A New Perspective for the Military: Looking at Maps Within Centralized Command and Control Systems

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Introduction

As an organizational structure, centralized command and control (C2) faces an increasingly important challenge within the contemporary military. The current C2 system provides exceptional benefits to the American warrior—a centralized location for information on operations, instantaneous transmission of data, and high quality maps and images to name just a few. However, the increasingly sophisticated systems of computer support that form the backbone of the current C2 system can also lull commanders and soldiers into believing that centralized C2 systems contain more information than they actually do and, worse, to seduce military personnel into partially ceding the autonomy needed to make effective decisions in combat.[1] In part, this seduction occurs because such computerized systems allow centralized C2 to collect, process, and distribute enormous amounts of data scientifically and efficiently. Armed with such large volumes of data and the ability to handle and distribute it efficiently, centralized C2 systems have accumulated a large amount of authority within the military. As technological products, maps, a vital portion of C2 systems, are valued because they are thought to represent accurate scientific displays of information and physical reality. One of the key problems with the maps produced by centralized C2 systems is that people forget the maps are models of reality, not reality *itself*.[2]

The Problem with Maps

Military maps in particular, while they are built from multiple data sources also have serious limitations. First, they are comprised of a mosaic of geographic surveys and information combined with lines-of-communication information and cultural information.[3] Then, layer upon layer of information—some more complete or up-to-date than others—is brought together within the computer systems controlled by centralized C2 systems to provide annotated maps that display information about a specific topic and area—Serb radar locations around Kosovo, for example. However, even these compiled maps, while considerably more sophisticated than simple displays of terrain, do not contain *all* of the information about a certain area. They are selective representations constructed for a particular purpose within the centralized C2 system. They contain, for instance, only the layers of information that centralized C2 analysts and commanders consider important or salient—bridges, but perhaps not the locations of community basketball courts; roads, but maybe not the location of neighborhood cafes; telephone lines, but possibly not the presence of soccer fields. In addition, each piece of data that goes into a map is collected and recorded at different times and via different sources.[4] My primary argument is that the characteristics of these computer generated maps exacerbate the organizational problems associated with the centralized C2 system itself, thus encouraging an over reliance on centralized sources of information.

The more military personnel understand about how maps function as both art and science, the better equipped the armed forces will be to deal with the challenges of centralized C2 systems. Given the nature of centralized C2—which vests power and decision making in a centralized, hierarchical organization; encourages faith in scientifically derived systems of map making; and supports a cultural belief in the infallibility of technological systems—military maps are imbued with an exceedingly high level of authority, accuracy and confidence. However, as stated earlier, maps are *not* reality.

Maps have been a blending of art and science since the first survey of an area was conducted and the results represented on a flat surface.[5] Cartographers are charged with the daunting task of creating a two-dimensional model of a three-dimensional world. They must also choose a scale at which to compose the map and decide how much detail will be useful and what to leave out. Moreover the cartographer will also have a purpose in mind when making the map. Within the military, maps are selectively constructed for the purpose of flying a plane, driving a tank, or walking a platoon.[6] This purpose, then, determines what type of information is included and, equally important, what information will be left off a map.

In today's Joint Operations Center (JOC), which serves as the operational nerve center of C2, most maps are digitally compiled and constantly annotated by C2 analysts, who chose what is important to include and what information can be omitted. The annotations, moreover, are written with a specific purpose in mind—for instance air order of battle or troop dispersion. Each map's annotations are digitally recorded and presented to the commanders or operators who are trained to rely on the information as a primary decision-making tool during a mission. In this complex context, there are many layers of selectivity and constructions going on that disappear when assembled into the final representation of a digitally produced map. In such situations, troops accustomed to relying on C2 systems for a centralized flow of information must be able to make their own decisions about the accuracy of maps they are using and to understand the limitations of these representations. Ideally, all military map users need to understand how maps are constructed and recognize that maps are selective displays that show the world with varying degrees of accuracy.[7]

Proposed Approaches

In this paper, I suggest three strategies for helping the military maximize the strengths and minimize the weakness inherent in the C2 system and its reliance on maps: First is the need to stay committed to the doctrine of centralized control and decentralized execution,[8] a commitment that could productively influence how maps are generated and used within the C2 system. Second, is the need to revise systems of map-making employed by the military so that they are truly user-centered. Finally the military needs to balance the efficiencies of a centralized C2 organization with the concept of communities of practice to ensure military map users can make the most effective decisions possible and become mapmakers themselves by feeding information back into centralized mapping systems. Before discussing the solutions I'll first delve into the problems inherent in the centralized C2.

The Paradoxical Role of Maps in General and in Centralized C2 Systems

Both a table of data and a map about the enemy share a common characteristic: they are signs that distort the information they signify. This may seem simple; of course symbols on maps or data tables are *not* what they signify.[9] Enemy troops are not *on* the map or *in* the raw data; they are represented as symbols on a screen. Within C2 and military maps, however, there is often an assumption that the symbology or data on a map is completely accurate. A map's symbology *must* distort the data in an effort to present a coherent informative picture. As Mark Monmonier (1996) says

> Not only is it easy to lie with maps, it's essential. To portray meaningful relationships for a complex, three-dimensional world on a flat sheet of paper or a video screen, a map must distort reality. As a scale model, the map must use symbols that almost always are proportionally much bigger or thicker than the features they represent. To avoid hiding critical information in the fog of detail, the map must offer a selective, incomplete view of reality. There's no escape from the cartographic paradox: to present a useful and truthful picture an accurate map must tell white lies. (p. 1)

Not only is the visual data presented on maps fundamentally distorted visual information, but the data *behind* that visual representation is distorted as well. Map data used by centralized C2 is compiled from numerous sources and at various times: intelligence assets, situation reports of friendly troops, meteorological and geographic data, etc.[10] All these sources of data also simplify, truncate, and compress information in order to record it, store it and then to deliver what the system's analysts have deemed relevant information. Computers must be programmed to do this filtration of data, because the military produces so much data that humans could not process it all. This storing and filtering of data is a strength of using computers within the system; these machines can sort data quickly using pre-selected protocols and fit it into pre-determined categories.[11] The weakness inherent in this process is that data is also inevitably lost, or at least hidden, from the end-user of the system. This weakness represents a key paradox of maps generally and more specifically within the centralized C2 system: the maps of centralized command and control—like any maps—both inform and hide information, they are both accurate and distorting.[12] Failure to remember this paradox in a centralized C2 may doom American forces to a "blind faith in military technology"[13] and failure in operations.

The map is a perfect place to start an exploration of the paradoxes of cartography and the constraints of centralized command and control. To begin this exploration I will discuss how information from various sources is layered onto military maps. Next, I will describe how maps gain authority within military contexts. Finally, I will survey a few of the key problems of maps compiled and used in such contexts.

In this analysis, it will become clear that the line between a map and centralized command and control system is difficult to discern. The entwined relationship between cartography and C2 exacerbates the cartographic paradox and extends it into the world of military command and control. Centralized command and control is an organizational structure that relies on more than just maps on plasma screens. C2 systems are responsible for compiling a wide variety of data in an attempt to understand the disposition of friendly and enemy forces. Centralized command and control is responsible for collecting, vetting and summarizing this data; and then combining it to provide a "common operating picture" for commanders. There is no shortage of data within this system, but the quality and age of data and centralized command and control's ability to process it need to be called into question constantly. C2 has always been a system that has too much data and too little data at the same time. Compiling so much information in command centers—while efficient in centralizing and standardizing a view of battlefields—serves to diminish the autonomy of fielded forces. One result is that commanders in the field make fewer decisions, because they do not have the same "God's eye view" that the command post *seems* to have. Centralized C2 may also encourage command posts to make more decisions, armed with an extraordinary collection of information, but not to rely on more localized views of a situation.

Although maps have become more exact with advances in cartography, it is worth noting that Monmonier's "little white lies" are always present. To teach a map as a true representation of reality omits not only the vagueness of the symbols but also the inexactness of the data that those symbols represent. Data itself is not knowledge. Data allows the user to build a synthesis of information, to tell a visual story that could be labeled as knowledge. In the following sections, I will explain how military maps are constructed in a way that exacerbates the problems associated with centralized C2 systems, how maps as documents gain credence and authority within such systems, and some of the problems that can accrue with these combined processes.

How Military Maps are Constructed

Mapmakers have always made choices about what goes on a map and, perhaps more importantly, what is left off. The advent of computers has changed the sources from which map data is gathered and the methods by which such data is combined. Today high quality overhead imagery, Global Positioning System data, and annotations from C2 specialists are combined to provide the warfighter with digitally created maps.

In the quest for ever-more accurate representations of reality on maps, satellite imagery has become the preeminent tool in the military cartographer's toolbox. Survey imagery from the space program has formed the basis of the geographic layer of data on today's maps.[14] Military imagery is not only collected in the visual spectrum, but across the electromagnetic spectrum. Imagery data about the enemy is also of particular interest within centralized C2 contexts. This imagery can come from aircraft, manned or unmanned, or from satellites. Whatever the source and the subject, however, imagery is not without limitations.

A photo's age is one of the biggest imagery limitations. As soon as a particular image is captured, it becomes obsolete, frozen in time while the world it represents continues changing—either slightly or drastically. These changes may occur naturally or as a result of human activity. If an enemy is aware that a building has been targeted, he may try to obscure it from view or alter its shape to confuse an aircrew trying to distinguish ground targets.[15] Aircrews and intelligence personnel who rely too much on imagery may fail to account for changes or be hesitant to apply their own judgment to the battlespace. If the images seen through a targeting pod on an aircraft at the time of an attack disagree with the pre-mission target photo then an aircrew might decide not to drop their bombs and, thus, fail to support a unit on the ground. Or worse they might mistake the target and cause friendly casualties that could perhaps be avoided with more current imagery.

Even imagery from near-real time streaming video from a Predator or another surveillance platform causes confusion. The angle from which the Predator views the target, for instance, may differ from that of the study photo thus causing the crew to begin questioning which photo is more real. Intelligence personnel trying to perform Battle Damage Assessment (BDA) can also lose track of which representation of reality is most accurate.

The ability to layer digitized imagery on geographic data and display in a simulated three-dimensional perspective has resulted in mission rehearsal systems, such as Lockheed's TOPSCENE. These systems provide three-dimensional views by overlaying photos of a target area onto available cartographic data. Mountains that were originally flat on a photo are given the illusion of depth when rendered according to data on contour maps. To simulate an exercise or mission in three-dimensions before it is undertaken is a phenomenal advantage for the US military. The modern mission rehearsal systems provide amazing realism for the crews to see before they fly.[16] Paradoxically, however, such realism, can seduce crews into thinking a mission will resemble exactly the rehearsal conditions. Missions are always different from the rehearsals; things on the ground continue to change after the photos are taken and will continue to change while the mission is going on. Operators need to remember that no matter how good the simulation, it is still only training.

The Global Positioning Systems (GPS) has done a great deal to eliminate the confusion of different geographical coordinates and multiple models of reality in military cartography. GPS provides a standardized model of geographic position and eliminates potential confusion over which weapon platform has the most accurate navigation system. GPS has become the system that the military trusts to place a building, tank, aircraft or infantryman in a specific location at a specific time.[17] Along with overhead imagery, the military uses GPS as a primary system to define the geography of the modern battlefield. GPS battlefields are translated from three-dimensions to two-dimensions in maps, charts, and photographs and back again.

Although GPS has revolutionized warfare by transforming Cold War relics like the B-52 into precision-guided weapons platforms and allowing air and ground forces to define terrain using the same coordinate system, it is susceptible to attack by a determined enemy. The signals from the GPS satellites are weak and vulnerable to jamming.[18] When clarity is most needed from GPS coordinates, military operators could receive unclear results. Unclear coordinates could eliminate the ability to use all satellite-guided bombs. Precision-guided munitions that rely on GPS coordinates need highly exact data if one side of a building is to be destroyed and not another. For the troops on the ground calling in close air support (CAS), a bomb that falls on the wrong side of a building can mean friendly troops killed instead of enemy troops.[19] If GPS coordinates are jammed in a conflict and cause errant bombs, or even worse friendly casualties, then GPS bombs will loose the trust of the military using them.

Among the final layers of information added to military maps are the annotations added by the intelligence community within the centralized C2 system. Intelligence, like cartography is part art and part science, and no information about the enemy is completely accurate. Even if the intelligence information about a given surface-to-air missile system is accurate in terms of location; human factors that determine how that system will be used will change constantly.[20] Intelligence analysts, operators and commanders must remember that there are flaws in all of the symbols that are used on a map—a missile on a map may represent the actual launcher or it may represent a radar site.[21] Now in the age of the personal computer, annotations are made electronically and look as authoritative as the original set of data built into an electronic map. It is not just the cartographer at National Geospatial Intelligence Agency that makes the decision about what goes on a military map, but every intelligence analyst or operator that makes annotations on maps and charts, either electronically or the old fashioned pen and pencil method.

How Military Maps Accumulate Authority within Centralized C2 Systems

One of the primary methods by which maps accumulate authority within centralized command and control systems is through the economic expenditures made in purchasing, assembling, and creating a mapping system. Arguing against a C2 system or the map constructed by a sophisticated and expensive computer system may become difficult, not only because of the layers of data that go into maps, but also because of the money that has gone into the system itself. It is, in part, the accumulated economic force of those expenditures that lends authority to military maps. When the centralized C2 system produces a map, there is the general recognition that millions of dollars and thousands of engineering hours have gone into that product.[22] Given this context, it becomes increasingly difficult for a person to question the accuracy of a map. To do so, he or she must resist not only a potent belief in the products of science, but also the belief that leaders can *always* make the best decisions through scientific products. The authority lent by money and a belief in science may override the judgment of the people in the field.

Visual story telling is a second means by which military maps accumulate authority within centralized C2 systems. Visual narratives help change maps from teaching tools that represent terrain to tools that allow centralized command and control to direct the movements of resources. The use of visual narratives represented on maps begins from the start of a warrior's training. The plan for how battles are to be executed is told through maps displayed in command posts. In World War II, for instance, flight maps were used not only for navigation, but also to control the flow of forces in the air.[23] The route line drawn by hand originally and now generated by computers on mission planning maps visually tells the story of the commander's intent. The intended effect of such visual narrations of battle plans is to control the way a battle unfolds. But this approach has weaknesses. Deviation from the route of flight becomes more difficult, not only because of the safety of flight concerns in large package operations, but because the line on the map *becomes* the story of how the mission will unfold regardless of how the enemy reacts. The authority of the map as a command and control device can make operators hesitate before deviating from the plan to complete the mission.

A third important way that maps accumulate authority in a centralized C2 system is through their use of potent symbols. The straight lines, boxes and other symbols used to signify the dispersed enemy represent meaning that helps to determine how a war will be fought. This symbolic system is necessary, but not without flaws. Historically for instance a line has been used as a mark to divide major forces in a conflict. The line, however, does not symbolize the *exact* location of the enemy. Rather the line represents an approximate location on the map that takes into account multiple variables such as its location near other symbols, significant geographic features, and the size of the line itself. Military history, however, invests the symbol of the line with great meaning: anything on the opposite side of a battle line is the enemy and can, or worse should, be destroyed.[24] Such a conceptual or symbolic approach, however, may not be the best to use in the contemporary military situation. With the invention of precision-guided munitions and the ability to avoid a great deal of collateral damage, a single line may not be a symbol with adequate representational power. In modern battles, troops are not always arrayed along a single battle line. Rather, they may be displaced in small pockets, individual buildings in different locations, or small cells in widely dispersed locations. Moreover, targets can now be defined more exactly to allow the use of precision-guided munitions. As targeting has become a more exacting art form, the symbology of maps also needs to change to be more exacting.

A fourth way in which maps accumulate authority within a centralized C2 system has to do with the digital intelligence annotations that are added to them. Military commanders have become so reliant on computers and communication technology that they may believe digitally delivered versions of battle information even if they are inaccurate, old, or wrong. In short, the information carries a certain validity simply from being the most current version of the map displayed on the command and control system's monitor. Digital annotations gain more authority as well when they are entered onto a computer generated mapping system. Although these annotations are human interpretations and subject to human error, they come to share the same look and feel of the original geographic or physical data on electronic maps. Unlike their historical counterparts—

made visible by grease pencil scrawlings on acetate overlays in the command post – digital annotations look and feel the same as all other data. The potency of these digital annotations is also multiplied by repetition and distribution in computer systems. Each map on every monitor throughout an entire military theater can show the same annotations, thus multiplying the power of a single interpretation. The accumulated force of these annotations—what appears to be scientifically derived data—is difficult to counter with human judgment from a frontline operator.

The fifth and final way, that centralized C2 maps accumulate authority has to do with the ways in which these documents are linked with the project of science and acquire the force of scientifically derived truth. The photographic images that are used to create centralized C2 maps provide a good example of this point. Since the 19th century, photography has been associated with the project of science.[25] Photography and other imaging techniques provide a way of capturing truth, recording reality, and identifying the physical presence of characteristics. People who believe that photography captures reality absolutely may not recognize that a photograph only shows what the particular imaging technology can capture. However, it is clear that photographic imagery, like all cartography tells “little white lies”. Most photographic imagery, for example, cannot show what is inside a building. In such cases, interpretive symbols and labels are added to military maps to indicate whether buildings are targets or not. However, the data used to attach a label to a particular image can easily be inaccurate, or the symbols used to represent them may be ambiguous. The bomb that destroyed the Chinese embassy during Operation ALLIED FORCE, for example, hit exactly what the B-2 crew meant to hit. The photographic image and the location of the building were accurate, but the building was mislabeled as a target.[26] The data was wrong yet the centralized C2 system failed to recognize the human error. This event is a perfect illustration that “fog of war” does not go away in the information age.

Imagery is an excellent tool for the military. Like all tools, however, imagery has limitations. Commanders need to remember the limitations of imagery when planning and executing an operation.

Some Problems with Military Maps within Centralized C2 Systems

The complexity of centralized C2 systems and the role of maps within them generate several important problems. First among these is the effect of centralized authorization. The centralized command and control system relies on the rapid collection, managing, and distribution of data for the individuals who need it. This system has evolved out of multiple legacy systems merged to create the digital networks that now form the backbone of command posts around the globe. Operating in the context of this system, commanders and operators alike are faced with the dilemma that there can be too much information at the same time there is too little. Overwhelmed by the quantity of data, field commanders may come to place too much faith in the information delivered by centralized C2 systems and maps. They may, even worse, stop searching for critical data on their own.

The second problem associated with maps created in centralized C2 systems has to do with the nature of military decision making and its timing. Commanders don't always have the luxury of time to sort through all available data to find the critical data.[27] They have years of experience at making decisions and quickly are able to analyze from the incomplete knowledge of a situation what they want to do to accomplish the mission. Making decisions without all of the data is nothing new for commanders. However, the sheer amount of data accessible through today's C2 systems may lead the commander to second guess himself and wait for more data, when a decision needs to be made quickly—as in a search and rescue mission.

A third problem associated with maps has to do with their essential incompleteness. Although they are clearly sophisticated and highly textured representations of reality, they still "lack the rich stimuli that humans depend on to develop such things as judgment."[28] Data on enemy forces, for example, may tell the commander how many enemy tanks are in the field, how old the tanks are, what kind of ammunition the tanks can fire, what kind of ammunition is in the enemy arsenal, etc. But the commander alone must gauge the loyalty of troops, the immediate likelihood of collateral damage, the presence of unanticipated factors, and other pieces of data perceived as critical. In such situations, the commander can neither hesitate to make a decision, nor trust that the modern C2 system will deliver the needed data at the proper time.

Communication Approaches to Minimizing the Problems with Maps in C2 Systems

The military's centralized C2 systems are complex overdetermined systems that, for many reasons, tend toward the consolidation of power and information. In part, military maps and the expensive, sophisticated computer systems within which they are made and distributed contribute to this tendency. Military leaders understand some of this complexity, having participated in the dynamics of centralized C2 systems, and having observed the centripetal tendencies of the system. Partly for this reason, the Air Force has adopted a doctrinal provision designed to address the complexity of the centralized C2 systems: centralized control and decentralized execution. This provision allows commanders to focus on their priorities by delegating some decision making locally. The Air Force Basic Doctrine pamphlet notes, "Delegation of execution authority to responsible and capable lower-level commanders is essential to achieve effective span of control and to foster initiative, situational responsiveness and tactical flexibility."[29] Centralized command and decentralized execution attempts to maintain a balance between the decisions a high level commander should make and the decisions he should allow subordinates to make. Decentralized execution encourages commanders to allow decisions to be made at the lowest possible level in the chain of command. Doctrinally and in training, the Air Force, and the military as a whole, need to remain committed to centralized control and decentralized execution to ensure the flexibility necessary for successful operations.

Certainly one of the factors encouraging the commitment to centralized control and decentralized execution is the growing threat of asymmetric warfare. Asymmetric warfare occurs when enemies of very unequal strength face each other and the weaker or these employs unconventional methods to fight.[30] Asymmetric warfare demands the flexibility of centralized command and decentralized execution. A contemporary example is occurring right now in Iraq where the insurgents have chosen alternative methods of fighting the US forces—using strategies designed to give them an advantage and adopting a plan of battle that differs from what the U.S. has planned for.

The American military may *want* to fight a war using sophisticated computer based communication, but determined enemies can force a very different and decentralized approach to the conflict.[31] Because asymmetric enemies—and almost any opponent of the U.S. would now be considered asymmetric—could exploit the weaknesses of centralized C2 technology and mapping systems, the Department of Defense needs to recognize the limitations of centralized systems and acknowledge the need for more decentralized execution. Centralized C2 systems are only one of many possible tools for fighting a war. Such systems cannot become the *reason* to fight a war a particular way. Technology is a means, not an end in the realm of warfare.

Although the doctrine of centralized control and decentralized execution has proven more flexible and successful in dealing with the kinds of conflicts the U.S. military faces in the world, the centripetal tendencies of centralized C2 systems still exert a powerful force with the contemporary military establishment, certainly in the specific case of maps. From my studies in communication, I can suggest two ways of resisting these tendencies and encouraging the balance of centralized control and decentralized execution: user-centered design and communities of practice.

User –centered Design

User-centered design is based on the understanding that humans can and should shape technological systems rather than simply adapt to them.[32] Within a military context, a user-centered design approach would suggest that the map user and the situation the map user is in should be balanced with the centripetal tendencies of C2 systems, thus supporting a balance between centralized control and decentralized execution. Too often, however, digital maps produced in a centralized C2 system seem to be designed for efficiency of the C2 system and not for effectively accomplishing the military mission in a local context.

Currently digital maps are part of a system designed to provide accurate and timely knowledge to decision makers at all levels. Disconnects between the designers of the military's computer based mapping system and the users of military maps are not unusual. The designers assume that the users fit into a certain mold and will use the system in certain ways. The reality is that the users in field situations often end up manipulating the digital system in ways that it was not designed for in order to accomplish the mission. Such problems might be effectively addressed through user-centered design and testing approaches. User-centered design recognizes that computer systems must work, but they cannot accomplish what humans can do. It is the *people* that accomplish the mission, not the centralized map making.

In his book *User-Centered Technology,* Bob Johnson describes processes of technical writing, but could easily be talking about what is needed in highly centralized command and control on which the military depends for much of its planning and execution of operations. He notes,

> …the study of … texts is not a hard science. Instead it is a human/social science that gains understanding from the observation of human nature. From … observations … within the actual contexts of use, we can develop the strategies that technical communicators can use … everyday... We need flexibility in our methods to meet the demands of changing technology and fluctuating contexts. The methods of hard science will not be appropriate at such early stages of understanding, because hard science tends to be concerned with the "ideal" and writers operate in the less stable world of the contingent.[33]

Like writing, the design and use of maps within centralized C2 is not a hard science. The users of C2 systems, too, cannot be concerned with the ideal world but must deal with the contingent. The human and social science of war should not be wholly dependent on a technical system that has pretty displays and animates the battle map as it progresses, like some PowerPoint presentation gone mad. As the technology of war has become more precise, the educational tool of computer based battle maps needs to become more sophisticated as well. A user-centered system for map-making in the military might allow operators to annotate or change maps based on their local experiences and the military situation—and those updates could even have precedence over distant sources. A more user-centered system might also involve C2 system operators in using, testing, and giving feedback on the computer systems used to create digital maps for military use.

Communities of Practice

Communities of practice[34] might also be a valuable communication concept for military-map designers and users. Communities of practice are groups of users, with all levels of experience, who share information on how a system functions and how to make it function better. Within a military context, communities of practice—because they focus on the input of information and expertise of individuals—could serve to resist the centralizing tendencies of C2 systems and establish a balance more characteristic of a centralized control and decentralized execution environment. Communities of practice could be used to inform military map designers about the different ways troops in the field employ maps, for example, and thus serve to shape mapping tools.

Brown and Dugid, in "The Social Life of Information" use Xerox technical representatives (reps) who repair the company's copiers at customers' locations as an informative example of a community of practice.[35] Although the process for repairing copiers may appear straightforward, in practice the reps often deviated from the procedures to get copiers working again. Even when following the procedures, the reps were frustrated because they weren't informed by the documentation why to do a task, they were just told how to do the task. The company provided training was not enough to fix the machines, but the reps had a social process through which they discussed possible solutions and combined individual expertise to solve difficult problems.

In some regards, communities of practice are already operating within many of the centralized C2 system at each command post. Military operations, like any large endeavor, involve highly collaborative efforts. Military map-making is also collaborative in nature—geographers, cartographers, intelligence analysts, photo interpreters, operations specialists, etc.—all create the socially constructed documents of military maps. These individuals bring multiple perspectives and understanding to the task of reading and using military maps. The military also encompasses a broad range of experience levels: some soldiers have served in Desert Storm, others, are cutting their teeth in Operation IRAQI FREEDOM. Each individual within these various military communities learns and operates differently and brings different understandings to the tasks they perform. In this difference is found the strength of a community of practice. Unlike effective communities of practice, however, individuals and groups involved in military projects do not always share information on how systems are working and functioning—especially from the bottom up. This problem is often characteristic of highly centralized C2 systems. In such systems, not every individual, intelligence center, or command post has systematic input into the design of centralized C2 mapping systems.

The concept of communities of practice could help the military community focus on the fact that how a map is *used*, by *whom,* and in what *circumstances* is just as important as how it is *created.* Along with this recognition might also come an acknowledgement that centralized systems of data collection which fail to support and encourage systematic local input may be too large, unwieldy, and unfocused to accomplish complex missions in situations that demand more decentralized decision making. Focusing on the strengths of communities of practice might help military map designers recognize the value of feedback from troops who use digital maps as tools for different kinds of tasks and, thus, address some of the limitations of maps within centralized C2 systems.

Focusing on communities of practice might also help the military do a more precise job of identifying the right knowledge to teach at the right time to the right person and to identify those situations in which human experience should override the digital technology. Finally, focusing on communities of practice could help military map designers and users recognize the value of individual experience and expertise, thus providing a counterbalance to the centripetal tendencies of C2. Given such a context, it could become easier for individuals to rely on experience and expertise when making a decision about whether or not to override a scientifically constructed military map. That decision can be the difference between life and death on the battlefield, but the community of practice can be confidant to make that decision.

Conclusion

I am not advocating abandoning the sophisticated computers and mapping systems that contribute to the centralizing tendencies of command and control. Rather, I'm advocating an awareness of the inherent limitations of such systems. I believe that educational efforts are vital. Training programs, for instance could be designed to inform all personnel of the complexities and limitations of modern centralized C2 systems and the ways in which the tendencies of such systems operate—especially in connection with the design, analysis, and use of military maps. Such programs should also include instruction in the user-centered design of maps and mapping systems, as well as instruction about communities of practice and how they could contribute to map reading and design efforts.

Young military leaders should not feel controlled or driven by technological systems; instead they should feel they have an impact on the design and use of military maps within a system of centralized control and decentralized execution. Using the concepts of user-centered design and testing, and communities of practice, the military can educate young leaders who understand maps as highly constructed visual arguments, who can see the "little white lies" that all maps tell, and who can help maintain the balance between centralized control and decentralized execution.

Notes

1. John Gentry, "Doomed to Fail: America's Blind Faith in Military Technology," Parameters: U.S. Army War College Quarterly 22, no. 4 (2002-03): 88-101.

2. Mark Monmonier, *How to Lie with Maps*. (Chicago: University of Chicago Press, 1996) 1-4.

3. Alan MacEachren, *How Maps Work: Representation, Visualization, and Design*. (New York: Guiliford Press, 1995) 219-222.

4. Mark Monmonier, *Spying With Maps*. (Chicago: University of Chicago Press, 2002), 3-16.

5. Mark Monmonier, *How to Lie with Maps*. (Chicago: University of Chicago Press, 1996), 43-49.

6. John Collins, *Military Geography For Professionals and the Public*. (Washington, D.C.: Brassey's, 1998), 3.

7. Mark Monmonier, *How to Lie with Maps*. (Chicago: University of Chicago Press, 1996), 113-122.

8. Air Force Doctrine Document 1, (17 November 2003), 28-30

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10. John Gentry, "Doomed to Fail: America's Blind Faith in Military Technology," Parameters: U.S. Army War College Quarterly 22, no. 4 (2002-03): 98-100

11. Ibid., 94-98

12. Dennis Wood, The Power of Maps (New York: Guilford Press, 1992)

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