Aligning Border Security Workflow and Decision Making with Supporting Information and Communication Systems

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ABSTRACT

As part of the National Center for Border Security and Immigration (NCBSI) led by the University of Texas at El Paso (UTEP), researchers from the University of Washington, Wayne State University, and UTEP conducted a three-site study of border security operations and the role of command, control and communication (C3) systems in support of those operations. While inevitably bringing some positive capability to the environment, if C3 systems are not consciously aligned with desired practices and decision-making, the implications will not always be for the better. This is especially true of C3 systems in the border security environment because these systems are intimately intertwined with complex and critical workflow and decision-making processes, often in the context of complex and, at times, competing missions.

Keywords

Common operating environment, situational awareness, collaborative decision making, service-oriented architecture, precision information environments, system development, cognitive schemas, adaptive development, command and control, communications, computers, C4, C3, C3 systems, C2, C2 systems.

INTRODUCTION

A field study of command, control and communication (C3) operations and processes of the U.S. Customs and Border Protection Agency (CBP) was conducted at three diverse border sites—Blaine, Washington; Detroit, Michigan; and El Paso, Texas. This study was designed to be "action research." Action research, a term first introduced by Kurt Lewin at Massachusetts Institute for Technology, is a process of cooperative problem solving between researchers and a "community of practice," designed to improve the way that community addresses issues and solves problems (Lewin, 1946). Action research is usually undertaken by large organizations or institutions, assisted by professional researchers, with the aim of improving their strategies, practices, and knowledge of the environments within which they practice. Three sector locations were selected to afford us a wide-range of border security processes in diverse environments and situations. The comparative analysis revealed a number of common major findings across the three sites, in addition to more localized single site issues. Our focus is on the common takeaways associated with the use of C3 systems in support of border security operations.

Early in this study of border security practices and environments, researchers began identifying a series of related high-level tensions that played out in somewhat different ways at each border site. It became clear that the management of intrinsic tensions was central to the long-range accomplishment of border security missions and strategic goals as outlined in the most recent U.S. CBP strategic plans (USCBP, 2005; USCBP, 2009).

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Acting USCBP Commissioner Jayson Ahern introduces the CBP strategic plan as a "flexible, comprehensive approach," capturing a central tension of U.S. border security policy--that between a comprehensive, centralized approach and a flexible localized approach (USCBP 2009). We reflect that CBP's mission itself actually embodies an inherent, strategic tension between security and flow of trade: "CBP is charged with the dual mission of securing the Nation's borders while facilitating legitimate trade and travel." (USCBP, 2005) Other naturally occurring tensions such as security vs. ease of trade and centralization vs. localization play out in numerous ways throughout CBP policies, practices and training efforts employed to achieve U.S. border security. To complicate this already delicate dance, while CBP is the primary authority in border operations, it is not the only one. Being able to command, control, communicate and coordinate effectively within the dynamic, larger security community deepens the complexity of employing C3 systems.

While C3 systems are designed to enhance CBP situational awareness, decision-making and coordination, they are rarely designed with adequate consideration of their role in the workflow and decision making processes, or their impact on the inherent mission tensions. This paper focuses on two examples of the recurring tensions that emerged in our research:

- Multiple Data Sources vs. Cognitive Efficiency
- Technology-Based vs. Experience-Based Decision-Making

It is not beneficial to view the tensions that are the focus of this report as harmful conflicts to be removed, nor as choices between right and wrong such that, with the right information, options could be assessed so as to select the correct solution and reject the flawed one. Rather, our findings highlight how these tensions are inherent in the CBP operational situation, and that current, traditional ways of C3 system development, fielding, policy and maintenance contribute to an exacerbation of these strategic tensions. To address tensions that are inherent in the complex missions and environments of border protection organizations, new intentional strategies are needed that integrate C3 system design and use with the cognitive, work and socio-technological processes they are intended to support. After further exploring these operational, tactical and strategic processes, the second part of this paper explores research and methods for aligning C3 systems design and management with workflow and decision-making processes.

OPERATIONAL PROCESSES, TACTICAL DECISIONS AND STRATEGIC TENSIONS

Before presenting and analyzing the strategic border security tensions that are the primary focus of this paper, it is useful to distinguish them from the critical tactical decisions faced daily by the personnel of CBP. It is also necessary to understand how the management of these larger strategic tensions impacts critical tactical decisions.

Every day, CBP personnel face critical tactical choices that, in hindsight, could be categorized as correct or incorrect. The decision to allow a truck with hidden drugs to cross the border without secondary screening was "incorrect;" the decision to deny a visa to an international traveler with terrorist intent was "correct." These individual security choices are where the "rubber meets the road," or, in other words, where policy is set in action. Even though our focus here is on the systemic tensions that impact processes, this is not intended to detract from the importance or difficulty of these tactical choices. In fact, the goal of analyzing inherent strategic tensions and the operational environments within which tactical decisions are made is two-fold:

(1) To use knowledge of the broad strategic environment to more fully empower border security personnel to make better specific tactical choices through better information, analytic support, and a fuller understanding of their resources and roles within the complex inter-dependent environment that they operate.
(2) To use knowledge of specific tactical decisions and the operational processes within which they occur to guide better strategic design and management of the systems intended to support those processes and tactical decisions.

Thus, the relationship between operational processes, tactical choices and strategic tensions is multi-directional—better understanding of tactical choices and operational processes leads to improved management of tensions within the broader strategic environment, and better understanding of the strategic environment and its tensions leads to improved operational processes and tactical decisions.

In our research, evidence of C3 systems contributing to an imbalance of naturally occurring, strategic tensions most poignantly appeared where operational processes and tactical choices intersected. More specifically, a failure to link individual tactical choices to larger strategic systems intended to support them led to critical operational process "disconnects" that prevent border security operations from being all that they can be. In the

current context of technology development and deployment, we found many examples of these disconnects between C3 systems at the border and the work processes these systems are supposed to support. In these cases, we found that border agents were left no choice but to establish workarounds to align these disconnects, and that these workarounds often detracted from and became cognitive distracters from their primary tasks and decision-making. The need for these workarounds could be so powerful as to even overshadow clearly stated policy. Here are some examples that demonstrate this unfortunate dynamic.

Multiple Data Sources vs. Cognitive Efficiency

Take, for example, the current situation where numerous individual and inconsistent C3 systems at an Office of Field Operations (OFO) port of entry, combined with a regular and fairly rapid rotation of operational roles, requires frontline border personnel to constantly juggle diverse C3 systems in the course of their daily work. A simple yet powerful cognitive distraction stemming from such diverse work environments is the multiple passwords that these systems require. Border agents we interviewed stated that despite clear policy that these passwords should not be written down, they were forced to engage in this "workaround" (even writing on their hands) in order to maintain the flow of operations as they switched from system to system. In this case, rather than enhancing work processes required to achieve primary missions, the multiple C3 systems required field operators to invent additional peripheral work processes that distracted from primary operations and even contradicted stated policy in order to accomplish their tactical mission.

This password example is perhaps the simplest case of the cognitive dissonance that can stem from requiring agents to work in a multiple system environment. Beyond the redundancy of multiple passwords is the distraction of inconsistent interfaces, terminology and functions. In most cases, the existence of the multiple systems environment is seen as a positive solution to an identified need – sharing information among multiple agencies across the broader security community. However, even within single agencies there are numerous systems with designs that are inconsistent or that don't fully consider the work processes they are intended to support, and there is even more inconsistency across multiple agencies.

For example, there has been a dramatic increase in the multiple databases that agents and officers may need to query for the intelligence components of their operations. CBP data indicates that the number of intelligence databases has increased from 9 to 22 from 2006-2009. This increase is presented in an FY 2009 performance metric that asserts the desirability of this increase in data sources.

Performance Measure	Total number of linked electronic sources from CBP and other government agencies for targeting information					
Description	The number of electronic sources to which CBP information technology systems are linked to share information for targeting purposes. The ability to accurately and efficiently identify a potential risk to border security in any conveyance entering the United States is improved by linking data sources from CBP automated systems and other government agencies, through ACE, as a single source for border decision makers.					
Fiscal Year Indicator	FY 2005 Actual	FY 2006 Actual	FY 2007 Actual	FY 2008 Actual	FY 2009 Target	FY 2009 Results
	N/A	9	16	19	22	22

Figure 1. Electronic Sources Performance Measure (*Performance and Accountability Report: Fiscal Year 2009*, p. 80.)

The performance measure explained by the description within Figure 1 assumes that the more databases you have access to, the more effectively and efficiently one can identify a potential risk. We observed that at a certain point, this performance measure actually creates performance hindrances, particularly when the job of accessing, understanding and making sense of the different databases becomes more primary than finding the risk being analyzed. We found that CBP has successfully integrated some of its databases (e.g. through ACE for

cargo purposes), but the same is not true for others, which still require multiple passwords and supervisory permission to gain access (e.g. FINCEN and ICE databases[1]), as well as employing different interfaces and data definitions. Thus beyond the access issues, we observed further cognitive burdens for the user in identifying what is relevant to the current decision and aligning the use of the databases with the mission-driven workflow.

Technology-Based vs. Experience-Based Decision-Making

Another critical tension we identified is between decision-making based on information provided via technology versus decision-making based on assessments from human experience and sense-making. Some interviewees saw this as an "old ways versus new ways" issue. The introduction of new systems to support work and decision-making is further complicated by recent growth in CBP hiring of border security personnel, with the majority of new hires younger and more technologically-oriented than the more experienced older workforce. Lacking experience, the new crop of hires is more willing to rely on quantitative data and analytical software that provides decision support (e.g. who to detain for secondary screening). Experienced officers and agents appeared more comfortable with qualitative input and sense-making based on the patterns and schemas they have developed over the years; they are suspicious of new hires who try to replace that experience with computer driven assessments.

This growing cultural difference in approach to work and decision making not only influences how an agency makes decisions, but can create highly different understanding and operational assessments, contributing to tensions between older, more experienced officers and agents and younger, inexperienced but more technologically-savvy ones. We observed this growing rift in our study of field operations, and a difference in the use of technology and personal judgment between experienced and newly trained officers and agents.

For example, one CBP officer saw potential pitfalls in the overreliance of recent hires on new technology without developing and integrating skills for human-to-human assessments. She related a story about the socio-cognitive methods she used to make apprehensions at the Seattle-Tacoma airport. This officer had an "intuition" (i.e. cognitively, a set of useful schema) about people and situations, developed over years of experience. She used this "intuition" to detect behavioral indicators of unease or incongruent elements in a situation. When she encountered passengers who were exhibiting certain behaviors or whose luggage and shoes didn't match their itinerary, she invited these suspects to "take a walk" with her around the airport. It was during these walks that she casually probed behavior and travel preparations to the point where she could generally tell not only if they were guilty, but even exactly where the drugs they were trying to smuggle were hidden (either on their person, or in their baggage).

This experience-based "Let's take a walk" approach contrasts with the use of algorithms, historical data, and technology to flag high-risk passengers for further questioning. As we see below, the future goal is to integrate these two types of decision making and apply the appropriately in differing situations.

We have reviewed two primary strategic, ongoing tensions that were found to impact the work conditions, processes and decision making of CBP officers and agents. These, again, are issues that cannot be managed as problems to be eliminated, but rather must be managed as a strategic balancing act that is inherent in the border security mission. The next section reviews a key strategy for managing these tensions: the ongoing effort to align operational decision making with the technology and systems intended to support this critical activity.

ALIGNING WORKFLOW AND DECISION MAKING WITH C3 SYSTEMS

> When we design interactive software we are also defining much about the work of its users. The software embodies a model of work processes for its end users because part of its job is to manage the content, format, and sequencing of the information that users need to do their work. The effect is that any application will preferentially enable certain work processes, and users will have to work harder to follow others. It is actually unavoidable. Developers may try to avoid the responsibility for promoting a particular work model by oversupplying information or features for flexibility. But this strategy is futile. It simply loads the user with an additional process, one for dealing with the resulting clutter. (Butler, Esposito, and Hebron, 1999)

In our field study, we saw a wealth of new technologies and systems being employed by DHS at the border. This effort has created significant opportunities for improved security and safe travel in terms of data collection, integration and analysis, but as Butler et al. observe above, these opportunities come with an unavoidable cost –

[1] FINCEN: Financial Crimes Enforcement Network,

ICE: Immigration and Customs Enforcement.

unintended constraints on the way agencies do their work. When design constraints are not consciously aligned with desired practices and decision-making, the impact of new technology will not always be for the better. This is especially true of C3 systems in the border security environment because these systems are intimately intertwined with complex and critical workflow and decision-making processes.

Bringing Balance to CBP's Strategic Tensions

Balancing Multiple Systems with Cognitive Load

To be wholly effective, the integration of multiple systems into a single work environment must consider strategic tensions and their impact on workflow and cognitive demands of agents and officers who must use them. For example on the one hand, there is a need to increase our "capacity to conduct seamlessly coordinated CBP operations and information and intelligence sharing." (USCBP, 2009) On the other hand, there is a need to create a work environment where "officers and agents will be able to increase their focus on ensuring the security and economic vitality of our country." (USCBP, 2009) We found that the latter desired "focus" can be disrupted by the multiple information system environments required to coordinate with other branches, agencies and regional organizations. These are two equally desirable goals, each a potential obstacle to achieving the other. This is where management must be engaged in an active strategy in order to balance competing desirable goals.

To be clear, we are not dictating right vs. wrong action, rather we are pointing out how C3 systems that are not designed with workflow and decision making in mind can exacerbate tensions in complex security operations. It is clear that increased linkage of data sources can be essential to the effectiveness of CBP field officers and agents. For example, we noted that in the case of Visas, the field officers in the booth did not have access to all visa data (such as biometrics) that the State department uses. As a result, CBP officers without the tools and information to discriminate between different people with the same name, sometimes detain people unnecessarily because their name shows up on a Visa database as potentially dangerous. However, the benefits of increased data sources are only one side of a strategic tension between desirable ends. The other side is the need to minimize the cognitive overload and workaround processes that can distract officers and agents from their primary tasks and missions. These distractions are increased when CBP officers and agents must function in an environment where multiple systems and technology from diverse agencies are not aligned with each other or with the field workers' decision-making or work processes. Current performance measures focus on the "anticipated" benefits of multiple data sources, but overlook the other end of the information sharing/cognitive overload tension.

Balancing Technological and Cognitive Decision-Support Systems

The tension between two valued ways of operating, technology-based and experience-based decision-making, (often represented by the division of new hires/experienced personnel) must be creatively managed if CBP is to get the best of both approaches, as well as guide the way that new hires are impacting CBP practices and culture. Training can be an important component of managing this tension, with a focus on understanding the difference between "technology to enhance craft" versus "technology to replace craft." New C3 technology which incorporates advances in visual analytics are opening up increased possibilities for precision information and decision making; however, as Einstein said, "Not everything that counts can be counted, and not everything that can be counted counts." Future training and performance measures will need to encourage and support the integration of both experience-based decision making into the design and use of supporting information and communication technology.

Integrating and balancing these two approaches for the best outcome is critical for the sustainability and success of CBP border security efforts. Given the increased reliability on information and communication systems and the increased hiring of new personnel with high degrees of comfort with these systems, and perhaps discomfort with human interactive methods, the most significant issue may be the under-valuing or even the risk of losing the more qualitative, socio-interactive experience-based analysis.

One way to address the growing gap between reliance on data and technology versus reliance on experiential judgment is to develop personnel training programs that clarify these different processes and their appropriateness for different situations and goals, and introduces new skills associated with integrating the two into operations. Another is to improve the way we design, develop, and manage C3 systems to assure that they also support the desired workflow and decision-making processes. We can find guidance for this approach from the significant research that has been done both on cognitive decision-making and aligning workflows with system design, which we address in the next session.

Strategies for Aligning Workflows and Decision-Making with C3 Systems

In supporting the development and implementation of new C3 systems, DHS is attempting to take advantage of innovations in technology and of the wealth of diverse data collected and stored as part of the overall national security effort. To assure a positive impact of these new systems on agency work flow and decision-making, and hence, national security, these system development efforts must include detailed analysis of core work practice and careful attention to cognitive processes associated with improved decision-making. The implementation of C3 systems within a decision making community will be better aligned for effective mission accomplishment if viewed both as a component of a socio-technical environment and as a support for human cognitive processes. Cognitive and socio-technical factors cannot be considered after the fact – they must drive the entire design, development, implementation, use, and maintenance process.

Valuing Cognitive Schemas and Collaborative Sense-Making

Cognitive research on decision-making can provide considerable insight into efforts to integrate the best in both experience-based and data-based decision making. For one thing, the significance of experience-based decision-making is strongly reinforced. A significant body of research argues not only that experts in a field can make highly accurate intuitive decisions, but also that by not exercising these skills or allowing them to develop, they soon disappear. For example, Dreyfus and Dreyfus (1980), Benner (1982), and Pyles and Stern (1983) suggest that intuition is developed over time as a practitioner becomes more experienced; thus, individuals who want to form complex, domain-relevant schemas must engage in repetitive practice over a long period of time. When various technologies and random selection devices are used by new border officers or agents in deciding who to send to secondary screening, does that retard the development of more intuitive analysis abilities? Can we design these decision support tools and systems to enhance, or at least not deter, these more integrated cognitive skills?

Some scholars are beginning to examine differences in how experienced cognitive knowledge structures are developed—by means of explicit or implicit learning. While explicit learning (actively seeking out the structure of the information) associated with expert knowledge may lead to far more advanced and effective intuitive decision-making in some situations, such extensive expert knowledge may not always be necessary for the formation of complex, domain-relevant schemas. Instead, Dane and Pratt (2007) suggest that schemas may develop through implicit learning, that is, the acquisition of knowledge outside of one's conscious awareness. Similarly, Reber (1989) tied implicit learning to "intuitive knowledge" and argued that it is through implicit learning that individuals come to form the complex cognitive structures necessary for intuitive judgments and decisions. This again raises the issue of how a reliance on technology focused on delivering quantitative historical data impacts the development of the analysis capabilities of recently hired agents. Because of increased hiring and the growing size of a new generation of border agents, this area needs further study at both the operational and training levels.

Also of particular interest is research on planning and decision-making in emergency management environments. Mendonca and Wallace (2007, p. 553) describe human planning behavior as "incremental, opportunistic, and multidirectional." Emergency response managers and workers must be able to cope with incidents that cannot be predicted or modeled by utilizing resources in whatever way the emergency incident requires. Mendonca and Wallace suggest that emergency management systems should be geared toward adaptability and improvisation to align with the unpredictable realities of emergency situations. Here again this implies that C3 border systems should support the experience-based evaluation of an evolving situation, in addition to providing access to a wide range of quantitative data and historical models.

Wu and Zhang (2009) focus on the issue that decision making and sense making in emergency environments is invariably collaborative, involving multiple people from multiple agencies with multiple jurisdictions, policies, missions, etc. They describe the difficulty of achieving collaborative sense making in emergency management stemming from the fact that simply conveying information does not guarantee mutual understanding. Current C3 tools such as e-mail and shared databases do not directly support collaborative sense making, and hence the authors propose map-based visualization tools in order to provide a shared picture of the incident situation. This approach has been endorsed by DHS S&T through its commitment to the development of GIS-based information systems such as Virtual USA. In the future, communities would benefit from an integration of C3 systems into a common map-based operating environment, reducing the distraction of multiple systems employing diverse interfaces and schema while supporting the integration of the various system outputs into a single integrated picture.

Adaptive Development for C3 Systems

Mattioli et al. (2007) point out that "information needed by each civilian and military emergency response unit differs according to its mission, the situation on the ground" and other contextual factors. They propose various information sharing strategies, including information coding standards and geo-referencing data, to cope with these disparate stakeholder groups' needs. In this vein, we propose that C3 systems exist within a common operating environment employing an ongoing adaptive development model and information sharing capabilities at various levels of granularity, so as to assist in providing the necessary and correct information to each stakeholder group. (Benson, Biggers, Wall and Haselkorn, 2010) Here again, DHS S&T is addressing this need for tailored information to diverse stakeholders through its initiative on Precision Information Environments (PIE).

Adaptive development is related to the naturalistic decision making concept developed by Gary Klein (Klein, 1993; Zsambok & Klein, 1997). Naturalistic decision making is a theory of decision making which holds that emergency responders, such as firefighters, do not manage by objectives, but instead make decisions based on using experiential schema to constantly reassess an emergency situation and act on the current best option. In his latest work, Klein calls decision making under ambiguous and unpredictable conditions "adaptive decision making" (Klein, 2009). Klein's work is central to the border security environment because it distinguishes schema-based from data-based decision making and provides a sense of how to apply the appropriate decision making process to the situation and, most importantly, role of the decision maker.

For example, Klein tells the story of a sergeant and a brigadier general observing during a desert war game. When an opposing tank appears in the distance, the sergeant whips out his PDA and sends the tank's position to HQ; then he is done and back looking for more data to send. He has done his job by adding new data to the overall knowledge base and is satisfied. The brigadier general, however, is already intuiting additional information based on his knowledge of war scenarios, terrain and tank formations and operations.

> …based on the position of that one tank, he focused on likely over-watch positions and found another tank. Based on the sections position and his understanding of the terrain, he looked at likely positions for another section and found a well-camouflaged second section. He repeated this process to locate the remaining elements of a tank company that was well camouflaged and blocking a choke point in the desert. The size and position of the force suggested that there might be other elements in the area, and he soon spotted an otherwise superbly camouflaged logistics command post. (Klein, 2009)

The sergeant's focus on data acquisition and communication is certainly important, but the brigadier general's experience-based, holistic analysis is even more so. This second type of analysis is especially critical at the border, and CS systems need to not only help us acquire and share data, they also need to support intuitive analysis based on experience and schema.

Modeling Work-Processes

As this story shows, peoples' roles go a long way towards determining the appropriateness of various decision-making processes. These roles become meaningful within the context of an overall operational environment and strategy that includes goals, processes, decisions and information needed to support those decisions. Therefore in order to align border security C3 systems with appropriate decision-making processes, it is equally necessary to align them with the large workflow processes within which these decisions occur. Because these workflow processes are extremely complex and evolve in response to diverse conditions, the first step is mapping and modeling those processes.

Considerable work has been done in the area of modeling work processes, including Business Process Modeling (BPM) and Hierarchical Task Analysis (HTA). Both BPM and HTA emphasize the role of people and organizations in this modeling task. They also focus not only on the need to align processes with system design, but also to find ways to improve those processes in the course of this activity. "BPM is not just about IT systems. It is about how a business carries out its processes in the most efficient manner, and how it supports staff to achieve this. It is about designing IT systems to support what people do rather than to have people do what the system tells them to do." (Turbet, 2005) Similarly, "[HTA] is seen not so much as a describing of actions or even cognitive processes as such but as a systematic method of investigating problems of human performance."

The research reported here ended after completion of initial field studies and the contextual analysis of border security operations. The broad analysis in this paper provides the necessary context for more detailed modeling of operational processes through methods such as BPM and HTA. We strongly recommend that this next

formal modeling step be taken soon, and that the results of this modeling be applied to the critical future alignment of C3 border security systems with operational workflow and decision-making.

CONCLUSION

The alignment of C3 systems with the border security practices and processes they are intended to support is one of our most significant opportunities for improving the efficiency and effectiveness of U.S. Customs and Border Protection and fellow agencies and organizations working within the border security community. Achieving and maintaining this alignment within the dynamic, complex system of border security (not to mention the highly political environment within which this system must operate) is an extremely difficult job, requiring ongoing strategic management with buy-in from the top–down *and* from the bottom–up. While tactics and tools for achieving this alignment exist (e.g. participatory design methods and task and process modeling techniques), they are difficult to apply within a secure classified environment as they require detailed modeling and analysis of roles, business processes and the information that supports these activities. Nevertheless, when one considers the considerable and ongoing investment that the Department of Homeland Security has made in information and communication technology to increase the security and safety of our borders, it seems clear that we should commit to the far less expensive (although sensitive) investment of ensuring that these technology-based systems actually support our most valuable security asset—the agents and officers who use them.

Tactics such as participatory design and process modeling techniques are based on the premise that the expertise and informed perspective of border security professionals are key to improved processes and technology. For these user-centered tactics to be successful, however, they need to occur under the umbrella of an ongoing high-level strategic effort to align C3 systems with effective border security operations. This is critical because of the numerous inherent tensions that must be addressed when integrating complex entities such as people, information, systems, and processes existing within an equally complex environment of jurisdictions, policies, missions and organizational cultures. Tensions such as those between (1) central standardization versus local flexibility (competing objectives) and (2) technology-supported decision making versus cognitive-supported decision-making (competing advantages) cannot be "fixed." Rather, they require an ongoing balancing act that strives to achieve the best of all the diverse alternatives, without allowing one to dominate at the expense of others. For this reason, strategic alignment must be engaged over time, not as part of a single solution. Any strategic decision intended to move towards positive alignment must consider not only current needs and future possibilities, but also past decisions and practices.

CBP and the larger border security community cannot manage C3 systems and operational processes in isolation. A new C3 system is not just one more capability being added to an already large and growing list. Rather, it is part of a complex, evolving socio-technical environment that impacts everything from how decisions are made to individual job satisfaction. Given the complexity of this management task, it is not surprising that we did not find many cases within CBP where the introduction of new technology was accompanied by a clear statement of increased operational competency or expected results or the real need being addressed by the allocation of resources. We spoke with many dedicated and self-reliant people and observed an organizational structure that was attempting to deal with local and national issues, but there was not much said about the organization's expectation of how their C3 technology and infrastructure was integrated with the "craft" of the border security professional.

We hope that DHS continues to invest in research that addresses border security practice and infrastructure within the context of these larger and more difficult socio-technical issues. It is perhaps the best way to assure that the dedication and expertise of the border security professional is incorporated into our solutions and future directions. It is also perhaps the best way to give these professionals the recognition, support and job satisfaction they deserve.

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REFERENCES

Benner, P. (1982). From novice to expert. American Journal of Nursing, 82(3), 402–407.

Benson, A., Biggers, K., Wall, J. and Haselkorn, M. Adaptive development of a common operating environment for crisis response and management. *Proceedings from the 7th Annual International Conference on Information Systems in Crisis Response and Management: Defining Crisis Management 3.0,* Seattle, Wa.

Butler, K., Esposito, C. & Hebron, R. Connecting the Design of Software to the Design of Work, *Communications of the ACM*, Vol. 42, No. 1,1999, p. 38.

Dane, E., & Pratt, M. G. (2007). Exploring intuition and its role in managerial decision making. Academy of Management Review, 32, 33–54.

Dreyfus, S. E., & Dreyfus, H. L. (1980). A five-stage model of the mental activities involved in directed skill acquisition (Operations Research Center #ORC 80-2), Berkeley, CA: University of California.

Klein, G. A. (1993). *Decision making in action : models and methods*. Norwood, N.J.: Ablex Pub.

Klein, G. A. (2009). Streetlights and Shadows: Searching for the Keys to Adaptive Decision Making. Cambridge, MA: MIT Press.

Lewin, K. (1946) Action research and minority problems. J Soc. Issues 2(4): 34-46

Mattioli, J., Museux, N., Hemaissia, M., & Laudy, C. (2007). *A Crisis Response Situation Model*. Paper presented at the 10th International Conference on Information Fusion.

Mendonca, D. J., & Wallace, W. A. (2007). A Cognitive Model of Improvisation in Emergency Management. *IEEE Transactions on Systems, Man, and Cybernetics-Part A: Systems and Humans, 37*(4), 547-561.

Pyles, S., & Stern, P. (1983). Discovery of nursing gestalt in critical care nursing: The importance of the gray gorilla syndrome. Journal of Nursing Scholarship 15, 51–57.

Reber, A. S. (1989). Implicit learning and tacit knowledge. Journal of Experimental Psychology: General, 118, 219–235.

Turbit, N. (2005) Business Process Modeling Overview. The Project Perfect White Paper Collection. http://nccd.pbworks.com/f/info_business_process_modelling_overview.pdf

US Customs & Border Protection (2010) *Mission Statement and Core Values*, Retrieved from: ttp://www.cbp.gov/xp/cgov/about/mission/guardians.xml

US Customs & Border Protection (2005) Protecting America: US Customs and Border Protection 2005-2010 Strategic Plan.

US Customs & Border Protection (2009) Secure Borders, Safe Travel, Legal Trade: US Customs and Border Protection Fiscal Year 2009-2014 Strategic Plan. P 2-4, 21

US Customs & Border Protection (2009) Performance and Accountability Report: Fiscal Year 2009, p. 80

Wu, A., & Zhang, X. (2009). Supporting Collaborative Sensemaking in Map-Based Emergency Management and Planning. Paper presented at the GROUP '09.

ZSambok & Klein (1997) *Naturalistic Decision Making.* Psychology Press.