Information for Battle Command

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Paper is very brief tutorial that explains principles drawn From Information Theory and Perception Control Theory that must apply to individual commanders and their organizations. The terminology is intentionally very simple, but quite rigorous.

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Information for Battle Command

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This paper explains the fundamental *principles of information that support* Battle Command and Information Operations in terms that commanders can understand and execute. The principles described here apply to any current or future force design.

Information for Battle Command provides the basis for decisions the Army must make to successfully execute at operational or tactical levels. Information has always been important, but the pace and scope of modern operations have turned information into a critical commodity that requires the same level of command attention as traditional combat resources. Commanders must develop a more formal understanding of information, their information needs, and the consequences for their command. Each commander must strike a balance between too much and too little, recognizing that there will be errors of omission and commission and costs associated with each.

The commander must have a principle information agent on whom he exercises battle command exactly as with maneuver subordinates -- who act as his agents in the their domains. He needs to make his intent clear, not in terms of old Commander's Critical Information Requirements (CCIR), but in terms of the decisions he expects to make and the informational needs expressed here. He needs the eyeball contact to insure this is understood, and that he understands the information agent's plan to carry out the intent, down one more echelon in that process. The subagents responding to the primary information agent need to understand the commander's intent, and their role in support thereof. This establishes minimal error with respect to the commander's objectives. The commander must establish his intent for information, just as with any other resource. The principle difference is that many information sources or transport means may lie outside direct control. This is a change from taking information for granted.

Joint Pub 1-02 defines information as the meaning that a human assigns to data by means of the known conventions used in their representation. Formally, *information reduces uncertainty in the decision space of the recipient*. The change in uncertainty is what distinguishes information from mere data. The distinction has several important implications.

First, the information must be relevant to the decision problem of the recipient. This applies to both the information content, and its timeliness. Information received too late to influence a decision is not relevant.

Second, the information must reduce uncertainty in the decision space, reducing or eliminating ambiguity created by disparate or conflicting data.

Third, while command decisions at the top of a hierarchy receive the most attention, many supporting decisions are made almost continuously throughout the

entire command. Thus, the information pertinent to each decision must flow from other parts of the hierarchy to the many decision nodes. Information flows top to bottom, bottom to top, and laterally. Organization, prioritization and maintenance of information flow for both command and supporting decisions is a command responsibility.

An individual's decisions and actions are directed toward changing the future. Specifically, they are directed at changing the current perception of the world into some desired perception, where the desired perception may include both the immediate and distant future. Information is required to support perception of the present, to project the future, and to perceive (track) progress along the way. Five perceptual modes have been identified that give rise to the information needs discussed below.

Information for intent establishes a subordinate's understanding of the superior's intent, at the highest and most pervasive level of abstraction, and with the least possible uncertainty or error. Information for intent establishes a basis for relevance, essential for converting subsequent data into information. The perceived intent is almost never the result of a single one-way transmission. Multiple exchanges occur until both parties are satisfied that the error is acceptable. Low error in the exchange is a value both parties must share. This two-way information exchange is so critical to all subsequent actions that a major part of Battle Command is devoted to its success.

Control Information addresses matters of primary and current attention, for which the individual will take immediate corrective action if the perceived *situation is not as desired.* Control has a very specific meaning in this sense (most closely related to the NATO definition in Joint Pub 1-02). Commanders, or their supporting authorities, must receive control information frequently enough to reconstruct a continuous and unambiguous estimate for those matters currently under control, and to maintain a good assessment of the situation with respect to those matters for which control is desired. Control Information is similar to CCIR, except exactly which information is critical for control is a dynamic that follows the attention of the recipient.

Individuals can actively control relatively few matters at any instant. The art of Battle Command includes judicious time-sharing of immediate attention and control, shifting attention when appropriate or necessary. Matters not under immediate control can be monitored with far less attention, and with less information.

Monitoring Information addresses matters an individual is not currently controlling, but which he may choose to control at any moment. So long as monitored variables stay within tolerable bounds, the commander will not attempt to affect them. However, if they move into areas of danger or opportunity, the commander will shift them to the category of "controlled perception" described above.

The information rate for monitoring any given topic varies considerably. At the upper bound, the rate is the same as for control -- although the monitoring is passive. The lower bound approaches that for alerting (see below). However, the total information rate may be very high because many more variables are monitored at any instant than are controlled. Monitored variables should be simplified into variables requiring low information rates until control is required/desired. Careful management of information rates for overall monitoring offers the greatest opportunity for improving organizational efficiency. Monitoring is rather similar to "routine" information, except for highly variable data rates and the potential for switch to control. Commander's guidance on monitoring and alerting information requirements should amplify SOP's, which are too static for the pace of battle envisioned.

Alerting Information permits a commander to ignore vast amounts of information until it becomes important enough to demand attention. Almost all the information available within a command at any moment from sensors or reports is irrelevant to those matters the commander is currently controlling or monitoring. If a commander's model of the environment is sufficiently stable, preset alerting criteria are established and no information on that topic is passed to the commander until the criteria are met.

The C2 system should employ a very large number of passive alerting pattern detectors operating in parallel. An alerting detector's job, whether machine or human, is to keep watch for a preset pattern and provide a signal that a given topic or situation requires immediate attention to deal with either danger or opportunity. The average overall data rate to the commander remains intentionally very low, but the peak information rate of an actual alert is very high. However, the total data rates to the various alerting detectors must be extremely high. It is a massive parallel/distributed processing requirement, arguing for domain-specific alert detection as close to information sources as possible to cut down the transport problem. Multiple-domain pattern detection requires data transport to central nodes which should be located to ease the transport requirement. These nodes may be relatively fixed or aligned with data transport nodes, since the alert patterns are predetermined. Post-detection alerting information is critical information. Commanders can greatly simplify their information requirements and supporting infrastructure by properly defining alerting requirements, particularly if the centralized monitoring function can be converted to decentralized alerting. Commanders must establish a balance between missed alerts and false alerts.

Sought Information provides rather specific information to clarify a perception and reduce ambiguity. This is usually because the information at hand is not adequate, or that current data are in conflict. The actual search is usually carried out by a subordinate and corresponds to "information pull." Each enquiry is usually quite specific, but widely disparate data may have to be combined to satisfy the request--which would not have been made if the answer were available in the first place. The volume of data is not especially high, but the short term information rate may be high if the enquiry is urgent. Searching is most common during planning; but may occur during execution, where a decision may be

deferred until the ambiguity is resolved. This condition is urgent, especially if control information is missing and is the object of search.

Exploration is a generic term to describe probing the world to "see what is there and how it reacts." It always involves action, the results of which are perceived by the commander and used to enhance/update the world model on which projections and decisions are based. Exploration is normally done when all the capacity for controlling is not in use. It involves control of probing agents, while redirecting sensors and report sources, and modifying guidance for processing. Exploration is a potent form of learning that requires a flexible information system. Reconnaissance and opposed exercises are forms of exploring.

Collaboration. Lateral information flow is also essential for organizational success. The information needs can be identified from the above discussion, with the caveat that one person's information is another's data, and vice versa. A peer's intent forms useful input in formulation of one's own intent. The principle of Unity of Command shows that two commanders should not require controlling information about exactly the same thing, although one may monitor another's control. Lateral transfer of monitoring or alerting information is important, but the recipient must consider carefully whether the rate of externally generated information is sufficient to support control, as discussed above. It is purely a matter of sufficiency for control, not ownership of the information sources.

Information Overload may take several forms, most of which are manageable by technology or procedure. Most frequently, information overload is really data overload caused by improper filtering and/or abstraction. When this occurs, the burden of rejecting or converting useless data falls directly on the user, who has progressively less time to deal with it in an urgent situation. There are two general strategies for managing the problem: knowing and filtering for data of immediate importance (i.e. distinguishing control information from all else); appropriate aggregation and abstraction of data to exactly match the problem at hand. Monitoring and alerting employ both strategies to reduce both the number of activities controlled at any instant and to reduce extraneous data. Attempting to control too many activities at one time may produce multiple overload problems.

This paper results from informal collaboration between the US Army Training and Doctrine Command and the Canadian Defence and Civilian Institute for Environmental Medicine, and represents the opinions of the authors. The fundamentals described herein are based on known principles of Information Theory and Perception Control Theory as applied to goal-seeking organizations, most specifically to Battle Command of military forces. Each of the points raised is subject to considerable expansion, in terms of both its scientific underpinning and its application. Questions or comments should be directed by e-mail to the authors: 'cunningb@monroe-emh1.army.mil' and 'mmt@ben.dciem.dnd.ca'.