability in an electronic flight bag).

CMC HFE's experience performing the range of activities shown in Figure 1 has become a key to our success in projects. For example, our team performed a number of external research projects to investigate the human factors concerns of sensor fusion. Promising results from this external work led to an internal project to explore the potential of sensor fusion for low-visibility landings. The internal project developed a synthetic vision system that fuses returns from a video camera and an infrared sensor to assist pilots in landing in low-visibility conditions. Our team's external research experience, the operational expertise of the pilots in our team, our capabilities in modeling and simulation, and our broader CEDM capabilities helped CMC develop a product that makes the most of new technologies by considering all of the human factors involved. Today this product is a significant contributor to CMC's bottom line.

Future Challenges for CEDM and CMC

CEDM concerns play an important part across the spectrum of the CMC HFE team's work. Much of our research and development work is informed by ongoing developments in the CEDM community. And our product development work draws heavily on CEDM principles, especially in the high cognitive workload environment of a cockpit.

As we perform CEDM research and apply the results to CMC's product development efforts, we encounter strengths and weaknesses in current CEDM practices. The most important strength of CEDM is its toolkit of analysis techniques that really work. We have analyzed the cognitive aspects of human work in command and control, civil, military, and unmanned aviation, and naval operations, and continue to find that our analysts are

able to use these techniques to efficiently gain a broad but suitably focused understanding of human work to generate strong design requirements. But CEDM's most significant weakness is related to this strength: while the CEDM toolkit is able to generate strong and relevant findings, it is difficult to transfer a holistic understanding of the analysis results to staff who did not perform the analysis. This problem is compounded by the fact that staff who understand the CEDM tools used in an analysis are typically senior (i.e., costly). This creates tension: it is beneficial to keep senior analysts on a project due to their knowledge, but cost pressures push us to transfer senior staff off a project as soon as possible.

We think that a part of this problem is that the CEDM toolkit is not being popularized effectively. Perhaps in an effort to increase their cachet, consulting organizations seem eager to create their own 'branded' versions of CEDM methods (think of the variations on Cognitive Task Analysis and Cognitive Work Analysis that currently exist). We certainly sympathize with the desire to create a conceptual niche from which skills can be marketed, but it would be useful if the academic community could work to re-digest the novel variations on established techniques to continually refine the 'canonical' techniques of our field. In our work, we frequently have to apply military and civil process and product standards, and think that the field of CEDM could benefit by creating standards of our own. Robert Hoffman and his colleagues have been doing some thinking in this area (e.g., Hoffman & Elm, 2006), and we would like to encourage this. Of course, no individual will ever be satisfied with a corporately adopted standard, but we believe that such standards will provide concrete handles for further innovation in our field.

References

Hoffman, R. R., & Elm, W. C. (2006, Jan/Feb 2006). HCC implications for the procurement process. *IEEE Intelligent Systems*, 21, 74-81.

Note: CMC Electronics is a wholly-owned subsidiary of Esterline Corporation.

2007 ANNUAL MEETING PROGRAM PREVIEW

CEDM program takes a hard look at the tough problems.

The CEDM program at this year's HFES annual meeting promises multiple perspectives at how people cope with complex decision making. The problems tackled by researchers in this group are focused on the rich real problems that are facing the world today. This year CEDM offers a mega-program with 15 sessions throughout the conference. Highlights in the program include three discussion panels on Modern Technology Failures, Cognitive Engineering Successes; Meta-information Communication and Representation; and Macro-Cognition Metrics: Meaningful Measures for Complex Processes. There will be lecture sessions on intelligence analysis, working with automation, and supporting situation awareness in complex environments. The problems are tough and complex, but this year's CEDM program brings together the latest research and perspectives on how to improve decision making when facing these complex problems.

PROFILES IN PRACTICE: CERI

By Santosh Gupta

CERI: A Multidisciplinary Institute

Cognitive Engineering Research Institute (CERI) based in Mesa, Arizona is an independent, not-for-profit research institute. CERI's mission is focused on research to solve problems in large command and control environments. They accomplish this through human-centered design, problem-oriented research, and multidisciplinary collaboration among scientists and practitioners working mainly in the area of command and control, team cognition, team performance, and communication.

CERI was founded by partners from private industry, academia, government laboratories, and the husband-and-wife team of Steven M. Shope and Nancy J. Cooke. Dr. Steven M. Shope is a physicist and the executive director of CERI and Dr. Nancy J. Cooke is a professor of applied psychology at Arizona State University and the science director of CERI. Dr. Cooke is assisted in her studies by post-doctoral researchers, and graduate and undergraduate assistants. All researchers have strong background in the areas of cognitive science, psychology, team cognition and communications. CERI's personnel are heavily involved in training programs related to cognitive engineering and human factors. They also interact with mechanical engineers, industrial engineers, air force pilots, UAV operators, psychologists, and health and wellness people specializing in sports. CERI benefits greatly through such interactions across disciplines since the expertise that others bring

complements that of the CEDM domain. In addition students have the opportunity to see various perspectives from individuals outside of the CEDM domain.

CERI is also committed to a goal of fostering women in science. CERI employees visit elementary schools to introduce male and female students to the variety of applied problems that can be addressed through science and engineering. CERI offers opportunities to women in science field through training programs and help them achieve and apply their talents in a technical field. CERI employees are also actively involved in the community development by volunteering hours with local service organizations and participating in fund raising events sponsored by national service organization.

Working with Customers

CERI hopes to achieve national and international recognition as a center of excellence in the areas of human factors of UAVs, and team cognition research. They strive to use their CEDM skills and apply CEDM theories and findings to problems in the field.

CERI's current projects include modeling and developing an intelligent agent for unmanned aerial vehicles (UAVs) based on ACT-R architecture, modeling and measuring team coordination, and communication analysis research. CERI works on a variety of applied problems, with unmanned aerial vehicles (UAVs) and team cognition as continued research thrusts. They study team performance and team cognition in the context of UAV ground

control. Research at CERI has revealed that teams with flexible, yet stable patterns of interaction tend to perform better than those without. CERI has developed a successful research team and a state-of-the-art test-bed for team performance. They have developed metrics for team cognition and published a book on UAV human factors (Cooke, N.J., et. al, 2006).

Notably, CERI recently hosted their 4th annual Human Factors of UAVs workshop. The event sponsors included the Air Force Office of Scientific Research, the Air Force Research Laboratory, L3 Communications, Research Integrations, and the Human Factors and Ergonomics Society. Through session discussions and UAV operator panels, CERI has been able to unite the human factors research community with the UAV developers and operational community to identify the critical human factors challenges associated with UAV operations.

Challenges for a CEDM Research Institute

Interdisciplinary research requires interaction between different communities and organizations. Working with a wide array of organizations is not always straightforward. CERI sometimes, for instance, faces conflicting goals from businesses that tend to focus on selling their products as opposed to conducting scientific research.

Funding and project management present significant challenges for a research institute. As a small organization CERI must balance funding and personnel priorities. People, specifically talented cognitive engineers, are their most important asset.

References

Cooke, N. J., Pringle, H., Pedersen, H., & Connor, O. (Eds.) (2006). Human Factors of Remotely Operated Vehicles. Volume in Advances in Human Performance and Cognitive Engineering Research Series, Elsevier.

Note: CERI was incorporated in October of 2003 and is now located at 5810 S. Sossaman Road in Mesa, AZ.

51st Annual Meeting Registration is Now Open

Make your plans now to attend the 51st Annual Meeting of the Human Factors and Ergonomics Society. The 2007 conference will be held in Baltimore on October 1-5.

Find more information at:

<http://www.hfes.org/web/HFESMeetings/07annualmeeting.html>

SEE YOU IN BALTIMORE!

Editor's Note:

Special thanks to CMC Electronics and CERI for volunteering their organizations for *Cognitia's* Profiles in Practice. If you are interested in volunteering your organization for a future profile, or would like to respond to the CEDM challenges raised in a *Cognitia* profile, please contact the Michael Linegang – linegang2@hotmail.com.

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Editor: Michael Linegang
linegang2@hotmail.com

Associate Editor: Santosh Gupta

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