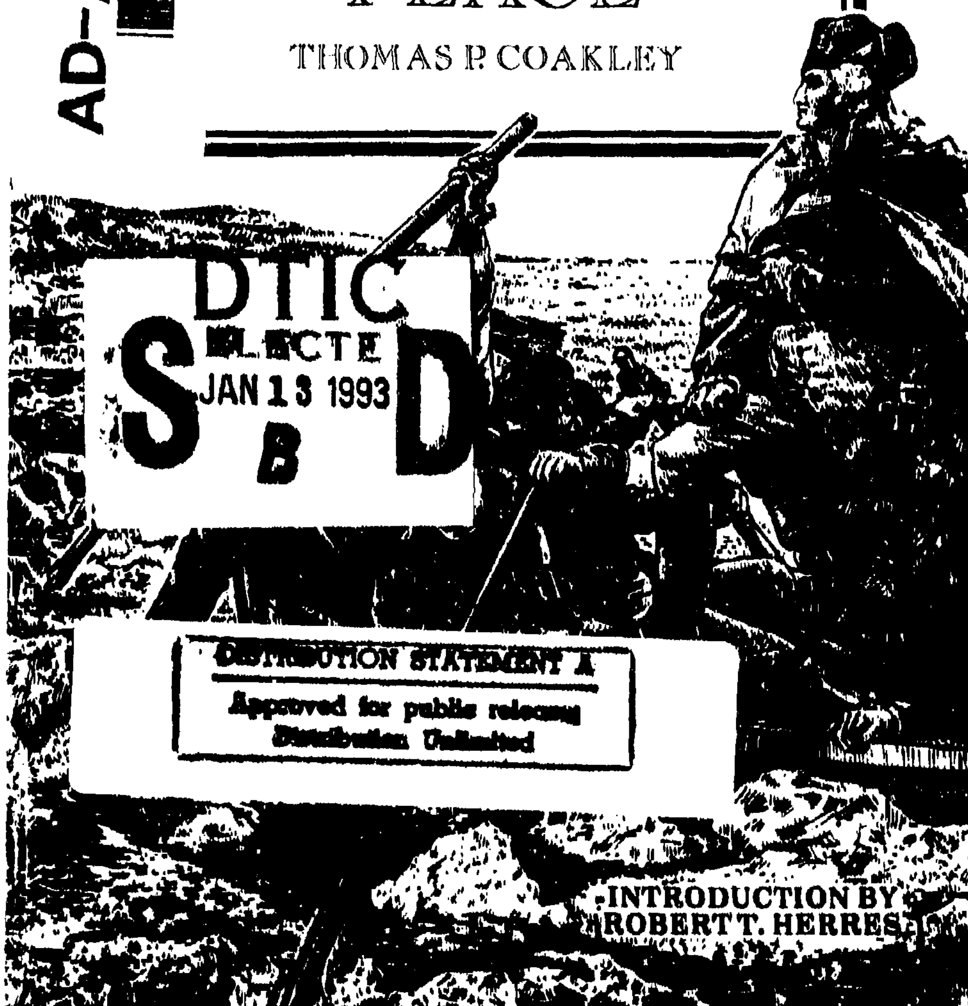
COMMAND AND CONTROL FOR WAR AND PEACE

THOMAS P. COAKLEY



The Command and Control Research Program (CCRP) is a part of the Institute for National Strategic Studies at NDU. Established in 1983, the CCRP directs research on emerging national issues in command and control, including ways to improve instruction on this vital topic in Joint Professional Military Education. The CCRP provides an active constituency within Joint Professional Military Education for command and control while performing a "bridging" role between the Joint doctrine, operational and engineering, and technological communities. The CCRP also promotes general understanding of command and control through efforts such as this book. The global scope of command and control and the three-dimensional interaction of command, control, and the world-wide communications that support the command and control process are symbolized by the CCRP logo.

The cover illustration is based on *Washington Crossing the Delaware*, an 1851 oil on canvas work by Emanuel Gottlieb Leutze. John Stewart Kennedy gave the painting to the Metropolitan Museum of Art in New York in 1897.

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WITH AN INTRODUCTION BY

ROBERT T. HERRES

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For Kathy

Today's world is one of exploding information, of the potential for making smarter decisions faster and of using smaller forces overall to respond quickly—hopefully in time to head off direct involvement in conflict.

—ADMIRAL BOBBY R. INMAN, U.S. NAVY (RET.)

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FOREWORD

With the passing of the Cold War, the United States is leaving a forty-year period of great danger but a degree of certainty and entering a new era of reduced danger but greatly increased uncertainty. Leaders face the challenge of meeting growing responsibilities with fewer resources and people, in less certain surroundings, and in even more distant corners of the globe. In this post-Cold War era, the need for effective command and control (C^2) is more pronounced than ever.

In *Command and Control for War and Peace*, Thomas Coakley attempts to resolve what former Vice-Chairman of the Joint Chiefs of Staff General Robert Herres calls in his introduction "the mystery that seems to cloak the world of command and control systems." Accepting this challenge and encouraged by General Herres to write a book explaining command and control in plain English, Coakley has demystified the arcane C^2 world. With common sense and with ordinary historical illustrations, he leads the reader to a clear understanding of the human, organizational, budgetary, and procedural elements fundamental to command and control.

This broad view enables the reader to deal better with communication technology and its often bewildering jargon. It also helps him understand why

C^2 has grown by steps to what many now call "C^3I^2"—command, control, communications, intelligence, and information. It encourages the reader neither to fear the technical side of command and control nor to expect perfect C^2 in combat. For all those reasons, this book should be useful to those having to deal with the extraordinary responsibilities of modern warfare.

J. A. BALDWIN
VICE ADMIRAL, U.S. NAVY
PRESIDENT, NATIONAL DEFENSE UNIVERSITY

ACKNOWLEDGMENTS

The list of people to whom I owe a debt of gratitude for help with this book is extensive. It includes Dr. Fred Kiley, Director of NDU Press, who conceived the absurd notion of an English professor writing a book about command and control, and Dr. Anthony G. Oettinger, Chairman of Harvard University's Program on Information Resources Policy, who not only seconded Fred's idea but also spent three years helping me research and think about the material in this book and a previous one.

The Program on Information Resources Policy, which Dr. Oettinger chairs, was established in 1972 with a novel funding mechanism. Because it would be dealing in areas of high stakes and corporate and political self-interest, it set out to establish a broad base of financial support from all sides on an issue that the Program addresses. The Program has participants from all segments of the information business, as well as organizations that are consumers of information. Competing industries and competitors within industries are represented. (Contributors current to publication of this book are listed on page 215.)

I'm grateful also to Brigadier General Erlind G. Royer, Dean of Faculty at the Air Force Academy (USAFA) and Colonel Jack M. Shuttleworth, Head of the Department of English, who gave me the time to work on the project; to Lieutenant Colonel R ner H. Schaeffer and his staff at the USAFA Libr ry—especially Mr. Robert E. Jennings and Ms. Florence Klemm—for their friendly and enthusiastic support of my research; to NDU's Dr. Stuart E. Johnson, Director of the Strategic Concepts Development Center, and Dr. Tom Julian, Director of Command and Control Research, who financed the project; to Dr. Oettinger's colleagues and staff at Harvard, especially John F. McLaughlin, Oswald H. Ganley, Claire Bishop, Maria Waite, and Mary Walsh, who helped with everything from developing ideas to proofing manuscripts; to Lieutenant Colonels Paul Taibl and John Clements, Ms. Laura Hall, and other members of the NDU Press staff—especially my very patient, thorough, and accommodating editor, Ms. Jan Hietala; and to my good and generous friends Jim Gaston and Doris Miller, who read, critiqued, and made very helpful suggestions throughout my work on the project.

Finally, I owe a special "thank you" to my wife, Kathy, and our children—Katrina, Tom, Sue, and Bekka—for their encouragement and support at all times, but especially over the past three years, during which period they spent an extraordinary amount of time hushing each other—"sshh . . . Dad's writing"—and rushing me to and from the airport. And, on top of all that, they read the manuscript.

Introduction

The mystery that seems to cloak the world of command and control systems has confounded a good many military people and defense specialists for years. The reasons for this are as elusive as are the hopes for ready solutions to the problems that constantly plague the stewards of these systems—their architects, managers, and users.

Although much has been written about specific command and control system problems over the past two decades, there is surprisingly little in print that addresses this business from a broad, conceptual viewpoint. Each of the practitioners tends to see the process from perspectives that vary widely and at the frequent expense of the balance such an approach demands. Users are not good students of the command and control process because there is far too little available to them to study without wading through either legions of technically oriented material or else simplistic, operationally focused treatments of exercises or "after-actions" work that addresses specific scenarios rather than concepts.

With his text, Thomas Coakley has done great service to those who aspire—or dare—to peer into this mysterious world and get at its basics. His delineation of the basic principles of command and control is as thorough and comprehensive as I have seen on the subject. While he orients his treatment of the subject toward the operational practitioner, I would suggest it as fundamental reading for any of the specialists in the wide variety of fields that pervade the command and control world, from the technical architect to the operational manager and the ultimate user. It adds measurably to the body of knowledge that must eventually emerge from scholarly treatment of the business and take an enduring form for future and aspiring practitioners to study. Senior commanders and novices on the threshold of a new career will benefit alike from the time they spend reading this material and reflecting upon how it all must play together.

Absorbing a new discipline into the hierarchy of military activities is never done without at least some painful adjustment and accommodation; but the sudden growth in dependence upon the various high technology instruments that enable commanders of today's forces to control them effectively has presented unique challenges in this regard. The reason, of course, is that these enabling tools and instruments cut so pervasively, not only across organizations but into every kind of endeavor within. Some of the tools are creatures of disciplines that are well established in the military infrastructure—communications being the most prominent example—while others have evolved with the exploitation of newly developed technologies. Data automation is the best example of the latter because it has not only transformed a great many weapon system capabilities but also the means by which they are directed and controlled. The niche in the infrastructure for this fast-moving "ADP" technology is typically tenuous: everyone agrees it is here to stay, but "where" is another question. The cost and technical complexity of these kinds of systems are additional factors which darken the mystery in this fascinating world.

For some years now I have espoused the need for development of a new military career field that would cultivate field grade and senior officers who could help commanders cope with the complexity of their command and control world. These new specialists (who will probably evolve, sooner or later, no matter what I espouse) could be described as "Command and Control System Operational Managers." While not technical specialists, they would be well versed and educated in the fields of communications and data automation, sensor systems, electronic warfare, and so on, and possess more than superficial knowledge of the operational characteristics of the units and weapons systems to be directed and controlled. The vast resources needed to feed modern command and control systems demand the best possible matching of the characteristics and capabilities of the various systems, techniques, and procedures involved in the entire force employment process, of which command and control is such a major part.

But evolution of such expertise into a professional career field is not likely in the absence of an authoritative body of knowledge, documented and accepted by operational, technical, and academic communities alike. Fulfillment of that need is slow in coming, as no one, until Coakley came along, seems to have had the time to sit down and think through what needs to be written down—and then, to do it!

ROBERT T. HERRES

Command and Control
For War and Peace

1

The Broad View of Command and Control

Imagine yourself in a position comparable to that faced by General Norman Schwarzkopf in the war with Iraq. You're in charge of and responsible for the coalition forces from eighteen or more nations who face the forces of Saddam Hussein. Those forces speak different languages, fight with different weaponry and tactics, and in some cases harbor mutual and ancient enmities.

You must direct all those forces and, indeed, the whole war from within a command post that gives you and your staff at least the appearance of protection and that houses the technology that makes it possible for you to know what is happening on the far-flung fields of battle.

Should all the radar screens and television screens in your command post suddenly go blank and all the radios silent, you would find yourself fighting blind, with little idea of what your forces, let alone the enemy's forces, were doing.

At that point you would be justified in saying your command and control process had failed, even though some part of the process might be surviving in the shape of plans formed and sent to your forces before the battle began. Had those plans allowed for the possibility of catastrophic system failure, giving operational control to commanders on the scene if communications failed, perhaps not all would be lost. Of course, specific operational plans established before the battle began would soon be of little value since, unless adapted to the rapidly changing conditions on the battlefield, they could quickly become counterproductive.

If you can empathize with the plight of a commander in such a situation, you can understand the critical importance of strong command and control. Fortunately, from the perspective of the United States and its coalition allies, it was Saddam Hussein whose command and control failed in 1991, whose forces ended up flailing impotently in the darkness.

"Command and control" (C^2—pronounced "see-two" or "see-squared") has been getting a lot of attention in recent years. It was a hot topic for Congress during discussions leading up to the Goldwater-Nichols Defense Reorganization Act of 1986, the first major overhaul of the defense establishment in more than a quarter century. Command and control became a hot topic for nearly everyone with the outbreak of the Gulf War in early 1991, as CNN and other news organizations offered hourly reports on the intense allied efforts to knock out the heavily protected Iraqi C^2 facilities.

This is a book about command and control for the general reader. *General reader* in the sense used here includes specialists and military commanders, as well as people for whom the topic is a new interest. The book is designed to be inclusive rather than exclusive, to offer potential readers a broader perspective than they would be likely to encounter elsewhere.

THE NATURE OF C^2

Command and control involves the complex collection of functions and systems an executive draws on to arrive at decisions and to see they're carried out. Thus, the acronym C^2 may be used to refer to anything from information to sophisticated communications and computer equipment, to the executive's own mind—the last involving education, training, experience, native intelligence, and other aspects of cognition.

The particular executive with whom we're concerned here is the military commander: the term C^2 is usually thought of in a military context. However, much that is said about C^2 will apply to other decisionmaking contexts as well.

DIFFERENT THINGS FOR DIFFERENT PEOPLE

Because C^2 has come to mean many different things to many intelligent, well-meaning people, discussions of this important topic can be very confusing and even aggravating. An engineer or contractor who thinks of C^2 in terms of technology—of computers or radars or radios—may be put off by discussions that focus on the human or organizational aspects of the topic. Likewise, behavioral scientists who see C^2 as a matter of information processing may be dismayed when debates concern budget issues. Other parties involved in C^2 discussions—military people and members of Congress, for example—are likely to fix their attention on still other aspects of C^2, such as strategies or vulnerabilities. Yet, C^2 comprises all of these things, as well as others.

This confusion about the nature of the topic causes many people to quickly lose interest when conversation turns to C^2, particularly when it's to an aspect of C^2 seemingly irrelevant to their special focus. This is when you see their eyes begin to glaze over and their heads begin to nod. Such Pavlovian responses can be funny, but they're also dangerous.

Command and control issues are matters of critical importance for our national security—all C^2 issues. They're all of critical importance because they're interrelated. The C^2 technology can be useless or counterproductive if it isn't designed with an eye to the functioning and limitations of the imperfect human beings who will use it. Designing new systems will itself be an exercise in futility if the process ignores the issue of costs. And minimizing costs will be a false economy if the lowest possible cost results in an unusable system.

THE IMPORTANCE OF C^2

Command and control is important because even the perception of vulnerability in our C^2 invites attack by enemies who believe they can have their way and escape retribution. It's important because our worldwide responsibilities, combined with the distant locations of most potential theaters of war, make for numerical inferiority vis-a-vis most potential enemies—an inferiority which can be mitigated by the extraordinary responsiveness superior C^2 makes possible. It's important because rapid mission changes dictated by shifts in focus—from Europe to the Middle East or Central and South America, or from superpower threats to terrorists and drug lords—require a degree of flexibility only highly capable C^2 can provide. And C^2 is important because vulnerable C^2 makes a joke of sophisticated scenarios for waging a controlled nuclear war.

Despite its importance, C^2 traditionally has been slighted by U.S. defense planners more concerned with weapons systems than with the means of orchestrating their use. Presidents Kennedy, Johnson, Nixon, and Ford were all concerned with improving C^2, particularly nuclear C^2, but time and again the good intentions of chief executives came to naught when the time came to iron out budgetary details.

This tradition of unintentional neglect started to change significantly during President Carter's administration, and President Reagan made C^2 a priority during his eight years in the White House. When defense budgets began their general decline in the early 1990s, funding for C^2 remained relatively stable.[1] Yet, even in the face of this increased interest at the national level, C^2 has continued to be little more than a vague cliché for many people who could benefit from knowing more about it.

THE NEED TO EXPAND THE C^2 COMMUNITY

Continuing breakthroughs in the information technologies which extend the reach and application of C^2 ensure that intelligent approaches to C^2 issues will remain critical. It's crucial, therefore, that the small group today making up the "C^2 community" be expanded to include more than a few engineers, behavioral scientists, communications specialists, defense contractors, and military people.

Some in that community will argue there are already enough people involved in C^2 debates. Keeping the C^2 community small certainly *should* have the advantage of making it easier to reach agreements, although few would characterize the paths to past accords as smooth. Limited inputs, though, can lead to narrow thinking, and C^2 issues are too important to be left to a few self-designated experts.

THE GOALS OF THIS BOOK

The primary goals of this book are to make C^2 a topic accessible to anyone with a stake in the national security of the United States and to suggest a practical approach to difficult C^2 issues. Stakeholders include members of the armed forces, who dedicate their lives to maintaining national security; officeholders, elected and appointed, who shape national security by making decisions about policies and budgets; engineers and contractors who design and provide the defense systems to support national security; reporters, editors, and analysts who monitor and critique the systems, decisions, and people involved in national security; and taxpayers, who include all of the above groups and, directly or indirectly, every other citizen.

Thus, the intended audience for this book is every interested person. In a sense which we'll explore later, C^2 is the nervous system that coordinates the muscles of our national security system, everything from weaponry to diplomacy. Therefore, regardless of one's place or lack of a place in the government hierarchy or of one's position along the political spectrum, everyone has a stake in C^2, a key element in waging war or maintaining peace.

BREADTH OF TOPIC

The breadth of C^2 is one of the central difficulties in dealing with the topic. "One of the least controversial things that can be said about command and control is that it is controversial, poorly understood, and subject to wildly different interpretations," writes one analyst. In the view of Colonel Kenneth Moll, U.S. Air Force (Ret.), "The term can mean almost everything from military computers to the art of generalship: whatever the user wishes it to mean."[2]

Everyone agrees the topic is too broadly defined, and everyone wants to remedy the problem by limiting C^2 to the narrower definition his or her group would choose. So the cycle of debates continues.

People can, for example, get lost in the terminological thicket—debates concerning whether one should talk about "command," "command and control," "command, control, and communications," "command, control, communications, and intelligence," and so on, right up to one wag's proposal that it be

> $C^{27}E$: command, control, communications, computers, cohesion, counterintelligence, cryptanalysis, conformance, collaboration, conceptualization, correspondence, camaraderie, commissaries, camouflage, calculators, cannon, cais-

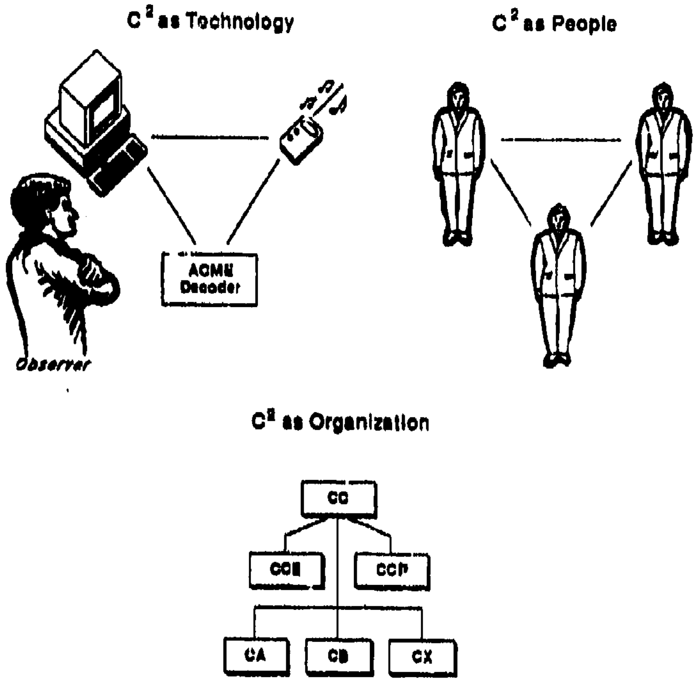
sons, canteens, canoes, catapults, carpetbaggers, caddies, carabineers, carrier pigeons, corn whiskey, camp followers, calamine lotion, etc.[3]

Eventually it becomes apparent most arguments about terminology are really arguments about more substantial issues, such as what our C^2 priorities should be.

Other C^2 debates focus on technological issues. For example, is "interoperability" or "redundancy" more important? In other words, should the goal be to connect all C^2 equipment—radios, computers, decoding devices, etc.—into one big network? Or, should we aim at smaller, overlapping networks, so that, when one fails, its functions can be picked up by others? Should we attempt to give our armed forces the most advanced, most capable equipment we can produce? Or, should we buy larger quantities of less advanced equipment?

Some specialists think of C^2 primarily in terms of human issues. How do human beings make decisions? Can we design equipment or procedures to help commanders make decisions easier? Faster? Better? Should C^2 equipment be designed to accommodate the needs and styles of commanders? Or, should commanders be trained to adapt their procedures to the equipment available? What can we do to ensure commanders have all the information they need but are not overwhelmed by receiving too much information? How can we give commanders the information they need and keep the enemy from getting that information?

Others see C^2 in terms of organization. Should our defense establishment be organized along geographic or operational (focused on a particular mis-



Different contexts of C² debates

sion, such as strategic defense)—lines? Should our organizational scheme emphasize specialization—i.e., air warfare, naval warfare, ground warfare, amphibious warfare—or "jointness"? Is our emphasis on civilian control of the military an inefficient base upon which to organize our defense forces? If so, is efficiency more important than civilian control?

These arguments about terminology, and technical, human, and organizational issues are important, but the rhetorical dust they stir up can unintentionally obscure the central topic.

HOLISTIC APPROACH

If we see C^2 as the nervous system which coordinates the muscles of our national security system, then we must admit each element of that system deserves attention. As specialization among physicians can be beneficial, so can specialization among those interested in C^2. But, as anyone knows who has suffered from it, uncoordinated prescriptions from non-communicating specialists can be dangerous to one's health.

Recognizing the multi-dimensional complexity of C^2 and admitting the legitimacy of all the dimensions involved may enable us to develop a more balanced and consistent approach to improving C^2. As things are now, "too many people," in the view of a former commander of the Army's Information Systems Command, "want to skin the cat differently."[4] We tend to lurch—first in one direction, then back to the starting point, then off in a completely new direction—as first one group, then another, gains the ears of the decisionmakers, or as decisionmakers change. This book attempts to give decisionmakers, from taxpayers to presidents, a balanced view of the whole spectrum—the "big picture" of C^2—and a practical way of bringing that view to bear on C^2 issues.

C^2—INFORMATION INTENSIVE

Some 2,600 years ago, Sun Tzu wrote,

> If you know the enemy and know yourself, you need not fear the result of a hundred battles. If you know yourself, but not the enemy, for every victory gained you will also suffer a defeat. If you know neither the enemy nor yourself, you will succumb in every battle.[5]

While the face of war has changed considerably in the intervening centuries, C^2 is still information intensive. Commanders need information about the enemy, about the environment in which an encounter may take place, and about the status and capabilities of their own forces. They need information about objectives: not only must they be clear about their own, but they must know those of superior commanders and, ultimately, those of the nation. They need a sense of what is possible—a data bank of options based on their own knowledge of history, their training and experience, the advice of their staffs, and any other available sources. They want to know what has been tried in comparable situations, what has worked and what has not. Once a commander's decision is made, it takes the form of an order. Orders are also information—information about what is expected of each player in the operation. When the action begins, the commander needs information in the form of feedback. Is the plan working? How must it be modified?

Information is at least as critical to today's commanders as it was to those of Sun Tzu's day. Indeed, one writer goes so far as to describe today's naval battle group as "a distributed offense/defense tied together by an information network."[6] According to

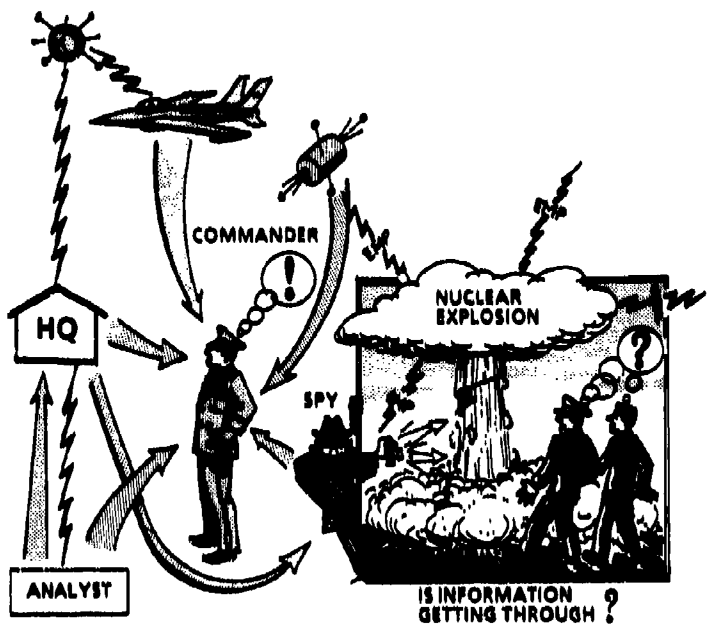
Dr. Eberhardt Rechtin, "Information is going to be so important in future conflicts that it may well determine their outcomes."[7] Ensuring the proper flow of critical information among friendly forces is, therefore, an essential C^2 function. And interrupting the enemy's information flow is just as important.

TECHNOLOGY OF THE INFORMATION AGE

The technology of the Information Age has produced and continues to produce spectacular increases in the amount of data available for C^2 and the speed with which it is delivered.

The more commanders know and the faster they know it, the more likely it is they'll be able to outwit and confuse enemy commanders. However, the mass of data available today can overwhelm commanders; it can also disappear suddenly. Therefore, the quest for those intent on improving C^2 must be to find better ways to shape and protect the data and its sources.

"Quest" seems the best way to describe the endeavor because, with every development changing the terms of the search, it must continue for so long as national defense is a concern. And national defense must always be a concern for anyone familiar with mankind's history. One of the ironies of the post-Cold War period has been the realization that the world is becoming "more conflict-ridden as ethnic strife and resource competition in an increasingly populous world are no longer held in abeyance by superpower rivalry."[8] Only someone blind to both



C^2 in the Information Age

history and current events would have predicted the Cold War would be the last war, or that concern for national security would become an anachronism. When worries about deficits and perceptions of diminished threats lead to further reductions in manpower and weaponry, the significance of C^2 becomes even more pronounced.

"The forces of the future will emphasize high-technology and quality," writes Colonel John E. Rothrock, a former chief of intelligence planning for the Air Force. "Both sides will depend less on numbers and more on suppleness and responsiveness—attributes almost totally dependent on improved command and control capabilities."[9]

Those attributes of "suppleness and responsiveness" will be critical whether the next war involves East and West or North and South or Haves and Have-nots.

2

C^2: Process and System

The DoD definition treats C^2 as first, a collection of command functions and ,second, those systems of people, procedures, and equipment which support command. Which aspect of the definition one emphasizes has much to do with the kind of stake a particular observer has in C^2; the emphasis will also be affected by the observer's position in the hierarchy. Emphasize what we will, though, the web-like nature of C^2 demands the consideration of all its aspects as we strive to improve it.

The Department of Defense (DoD) defines *command and control* this way:

> The exercise of authority and direction by a purposely designated commander over assigned forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission.[1]

Command and *control*, in other words, are both verbs and nouns. As verbs, they are what a commander does; they constitute a process. As nouns, they are the "arrangement" of people, equipment (including hardware and software), and procedures that helps commanders do what they do; they name a system.

THE SCOPE OF C^2

To get a sense of the scope of C^2, let's look at a sports analogy. It's often noted that conceptual similarities between football and battle abound, extending beyond a shared vocabulary that includes "bombs," "ground attacks," "aerial bombardments," "interceptions," "blitzes" and so on.[2] One example of those similarities is the support provided football coaches by as close an approximation of perfect C^2 as one is ever likely to encounter—far better C^2 than commanders could ever expect to have in the life and death situations of actual combat:

Imagine you're the head coach of the Colorado Springs Zebs, a semi-pro football team in the Gulf-Western League. Your club's owner has told you that, as far as he's concerned, your upcoming game with the San Antonio Cowpokes is the most important game of the season. His strong feelings are apparent in the daily discussions you have with him as you prepare for the game.

You've sent a trusted assistant to watch the Cowpokes' last two games and asked another to analyze the San Antonio Light's *reports on all the Cowpoke games this year. You've personally reviewed film highlights broadcast by a San Antonio TV station and recorded by a friend who lives in New Braunfels. You're familiar with the Cowpoke Stadium and know that it sits at 400 feet above sea level.*

Your daughter has videotaped all of the Zebs' games and you've continued your practice of closely reviewing the most recent ones. One of the things you've noticed lately is that two talented halfbacks have been getting their signals crossed regularly. In talking to your head trainer, you've learned that one is dating the other's "ex."

Based on what you've learned about the Cowpokes' performance this season, you've told your defensive line coach to spend a lot of practice time on the blitz; when rushed frequently, the Cowpoke quarterback appears to get flustered and angry, causing the Cowpokes' game to deteriorate. There have been some reports that an injured wrist will keep the quarterback from starting this game, but you've disregarded them, knowing similar stories, leaked before two earlier games, proved false.

You've directed your offensive coach to stick to the play book and have the halfbacks hitting the right defensive guard position early in the game. The Cowpoke guard is new to the semi-pro ranks and the team and will probably be jittery. You arrange to have your plane land in San Antonio eighteen hours before the game: early enough to allow the team to get some sleep; close enough to game time to maximize the benefits from their high altitude conditioning.

As the game begins, you have your coaches and their assistants positioned strategically in the press box and on the field. Each has a headset and can be in touch with you quickly. The team owner, sitting in a private box, has his own headset through which you keep him advised of your plans and occasionally get his suggestions.

Your team wins the toss and elects to receive the ball. Your deep receiver is tackled on the fifteen, and you put the ball in play there. On the first two plays from scrimmage, your two halfbacks run into each other, and the ball carrier is stopped for a loss. You call time out and huddle with your assistants and quarterback. You then replace one of the halfbacks. On the next play, the other halfback breaks through the middle and goes 25 yards.

You're on your game plan.

SOME PARALLELS

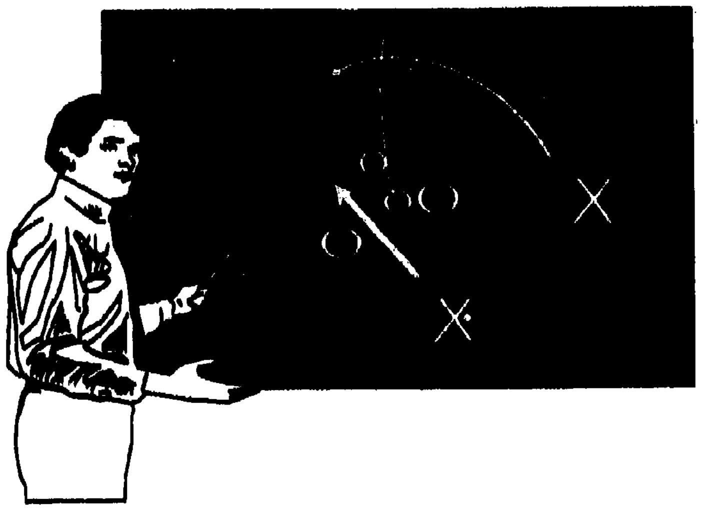
Football is not combat, and a one hundred-yard playing field is a far cry from the global battlefield, but the parallels between the activities of a coach and the activities of commanders can help us better understand C^2. Our football coach, like commanders, receives his mission from a superior to whom he reports throughout the process—in this case, the team owner.

Next, the coach learns everything he can about the opposition, using scouts and analysis of newspaper reports and television films; this is analogous to military commanders gathering intelligence.

The coach incorporates what he knows about the playing environment—the altitude of the Cowpoke stadium—into his game plan, just as commanders use what they can learn about the mission environment in their battle plans.

When the coach studies the videotapes of his own team's games and talks to the trainer about the problem with the halfbacks, he is evaluating his own resources, just as commanders must.

As the coach assigns offensive and defensive tasks to his assistants, commanders divide a mission into tasks and assign those tasks to subordinate commanders. The coach, aided by his assistants, watches the start of the game, spots a problem in the poor performance of the halfbacks, decides on a corrective action which is based on previously acquired information about the halfbacks, and goes back to monitoring. Similarly, commanders monitor the carrying out of assigned tasks and make whatever adjustments they decide are necessary.



Coach incorporates the "Known" into the game plan

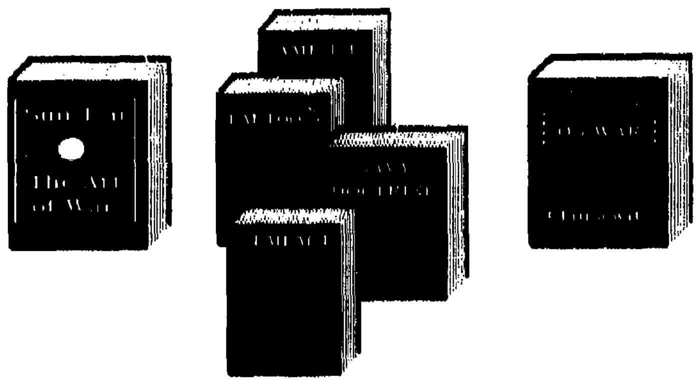
Finally, as the coach compares the action on the field to his game plan in order to determine what else he needs to do, so commanders compare the results their forces are achieving with mission requirements. When the results and the requirements don't match, commanders will attempt the same kind of problem analyses our coach used in the scenario. They too will modify tactics or make personnel changes as necessary to achieve the desired result.

OBSERVATIONS

One benefit of the football analogy is that it can lead to some useful observations. For example, with all the facilities available to them, coaches still lose football games. That's partly because good information doesn't guarantee good decisions; nor does it eliminate the role that chance plays—from the coin toss onward. It's also a reflection of the fact that "enemy" coaches have comparable support systems.[5]

It's also worth noting a C^2 process can exist independently of technology: owners, coaches, and assistants worked together quite capably before headsets and radio systems came along. The same is true of commanders and their subordinates. The massive amounts being spent on what is broadly characterized as C^2 should not mislead us into assuming the process and the equipment are synonymous. At the same time, we should keep in mind that, like the systems which allow coaching assistants to place themselves strategically throughout the stadium and still be in touch with the head coach, technical improvements in C^2 open new possibilities commanders can't afford to ignore.

The team's "play book" is an essential part of a football coach's C^2. The play book is the repository of the tactics the team has studied and practiced, as well as the code phrases for the plays. When the coach says the next play will be "27-right," for example, he counts on every player knowing what he means. The play book, in effect, contains the team's shared knowledge and is based upon coaching expertise—a sense of what works and what doesn't.



Sources of C^2 "procedures"

PROCEDURES: DOCTRINE, PRINCIPLES

The "procedures" mentioned in the DoD definition of C^2 are comparable to the football play book.

They're derived from experience, common sense, the lessons of military history, and theory; and, they constitute "shared knowledge," the common thread which, ideally, unites the minds of commanders from the top to the bottom of the chain of command. The procedures range from Service doctrines, which govern the use of weapons systems, to the "principles of war," which guide commanders in their choices of strategies and tactics.

Two of the best known formulators of the principles of war are Sun Tzu and Karl von Clausewitz. Sun Tzu's *Art of War* and Clausewitz' *On War* were written nearly 2,500 years apart. The two works differ considerably in scope, emphasis, and even intent. Yet, for all their differences, *Art of War* and *On War* share fundamental principles. For example, while emphasizing maneuver—an aspect of war with which he is often identified—Sun Tzu is clear about the desirability of massing a superior number of troops at the point of battle. Likewise, Clausewitz, though sometimes ridiculed as the "Mahdi of Mass" by unfriendly critics, understands the effectiveness of deceit and maneuver against an enemy's superior forces.

In essence, the principles of war have remained fundamentally unchanged from Sun Tzu's day to the present, although they have been articulated differently from age to age. In 1921, for example, the War Department of the United States listed nine "basic and immutable" principles of war:

> The "principle of objective" required a commander to make the unit's assigned objective the basis for interpreting orders, making decisions, and employing forces.
>
> The "principle of the offensive" reminded commanders that only through offensive action could an encounter with the enemy be made decisive, although defensive operations could be useful in delaying for a more propitious moment or taking advantage of the terrain to compensate for one's own force's weakness.
>
> Including as "mass" everything that contributes to "combat power"—"numbers, weapons, tactical skill, fight-

> ing ability, resolution, discipline, morale, and leadership"—the "principle of mass" called for concentrating a force "in a main effort at the proper time and place for the accomplishment of a definite purpose."
>
> Closely related to the "principle of mass" were those of "economy of effort" and "movement" which would have the commander move forces engaged in non-critical efforts to the most critical point in the battle, or to a point suitable for counterattack in a defensive operation.
>
> The important "principle of surprise" could take any form—"time, place, direction, force, tactics, or weapons."
>
> The "principle of security" covered any measure taken to protect against "observation and surprise."
>
> The "principle of simplicity" called for uncomplicated operations, direct and clearly stated orders, avoidance of frequent changes to a plan, and "unity of command."
>
> The "principle of cooperation" required "teamwork" of "all military persons" and was based upon thorough coordination.[4]

These "principles"—like those of Sun Tzu, Clausewitz, and other theorists—are "immutable" in the sense that they're derived from common experience and common sense and have continued to be useful through the ages, despite dramatic changes in weaponry and other aspects of war.

NOT HARD AND FAST RULES

Being "useful," however, does not mean that the principles are rules which, if followed, will guarantee success in warfare. Nothing guarantees success in battle or war. Goliath lost to David; Alexander the Great with his 30,000 men triumphed over the Persian king Darius and his 200,000 plus at Issus; and the Viet Cong and North Vietnamese won the battle for Vietnam.

We may say that, in the case of Goliath and David, "mass" as tactics, coupled with "surprise," triumphed over "mass" as bulk. At Issus, "mass" in the sense of resolution and leadership overcame "mass" in the sense of numbers. It could be argued that in Vietnam, "mass" as a combination of resolution and numbers helped the Viet Cong and the North Vietnamese deny the United States a victory.

LONGING FOR CONSISTENCY

It quickly becomes apparent that, when they are defined as broadly as the War Department defined "mass," the principles start to look pretty meaningless. They are like a lens which, if pushed and twisted into the right shape, can always be counted on to reveal the same image, regardless of what the object being viewed might be. They suggest that military theorists value consistency over reality.

The fact is, we all do. A consistent world is a safe world. In such a world, we need only learn and play by the rules in order to survive. Unfortunately, wishing doesn't make it so. If we substitute our vision of a safe, consistent world for the reality, we imperil ourselves. When we assume the rules we've defined will always apply, we allow our enemies to use the rules as weapons against us.

When the rules say, "Never fight uphill" (as they do in Sun Tzu's formulation), and our forces are on the top of the highest hill, we may either assume we're safe or spend all our time watching the sky. In such circumstances, an alert enemy can surprise and defeat us by climbing up the hill when we're not looking, as the English general Wolfe did to the French general Montcalm at Quebec, during the French and Indian War. We could say General Wolfe emphasized the rule of surprise over the never-fight-uphill rule.

BALANCING RULES

More often than not, battles are won by achieving the right balance among the rules. The Japanese might have done better at the World War II Battle of Midway if they had put more emphasis on the principle of security and less on the principle of cooperation.[5] Some critics say the U.S. invasion of Grenada might have been even more successful than it was if planners had put more emphasis on the principle of cooperation and less on the principle of security. Unfortunately, the only way to determine the "right balance" with perfect certainty is retrospectively.

Initial post-war analyses suggest the United States and its allies found most of the right balances in the campaign against Iraqi forces in the Gulf War of 1991. Certainly the technical superiority of the U.S.-led coalition forces was a critical factor in the quick, lopsided victory, but as the U.S. experience in Vietnam and the Soviet experience in Afghanistan demonstrated, vast technical superiority is no guarantee of victory.

In the Gulf War, the coalition forces orchestrated the use of their technical superiority with extraordinary effectiveness. They translated their goal of freeing Kuwait into an initial military objective of isolating the occupying forces. They accomplished that objective by blinding the Iraqi high command almost immediately through gaining air superiority and launching devastating attacks on C^2 facilities in both Iraq and Kuwait. The air superiority, which the allies maintained throughout the conflict, gave them unimpeded access to detailed reconnaissance while severely limiting enemy reconnaissance. Destruction of the C^2 facilities restricted coordination among the Iraqi forces and the sharing of any intelligence that might have been available. Interdiction of ground transportation between Baghdad and the theater of operations completed the isolation of the Iraqi forces.

With Baghdad blinded, Iraqi air operations effectively shut down and their ground forces isolated, confused, and demoralized by six weeks of relentless pounding from the air, the coalition forces began their ground offensive. In roughly 100 hours of fighting, they routed the Iraqi forces with a strategy that included tactical feints such as a much anticipated amphibious attack which never occurred, the massing of forces to punch through Iraqi defenses at carefully prepared points, and a surprise envelopment that cut off the Iraqi retreat toward Baghdad.

In a nutshell, the United States and its allies performed brilliantly. As more details about the conflict emerge, we'll undoubtedly discover that the fog of war was indeed present and not all operations went as smoothly as hoped or as we initially thought. That's the ugly reality of war. In terms of C^2, though, Operation Desert Storm appears to have been a clear success. While some observers have maintained that superior tactics and leadership rather than high tech weaponry were responsible for the rapid U.S. victory, their argument ignores the fact that high tech weaponry destroyed the enemy's C^2 early on, making it difficult if not impossible for him to discern U.S. tactics.[6] Superior technology, the employment of which was orchestrated by superior C^2—including "tactics and leadership"—gave the United States and its allies the necessary edge, the "right" balance.

FORCE MULTIPLIER

The classic modern C^2 success story, the example usually cited when the topic is the force multiplier effect of capable C^2, is that of Air Marshal Hugh Dowding's Fighter Command in the Battle of Britain in 1940. While the Luftwaffe had superiority in both numbers and technology, Fighter Command had superior C^2. And it used that C^2 to defeat the German plan to bomb Britain into submission.

Peter Townsend, one of the British pilots, describes the British system in these words:

> The "eyes" of Fighter Command, 60 Group, comprised a network of some fifty radar stations. They detected enemy aircraft and passed the plots to Fighter Command Filter Room, where they were sorted out and passed on to Fighter Command Ops Room, from where they were passed on again to group and to sector ops rooms. The sector controller guided or "vectored" the fighters to intercept. Over land, the Observer Corps took over from radar and passed on direct to group ops rooms up-to-the-minute information on everything within view or earshot.[7]

The "eyes" referred to by Townsend were radars developed by a British team with the motto "Second

Best Tomorrow," meaning that their goal was something immediately useful, rather than a "best" system which wouldn't be available for years.[8] In fact, it wasn't British technological superiority that made their C^2 superior to the Luftwaffe's. The German radars—the Freya and Wurzburg systems—were more sophisticated and capable than those of the British.[9] Rather, it was the British organization—the setup that linked radars, observers, and pilots to the Operations rooms—that gave them the upper hand. In Townsend's words, "The Germans knew about British radar but never dreamed that what the radar 'saw' was being passed on to the fighter pilot in the air through such a highly elaborate communications system."[10]

Information gleaned from radars and observers came together in the big picture assembled in Operations. Initial radar reports were passed through a "filter room," where conflicts were resolved. In the Operations room, the filtered information from the radars was combined with reports from observers and data on friendly forces. At this point, the "bogies" (unidentified aircraft) or "bandits" (enemy aircraft) were assigned to a sector selected by the Group commander. The sector controller would then guide assigned aircraft to meet the enemy. The "big picture," in other words, became the basis for deciding which planes to send where.

Fighter Command used the unprecedented capabilities of its C^2 system to anticipate the Luftwaffe's attacks (security), to link observers, planners, and pilots (simplicity, cooperation), and to move all available planes to critical points (mass, economy of effort, movement) where its pilots surprised and attacked the enemy (surprise, offensive). In doing so, Fighter Command defeated the German attempt to gain control of the air over Britain (objective). In retrospect, it's clear the Royal Air Force found "the right balance" in applying the principles of war. It was good C^2 that allowed the "few" to do "so much."[11]

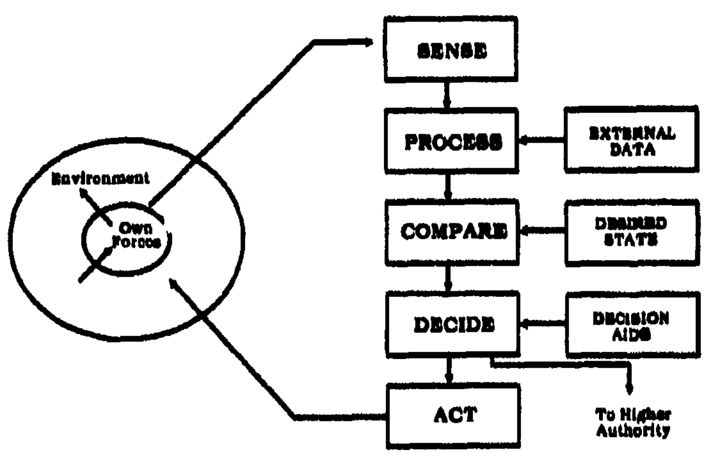
NOW AND THEN

For each of the components of today's C^2 systems, Dowding's system had its analogue. Whereas Desert Storm commanders could draw data from satellite and aircraft sensors, as well as highly sophisticated radar systems, those in Dowding's system relied on primitive radar and human observers. In place of today's computerized fusion centers, Dowding's system had operations rooms staffed by skilled officers who distinguished "friendlies," "bogies," and "bandits" on the basis of shrewd analysis and intuition. Instead of today's advanced and complex "decision aids," Dowding had women pushing colored markers across map tables. Dowding's system had its "doctrine"—rules about when and how to engage enemy aircraft; its communication system of radio-telephone links between ground and air; and, most important, a commander—Dowding himself—who, for the duration of the battle, was able to resist pressure to abandon his objective of providing a defense against the German bomber fleet.[12]

Fundamentally, there's little difference between the C^2 system the British used during the Battle of Britain and any modern one. For that matter, a generic "model" of C^2, such as the one proposed by Joel S. Lawson, would probably be as applicable to the C^2 systems of an Alexander or a Napoleon as it would to Dowding's system, or that of any commander in the 1990s.

LAWSON'S C^2 PROCESS

The Lawson model accommodates five functions: *sense*, *process*, *compare*, *decide*, and *act*. The *sense* function gathers data on the environment—the world "out there," including friendly and enemy forces, allied forces, terrain, weather, and so on. The *process* function draws together and correlates the data to give the commander information about the environment. The *compare* function juxtaposes the existing



Lawson's model of the C^2 process
Source: Alexander Levis and Michael Athans

state of the environment—the relative strengths, weaknesses, positions, etc.—with the desired state, the commander's view of what the state of the environment should be. The *decide* function chooses among available courses of action for reconciling the existing state of the environment with the desired state. The *act* function translates the decision into action.

Working with a similar C² model, Colonel John Boyd, a pilot and combat theorist influential in the so-called Military Reform movement of the late 1970s and 1980s, combined what he knew of aerial warfare with C² lessons gleaned from military history to conclude that the key to military victory—regardless of the relative sizes of the opposing forces—is "getting inside" the enemy's decision cycle or C² process.[13] In other words, whether we're engaged in a dogfight between two airplanes or a major ground battle, the way to win is to work through the sequence of functions that constitute C² faster than the enemy does. In the words of the Marine Corps' manual, *Warfighting*, "Whoever can make and implement his decisions consistently faster gains a tremendous, often decisive advantage."[14] Having faster C² processes allows us time to figure out what enemy commanders are trying to do, and time to cut off their opportunities for doing those things. It allows us to determine what indicators enemy commanders will key on, so we can manipulate those indicators to mislead the enemy. In short, faster C² is the key to playing with the enemy's mind. This is what military briefers meant when, during the 1991 Gulf War, they spoke of "getting inside the enemy's decision cycle," though some members of the press interpreted the phrase as a reference to some sort of intelligence coup.[15]

OBJECTIVE: THE ENEMY'S MIND

This playing with the enemy's mind should be a commander's primary goal, according to some students of warfare. Lieutenant General Raymond B. Furlong writes,

> Our object in war or strategy is the behavior of a limited number of people. We wish to conduct our affairs in such a way that these people will act in a way that we prefer—our goal in strategy is to influence human behavior in a way favorable to our objectives. I suggest, then, that our strategies ought to seek this as their principal object—the mind of the opposing commander.[16]

Speaking of the enemy's "mind," in this sense, is equivalent to speaking of C^2. In ancient warfare, the commander's "mind" was the core of a force's C^2. An Alexander, for example, would rely largely on his own observations and knowledge of the enemy, his own experience in war, and his own genius in formulating his battle plans. Gradually, though, the increased scale and complexity of war—abetted, perhaps, by a norm of commanders less gifted than Alexander—caused C^2 functions to be externalized in the form of staffs.

"COMMAND" OR "COMMAND AND CONTROL"

In Alexander's day, C^2 functions would have been referred to as "command" functions. The phrase

One theory about differences between
"command" and "control"

command and control didn't come into widespread use in place of *command* until after World War II.[17] For thousands of years, *command* had covered everything: the leader fulfilled all of the functions that are today labelled as C² functions. Some people feel the word *command* is still adequate.

Any attempt to explain how and why *command* evolved into C² is speculative. One theory ties the change to the evolution of military forces.

As armies grew in size and complexity, it became increasingly difficult for a single leader to do everything. Tribal chiefs standing in front of their warriors could usually look over the enemy crowd and make an on-the-spot decision about how to best use their own people to combat the enemy. General Eisenhower, on the other hand, faced too complex a task to do his job without the help of large training, logistics, maintenance, planning, and intelligence organizations. While he retained command over all his forces, he delegated control of supporting organizations. *Command* is strategic—concerned with the "big picture"—while *control* is tactical or operational and focused on the more immediate management of forces.[18] Unfortunately for advocates of this theory, very large armies appeared on the scene centuries before *command* became *command and control*.

According to another theory, the linguistic splintering of *command* into *command and control* can be traced to the automation of some functions during and after World War II. It made more sense to say someone controlled a system composed of radars or computers than to say one commanded such a system. One commands people; one controls things. The problem with this theory is that "things," from rocks to missiles, have been a part of war for as long as people.

Perhaps the emergence of *control* is a response to an increased reliance on "things" in war. Or maybe there is something about automation that evokes a new term—a term to describe the relationship between a commander and an automated thing; *command and control* came into use about the same time computers started playing an important role in the "control" of industrial processes.[19]

The desire to establish safeguards or "controls" to prevent accidental or unauthorized use of atomic and nuclear weapons may also have been a factor. A view frequently expressed in military circles is that the concept of "control" originated in the desire of civilian officials to have a say in the disposition of military forces, especially those involving nuclear weapons: being outside the military chain of command, the civilians "invented" control as a synonym for a type of management which transcended the chain of command and was imposed on it from above. In any case, the phrase *command and control* (and some enhancements which we'll get into later) is today used where *command* once sufficed.

Somewhat analogous to different theories about the coupling of *control* with *command* are the views of the former held by the different military services.[20] In the Army, *control* seems to be viewed largely as an organizational issue: does Commander A have operational control or administrative control (or both) of Force B? In the Air Force, control appears to be an application of command: in directing an aircraft to a target, a weapons controller is applying a commander's order. The person sitting in front of the radar screen may be telling the pilot what to do, but no pilot would accept that as an instance of command. The Navy seems to take a more negative view of control than do the Army and the Air Force—to see it as a constraint.[21] This probably has something to do with *control* emerging about the same time ships' captains were losing some of their autonomy—the time when advances in communications technology were strengthening the links between shore and ship.

In still another view—one not associated with a particular Service—control is seen as a commander's knowledge of his own forces, as "friendly" intelligence. At one point during the Cuban Missile Crisis, President Kennedy directed General Maxwell Taylor to find out whether the U.S. Air Force had moved its airplanes in the southeast out of their vulnerable wingtip-to-wingtip apron formations. U-2 photos revealed they had not been moved.[22] President Kennedy's use of reconnaissance in this instance might be seen as an exercise of control.

A PUSH-PULL DICHOTOMY

It may be useful to combine some of these different views and think about command and control in terms of a push-pull dichotomy: command sends or pushes forces out into the environment to do something; control pulls them back or restrains them, through monitoring and imposing limits on how far those forces can go in accomplishing their mission. In this oversimplification, control works like a leash. When a medieval English king sent an army off to fight on the European continent, he did so without worrying much about the fate of individual soldiers or even the outcome of particular battles. He was exercising command in sending the army out, but he had no control over them—no leash—once they had travelled any distance from his realm. Only with great difficulty could he pull them back or even find out what they were doing.

Today's technology gives a chief of state such as the president of the United States the ability to exercise both command and control over forces. With nuclear weapons, "controls" (in the form of electronic locks called "Permissive Action Links" or "PALs") have made it possible to divorce possession from the ability to use a weapon. A nuclear weapon may be in the possession of a military unit, but the president retains control of it until he or she transmits a coded signal which "unlocks" it.

MORE ACCOUNTABILITY, MORE CONTROL

In terms of conventional (non-nuclear) forces, presidents don't normally exercise their control; they usually leave that to their military commanders. The fact that they sometimes exercise control results as much from the increased likelihood of their being held responsible for the actions of their forces as it does from technology's enhancement of their ability to do so.

The same technology which allows the president to communicate directly with the soldier in the foxhole allows the citizenry of the United States to know almost immediately what is going on in that foxhole or anywhere else in the world. When a soldier—who is also a citizen and someone's beloved child, sibling, or spouse—is killed, the president can expect to face a barrage of questions about his or her responsibility for the death. Was the soldier adequately trained? Equipped? Protected? Was the mission really necessary?

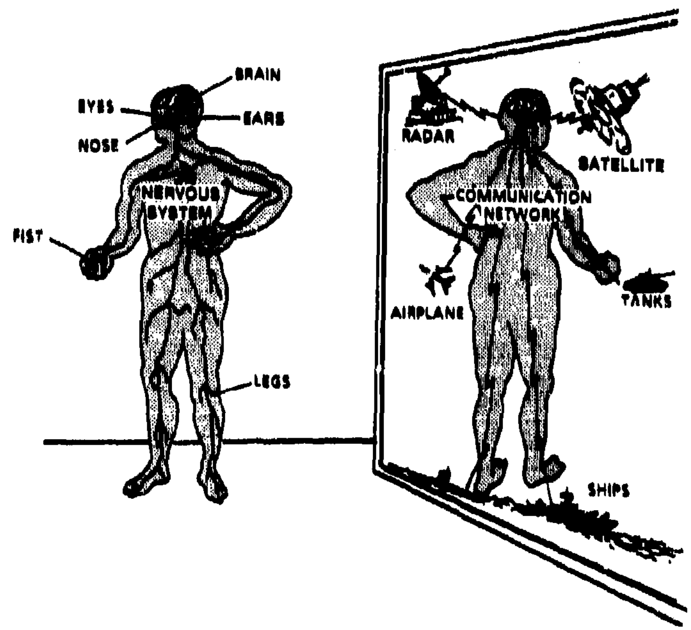
If medieval monarchs ever faced such questions, it was only if their entire force had been decimated. Even then, the questions would sometimes come so long after the loss they'd be meaningless, particularly in cases where the monarch had remained at home while the army went abroad.

It might be fair to say twentieth century presidents give their commanders shorter leashes because citizens have the presidents themselves on shorter leashes. Indeed, in a world endangered by nuclear weapons, short leashes may be the most appropriate kind, though they're unlikely ever to be popular with those constrained by them. There's also a trend toward shorter leashes as one moves down the chain of command.

LOST CAUSE

In the final analysis, the line between command and control is blurry but established by usage. It is significant to some people, unimportant to others. Similarly, *control* means one thing to some people, other things to others. Clues to its meaning in a particular usage have to be derived from the context.

Were it possible to move back the clock to the time when most people used *command* rather than C^2, it might, for the sake of simplicity, be desirable to do so. However, it seems quixotic to avoid use of *command and control* or C^2 today. Though linguistically inelegant, C^2 carries with it a connotation of complexity, as well as a somewhat mathematical or "high-tech" look. Given the nature of command in the modern world, both are probably appropriate.

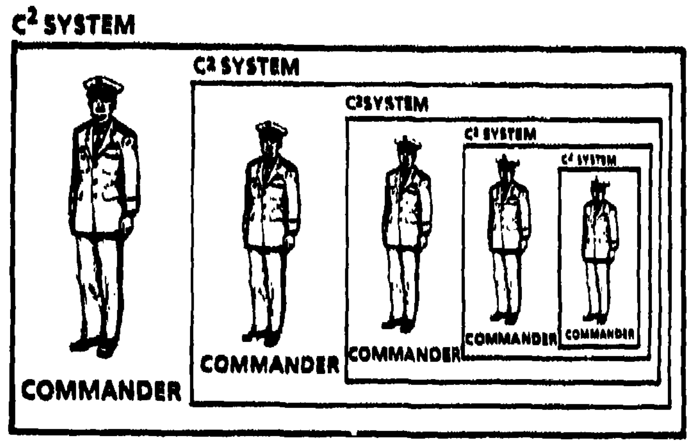


Nervous system-C^2 analogy
Source: Lieutenant General Hillman Dickinson

BRAIN:NERVOUS SYSTEM:COMMANDER:C^2

As mentioned earlier, the most commonly used analogy for C^2 is the nervous system which supports the human body.

The sensory nerves detect what is going on both within and outside the body and send the findings to the brain. The brain interprets the findings, compares the existing condition to the desired condition, decides on a course of action, and sends the appro-



Commander's relationship to C^2 systems

priate orders to the muscles by way of the motor nerves.

Just as some people see the brain as a part of the nervous system and others see it as something which stands apart from and directs the system, debates rage about whether or not the commander is a part of C^2.

One way to approach the issue is to go back to the system-process dichotomy. One might say Commander A stands apart from the C^2 system that supports him, though he is a part of the C^2 system which supports superior commanders. Similarly, the coach may be distinguished from his coaching system, though he is a part of the team owner's coaching system.

On the other hand, all commanders are a part of their own C^2 processes as well as the C^2 processes of superior commanders. Even the president is kept on a leash by the sovereign people of the United States; he (or she) is part of our democracy's C^2 process.

HIDDEN AGENDAS

In reality, the issue is largely a territorial matter. If commanders are part of C^2, then at least some research and development efforts should be directed toward determining how these human components function under various circumstances, how they make decisions, how information might best be displayed for their use, and so on; in other words, if commanders are part of C^2, part of the C^2 research pie should belong to psychologists, behavioral scientists, sociologists, and others who study human beings. If commanders are not part of C^2, then most of the research and development can be allotted to engineers. The bigger the pie gets, the hotter the debates grow.

In the Information Age, the C^2 "pie" has grown bigger than ever. References to C^2 abound—in discussions of everything from President Reagan's Strategic Defense Initiative to the latest tank design—and improving C^2 has been an announced goal for Congress as well as the Department of Defense. Between 1977 and 1986, funding for C^2 equipment jumped nearly 150 percent, from less than \$10 billion to nearly \$25 billion a year, as computers, communications systems, and surveillance systems acquired status comparable to the most advanced bombers and submarines.[23] Furthermore, concern for C^2 in its broader sense was a leading force behind the Goldwater-Nichols Defense Reorganization Act of 1986. So, the debates continue.

TERMINOLOGY

Besides the thinly veiled territorial disputes, anyone wishing to get a handle on C^2 must deal with inconsistencies in terminology. Each of the alternative labels (*command and control* or *command, control, and communications* or *command, control, communications, and intelligence*, etc.) can and has been justified by its emphasis on a vital element of the system. For example, without communications, a commander is isolated; without intelligence, a commander is blind.

Sometimes elements are combined on a pragmatic basis: *Command, control, communications and intelligence* (C^3I), for example, gained currency in the Department of Defense largely for fiscal and personnel reasons. Since C^2 on the one hand and communications on the other involve similar types of equipment, it seemed to make sense to lump them together for funding purposes; later, intelligence was added to C^3, partly because it too involved a lot of computers and communications equipment and partly because the Secretary of Defense wanted to assign responsibility for intelligence without increasing the size of his staff.[24] Thus, the *Deputy Undersecretary of Defense for C^3* became the *Deputy Undersecretary of Defense for C^3I.*

The reasons for using the C^2 label in this book are similarly pragmatic and philosophical. First, more people seem to use *command and control* or C^2 than use any of the alternatives. Second, *command*

and *control* are, from a commander's perspective, functions. *Communications* and *intelligence* are elements that support C^2. If our purpose were to emphasize one element, such as intelligence, there would probably be more effective ways to do that than by lumping it together with C^2. Furthermore, grouping elements like communications and intelligence with C^2 functions contributes to the misleading impression that C^2 problems are essentially equipment problems. None of this, of course, is meant to imply that communications and intelligence issues are not germane to the discussion of C^2.

FUNCTIONAL AND HIERARCHICAL PERSPECTIVES

Many of the difficulties described thus far—including the territorial disputes and the debates about terminology—are linked directly or indirectly to the diversity of groups which have a stake in C^2. Historically, the military services have seemed anxious to downplay C^2 equipment, emphasizing instead the muscles of defense—the planes, ships, tanks, and guns. Confronted with day-to-day shortages in weapons, people, spare parts, fuel, and ammunition, they've tended to assume C^2 will "be there" when needed. Until faced with inadequate C^2, their attention has usually been focused on the muscles rather than the nervous systems of defense. Some critics complain that members of the military are shortsighted with respect to C^2. Others say it's more a matter of the budget process distorting perceptions of the military attitude toward C^2; commenting on the Gordian nature of C^2, Colonel Harry G. Summers, a former Army strategist and the author of *On Strategy: A Critical Analysis of the Vietnam War,* writes,

> Unfortunately, the Constitutional requirement to justify Army needs to Congress in monetary terms can cause this complexity to be overlooked. Listening to only such testimony an otherwise uninformed observer might believe, for example, that Army command and control is solely a matter of telecommunications and electronic equipment. What would not be apparent is the critical role of doctrine, training, and mission-type orders in battlefield command and control.[25]

Engineers naturally tend to focus their attention on the technology of C^2—the radios, computers, satellites, local area networks, and so on. That doesn't mean they ignore the human aspects of C^2—as is implied by critics who use terms like "wireheads" or "techies" in referring to engineers. Scientific and engineering backgrounds predispose people to think of C^2 in terms of the equipment, communications, and facilities aspects of the DoD definition. Some engineers' interest in the personnel aspect is limited to ensuring users are trained well enough to be able to clearly articulate their needs and to employ systems without screwing them up; some think of procedures in terms of red tape or bureaucratic tangles that hinder timely development. However, like Robert Watson-Watt, who led development of Britain's "Second Best Tomorrow" radar for World War II, most experienced C^2 engineers know meeting the commander's needs is more important than always being on the leading edge of technology.

Theorists approach C^2 with still a different perspective. They often insist on modelling as the first step in the complicated process leading to improved

C^2. Start anywhere else and we risk losing sight of important requirements for a system. Everything must be mapped out—how the commander's mind works, the steps a mind goes through in reaching a decision, how and where a new system must connect with existing systems, etc.—in advance of physical development. Some critics view theorists as irrelevant and lost in abstractions; as dedicated to endless haggling about definitions, models, and wiring diagrams; to writing unreadable articles in journals inaccessible to anyone other than theorists. However, most people involved with C^2 recognize the value of the "front end" insights theorists provide.

A new group emerged in the early 1980s when Congress decided the defense establishment was not giving C^2 enough attention. This group of senior government officials and high-ranking military officers found themselves appointed to newly created posts in DoD and the Joint Staff—posts established to coordinate C^2 policy in DoD and among the military services. As their offices lacked regulatory authority and control over budgets, they took on roles as advisers, mediators, and advocates of C^2. In the eyes of some observers, the members of this group were victims caught between a rock (Congress and, to a lesser degree, the operational commanders—see below) and a hard place (the administration and the military services).

By the mid-1980s, the military services—i.e., the Army, Navy, Marines, and Air Force—in a flurry of enthusiasm triggered by the Carter and Reagan administrations' interest in C^2, began submitting budget requests crammed with communications systems and related technologies. At that point, the commanders-in-chief (CINCs) of the operational or fighting commands decided they had better get into the act lest they find themselves saddled with an abundance of shiny new equipment which would not meet the needs of their commands.

The CINCs argued that people who have to use systems should have some voice in their design. Because most of the operational commands involve more than one military service and frequently the military services of more than one nation, the CINCs were especially concerned with interoperability—the ability of one system or set of procedures to be linked to another. They worried, for example, whether Navy and Air Force pilots would be able to communicate with each other or with ground commanders.

The military services, on the other hand, have always argued that the system requirements for an aircraft radio differ considerably from those for a shipboard radio or the radio carried by an infantryman. They maintain that the best approach to C^2 equipment acquisition is to have the military services determine the systems and then have the operational commands determine the "interfaces"—technical or procedural connections—needed to allow one system to communicate with another.

Other groups involved in the debates about C^2 include defense contractors, whose views tend to parallel the engineers' and the theorists', though the contractors' closest ties seem to be with the military services' procurement organizations; and politicians, whose concerns run the gamut of issues discussed here and on to budget issues and more parochial matters pertinent to their constituents. Sometimes the interests of different groups overlap; other times they are at odds.

One's position in the hierarchy can also affect perspective. The fact that modern communications will allow the president to talk directly to the soldier in the foxhole may be perceived as a plus by the president, while the soldier (or the soldier's commander) sees it as a distraction. The military services may see a new approach to acquiring C^2 equipment as streamlining, while Congress sees it as an invitation to fraud. A restriction an intelligence officer sees as necessary to protect sources may be perceived as an obstacle to thorough planning by an operational commander. While the White House focuses on how to improve information flow upward, from the field to the commander-in-chief, the military may be more concerned about getting needed information to the battlefield commander. In short, C^2 issues offer many opportunities for honest men and women to disagree about what constitutes an improvement.

INTERACTION NEEDED

While such a variety of perspectives can be fruitful, being so requires that holders of the various perspectives talk with each other. Without interaction, different perspectives can lead to distrust, misunderstanding, and unnecessary confusion.

In the old tale of the blind men and the elephant, each one of the men fooled himself into believing the part of the elephant he had in his grasp was the key to the elephant's essence and that his peers were both literally and metaphorically blind. Thus, in the absence of real dialogue, differences of perspective can lead to long and fruitless pursuits down multiple blind alleys. That has often been the case in the domain of C^2.

The fruitful development of that domain requires the participation of the military—Services and CINCs—with their knowledge and experience of operational conditions; of engineers, with their grasp of what is possible; of theorists, who can provide insights into the functioning of the human elements in C^2 systems, as well as the broader picture of what such systems should be designed to do and how their elements should fit together; of contractors, with their sense of economic realities; of politicians, who can articulate both political and fiscal requirements; and of taxpayers, who will be asked to pay the bills.

COSTS OF EGOCENTRICITY

The exclusion of one or more of these perspectives can result in costly, tragic C^2 failures. Historically, many such failures have resulted, not from a lack or breakdown in C^2 equipment but from shortcomings in other aspects of the C^2 process. Half a century ago, a "coordinating" failure at Pearl Harbor cost the United States 3,472 casualties, 18 ships, and roughly 200 airplanes.[26] Both Admiral Husband E. Kimmel, commander-in-chief of the U.S. Pacific Fleet, and Lieutenant General Walter C. Short, commanding general of the U.S. Army's Hawaiian Department, were charged with "dereliction of duty" for their failure to coordinate with each other on defensive preparations for the island.[27]

More recently, according to Raymond Tate, former deputy director of the National Security Agency, a coordination failure involving confusion and poor judgment in multiple lines of command led to the North Korean capture of the USS *Pueblo* in 1968 with both loss of life and embarrassment for the nation.[28]

In the controversies surrounding the failure of the mission to rescue American hostages held in Iran in 1980 and the terrorist bombing of the Marine barracks in Beirut in 1983, one recurrent note concerns "planning" failures. Some critics argue that planning for the rescue mission was unnecessarily complex, allegedly because the planners wanted to make sure all the military services got a piece of the action, and unrealistic in failing to allow adequately for the friction of war.[29] Whatever other shortcomings may have played roles in the loss of 230 U.S. Marines in the Beirut bombing, the failure to take into account intelligence and security needs was central.[30]

Clearly, multiple factors were at work in these and other incidents, such as the failure of the USS *Stark* to defend itself from an Iraqi attack in 1987 and the USS *Vincennes'* unwarranted downing of an Iranian airliner a year later, but all were in some sense C² failures. In a nuclear confrontation, the cost of C² shortcomings would likely be far greater.

SENSE OF DIRECTION

The first step toward avoiding such shortcomings is deciding where we're headed. To that end, this statement of C^2 "philosophy" by General John W. Vessey, Jr., former chairman of the Joint Chiefs of Staff, offers useful guidelines. The statement's particular value lies in its implicit recognition of the balancing acts involved in C^2:

> Our philosophy of command and control is disciplined by the underlying principle that decisions are made at the lowest possible level so that flexibility is given along with the resources, authority and responsibility to those who can use them to best advantage—the commanders on the scene. Employing C^2 in a disciplined way means providing the really important information, not superfluous data, to the right people in a timely way up and down the chain, and laterally as well. We do not tie the infantry squad to remote command centers just because we have the capability to do so, nor do we choke important channels to the point we become information rich and execution poor. Our command philosophy requires that we develop systems, concepts, and procedures which provide critical information to the right people at the right time. We must be disciplined enough to provide commanders at all echelons the necessary information and resources and then give them the "rattle room" to exploit situations or to resolve problems under a system in which orders are given in broad descriptions of the intended outcome—rather than as detailed prescriptions of what precisely is to be done.[31]

Technical capacities and warfighting needs constitute one of the balances; information and action, another. One of the most important—and most sensitive—is the balance between control and the commander's autonomy. Getting these and the many other balances involved "right" is an ongoing struggle, rather than a one-time adjustment. Therein lies the real challenge of C^2.

THE DEFINITIONS WE'RE USING

Before we begin to examine the nature of that challenge more closely, a little housecleaning seems in order. As we've spent this chapter juggling sometimes overlapping, sometimes contradictory views of what constitutes C^2, it may be useful to close by stating the C^2 definitions we'll use throughout this book:

> In general terms, C^2 is everything an executive uses in making decisions and seeing they're carried out; it includes the authority accruing from his or her appointment to a position and involves people, information, procedures, equipment, and the executive's own mind. A C^2 process is a series of functions which include gathering information, making decisions, and monitoring results. A C^2 system is a collection of people, procedures, and equipment which supports a C^2 process.

Like the "official" definition of C^2 on which it's based, this statement is very broad, and C^2 specialists who wish to will have no difficulty finding fault with it. However, as we've seen in the course of this chapter, any narrower view of the topic is difficult to justify.

3

C^2 Technology

While the fundamental nature of what we call C^2 has remained unchanged throughout history, modern technology has extended its reach. Today's C^2 allows commanders to see further, control larger forces, access and digest more data, and—in theory—make decisions faster and more reliably. However, while our technological edge is vital and must be maintained, we can't dump the entire burden of C^2 on technology. Most C^2 failures of this century have resulted from human mistakes rather than a lack of equipment or equipment failure. Furthermore, advanced technology brings with it its own limitations and vulnerabilities. The bottom line is that C^2 technology won't be a "force multiplier" unless we acquire, maintain, and use it intelligently.

As we observed in the last chapter, a common misconception equates C^2 with equipment or technology.[1] Most engineers, military commanders, theorists, and contractors know better. They know technology can be used to support C^2, but they also know C^2 transcends technology.

Let's take another look at the Lawson model of C^2 as we consider how technology can support the process. Because it's relatively simple, Lawson's model avoids the pitfalls of efforts that try to account for all the nested, parallel, and iterative activities characteristic of real-life C^2 processes. In other words, anyone who tries to build a model covering everything that goes on in C^2 ends up with something too complicated to be much use in understanding the process. A simple, abstract model like Lawson's misses most of the details but aids understanding, as long as we remember the model shows just a tiny piece of the process. It's like a still photo—a frozen moment at one of many levels.

What elements in the C^2 process can be supported or improved by technology? Well, satellites—which can take pictures of extraordinary resolution over just about any target area, or eavesdrop on communications, or intercept telemetry (the signals used to track and monitor the status of missiles), or monitor weather patterns—can provide invaluable support for the *sense* function, as can radars and other sensors. Computers that sift through and analyze the mountains of raw data made available by satellites and other high tech sensing systems can make the *process* function feasible. They can also shape the data in ways that allow them to *compare* the actual state of natural conditions and enemy and friendly forces with the desired state. Computers can also support the *decide* function by giving the commander fast access to relevant maps, environmental details, and expert advice—anything from a data bank of principles, doctrine, military history, political objectives, and so on to sophisticated syntheses of these elements. Finally, secure communications systems linking commanders and subordinates can help translate decisions into actions, thereby supporting the *act* function.

PROCESS VERSUS TECHNOLOGY

Even this sketchy outline of the ways technology can be brought to bear on the C^2 process makes the mistaken identification of C^2 with technology more understandable. Because the technology of the Information Age lends itself to supporting every phase of the C^2 process and because, being expensive, it gets a lot of attention in budget discussions, it's quite easy to overlook less flashy elements of the process. However, as we noted in discussing the football analogy, the process existed long before the technology came into the picture. General Robert Herres, U.S. Air Force, former vice chairman of the Joint Chiefs of Staff, asserts that C^2 functions are essentially timeless:

> When Alexander stood on top of a hill, maybe in his chariot, and hollered to his troops, "That company over there move ahead 100 yards, and that company over there move sideways 50 yards, and that company charge," or whatever he told them, he was using a command and control system. He may have communicated with runners, he may have used flag signals, he may have just hollered at them. He was standing on a hill because he could see better, and he was using his eyeballs for sensors. He was probably listening, because you can tell a lot by what you hear. If one company is hollering a little louder than another, then it's bound to mean something to an experienced field commander. He puts all that together in his mind, he makes decisions, and he gives direction to control his forces. He gets feedback by watching what's going on, what the enemy's doing, what his forces are doing, and how they're progressing as they engage.[2]

Whether it takes place primarily in the mind of a commander or over a computer network linking the president, CINCs of the operational commands, and battlefield commanders, the C^2 process has its own identity, independent of any technology involved.

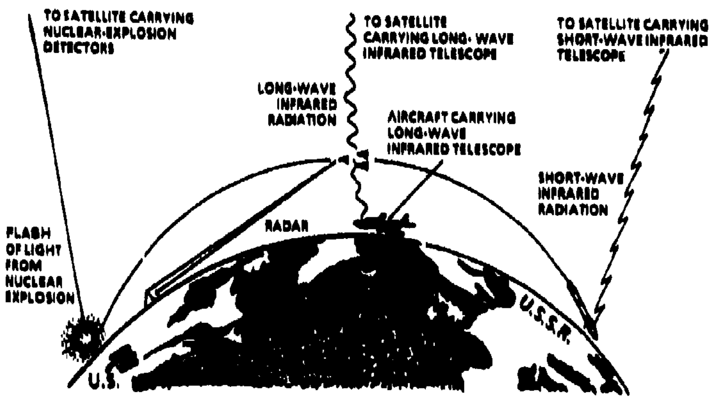
TECHNOLOGY'S SUPPORT OF C^2

With that important caveat in mind, let's look at specific ways technology has been brought to the support of C^2 in the last decades of the twentieth century. In this chapter, we'll look at some existing and projected uses of C^2 technology, as well as some of its drawbacks and limitations.

In the late 1970s, President Jimmy Carter realized existing C^2 facilities severely limited a president's options for responding to a nuclear attack. Because those facilities were vulnerable, presidents could not be sure they or any of their links with U.S. military forces would survive an initial nuclear attack. This meant that upon receiving warning of an incoming nuclear attack, a president would have to decide—probably within a few seconds—whether or not the warning was valid, from where the attack was coming, and whether to respond by launching all U.S. nuclear missiles and bombers—in "one orgasmic whump," as one presidential adviser put it[3]—or to sit out the attack and risk losing the ability to respond in any form. End the world or capitulate: those seemed to be the alternatives a president would face.

In a series of presidential directives, President Carter called for measures that would strengthen strategic C^2. Command posts were to be "hardened"—i.e., physically protected against the effects of a nuclear attack—facilities for warning upgraded, and communications made more resilient, through a combination of hardening and redundancy.

The impact of Carter's initiatives, coupled with growing enthusiasm for theories like Colonel Boyd's



Satellites and improved radar systems for attack warning and assessment
Source: Based on a figure by Ashton B. Carter in "Command and Control of Nuclear War," copyright *Scientific American* 1985.

about executing C² faster in order to get "inside" the enemy's decision cycle, led to an unprecedented interest in enhanced C² at all levels as the 1980s began.[4] As we noted earlier, President Reagan sustained and extended Carter's C² initiatives. According to former Chairman of the Joint Chiefs of Staff Admiral William J. Crowe, Jr., the C² program quickly became "the fastest growing part of the DoD budget."[5]

Budget equals *dollars,* and most of the C² dollars of the 1980s were spent on technology. At the strategic level, they bought the president more resources for evaluating an apparent nuclear attack.

For example, the C^2 budget paid for the continued development and deployment of the Defense Support Program (DSP), a system of satellites which carry short-wave infrared sensors capable of detecting the heat of a missile exhaust plume.[6] Another C^2 development was the Nuclear Detection System (NDS) carried aboard satellites of the Global Positioning System. The NDS combines light, X-ray, and electromagnetic pulse (EMP) sensors to provide immediate location, height, and yield assessments for nuclear explosions.[7] The DSP satellites provide information about launches of ground-based missiles—the most accurate type and greatest threat to our own intercontinental ballistic missiles (ICBMs); the NDS would detect impact of submarine-launched ballistic missiles (SLBMs) which could strike the United States ten to twenty minutes before the ground-based missiles. Between them, the two systems give the president more timely and accurate information about the dimensions of an attack. The NDS also provides damage assessment, allowing us to determine quickly the kinds and extent of damage done to us as well as the impact an initial U.S. response has brought on the enemy.[8]

The Carter and Reagan C^2 budgets also provided for the modernization and expansion of ground radar systems for detecting missile attacks. The computers and software of the Ballistic Missile Early Warning System (BMEWS) radars were updated and replacement of the older radars at Thule, Greenland, and Fylingdales Moor, England, with new phased array radars was begun.[9] Additionally, two new "Pave Paws" radars improved our ability to detect SLBMs.[10]

The C^2 budgets of the 1980s also funded the construction of over-the-horizon backscatter radars (OTH-Bs) to detect and track threatening aircraft and cruise missiles. According to Donald C. Latham, assistant secretary of defense for C^3I under President Reagan, the OTH-B system provides "complete continental United States coverage against air-breathing threats."[11]

Additionally, the C^2 initiatives of the 1980s strengthened the links between the president and the sources which would provide attack warning and assessment, and the links to forces that would carry out presidential orders to respond to an attack or other threat. The Defense Satellite Communications System (DSCS III) was upgraded to provide more dependable Super High Frequency (SHF) communications.[12] Two other satellite systems, the Military, Strategic, Tactical, and Relay Satellite Communication System (MILSTAR) and the Navy's Fleet Satellite Communications System (FLTSATCOM) were designed to provide Extremely High Frequency (EHF) and Ultra High Frequency (UHF) communications channels.[13] MILSTAR, hardened against physical threats, including high-powered lasers and EMP, would supplement the more capable but vulnerable FLTSATCOM and DSCS in times of crisis or war.[14] All of these systems could be used in conjunction with relay aircraft and rockets as alternatives to vulnerable telephone land lines. The Ground Wave Emergency Network (GWEN), another communications system developed in the 1980s, consists of a series of low frequency (LF) towers that can relay low data rate messages between command centers.[15]

Part of the C^2 budget was devoted to providing alternative shelters and command posts for the nation's leaders. The National Emergency Airborne Command Post (NEACP, usually pronounced "kneecap"), a specially configured Boeing 747 developed in the 1970s, would carry the president or the president's successor to an altitude where line-of-sight techniques would link the commander-in-chief to the strategic forces. Under President Reagan, the four NEACPs were "hardened" to protect them against a variety of potential threats, including EMP.[16] The Reagan C^2 money also bought additional fixed and hardened command posts, as well as ground mobile command posts.[17]

Richard S. Beal, who, until his death in 1984, directed crisis management planning for President Reagan, helped bring technology to bear directly on the *decide* phase of the Lawson model.[18] Prior to Beal's arrival, the president and his chief advisers in a crisis had met in a room equipped with little more than tables, chairs, and pencils. Beal put together a state-of-the-art command post, complete with the latest capabilities in digital and graphic displays, data base access, and communications equipment. He focused much of his attention on gathering all the background information and "real time" data available pertaining to the crisis at hand and "crunching" it into an easily assimilable form—usually graphic—for a president hurried by an avalanche of information from around the world.

The interest in C^2 impacted lower levels of the national security structure as well, with the development and fielding of tactical equipment. The Global Positioning System (GPS), a satellite system designed to provide an instantaneous navigational fix for aircraft, ships, submarines, ground vehicles, and even individuals, belongs in the grey area where strategic and tactical concerns overlap. As mentioned earlier (see page 60), the GPS satellites carry the Nuclear Detection System packages.

A major tactical communications system developed in the 1980s for the Army, the Marines, and the Air Force is the Single-Channel Ground and Airborne Radio System (SINCGARS). SINCGARS is capable of switching frequencies roughly 100 times a second to avoid jamming and interception.[19] The system was designed as a replacement for the standard FM field radio used since Vietnam.[20]

Development of the Joint Tactical Communications Program (TRI-TAC), a system supposed to allow different military services to communicate with each other as well as with allied forces, continued under Presidents Carter and Reagan, supported with varying degrees of enthusiasm by the military services. One element of the TRI-TAC system is the Army's Mobile Subscriber Equipment (MSE), designed to link all units—from the corps to brigade components—at a cost of over four billion dollars, "the largest procurement of tactical communications in the history of the Army."[21] MSE provides voice, data, and facsimile services over a network similar to civilian cellular systems.[22]

Even more ambitious is the Joint Surveillance Target Attack Radar System (JSTARS). JSTARS uses a synthetic aperture radar system, capable of providing images of targets at great distances, in a modified Boeing 707, the E-8A.[23] The E-8A acquires targets and relays target data to attackers through AWACS and mobile ground stations developed by the Army.

The Joint Tactical Information Distribution System (JTIDS) was designed to provide U.S. and NATO forces with a secure, jam-resistant, high-capacity data link, from both internal and external sources, of "near real-time" data on enemy aircraft: the JTIDS data link can provide detailed information about the location and identity of many different targets.[24] A variety of airborne warning and control aircraft and fighters can carry the system; ground and shipboard terminals can also be used in air defense applications of JTIDS.[25]

INTEGRATED SYSTEMS

Calls for C^2 development at all levels grew steadily, from the early 1980s, when Lieutenant General John H. Cushman assessed theater C^2 as "gravely deficient," through the 1986 passage of the Goldwater-Nichols Defense Reorganization Act motivated, in part, by a desire to give the CINCs of the operational commands more control over the design and acquisition of C^2 equipment.[26] One approach to meeting that demand is the integration of strategic and tactical systems. We can get a sense of what an integrated system might be like—ideally—by looking at Vice Admiral Jerry O. Tuttle's concept of a common data base for military users:

> By everyone having a common database, only changes to that database from any sensor source need to be transmitted, which will reduce communication requirements. Admiral Crowe will be concerned with the world. Admiral Hayes

in Hawaii will be concerned about his AOR [area of responsibility], and will determine what he pulls up from the database. All he wants to know is where blue [friendly] forces and the major red [enemy] combatants are. Whereas Rear Admiral Tony Less, the Joint Task Force Commander in the North Arabian Sea, wants to know more about his environment to a greater granularity, and he does it by profiling the database by emitters, geography, and range of weapons sweep, both the enemy's and his. The database can be further tailored right on down to the ship commanding officer who wants to get a Tomahawk or Harpoon targeting solution. He has got to know more about his environment so he doesn't have a false target and can achieve target discrimination. All of the foregoing can be served by the same database.[27]

PUTTING IT ALL TOGETHER

The Gulf War of 1991 provided many examples of advanced technology being brought to bear effectively in warfare. The opening round saw F-117A Stealth fighters eluding Iraqi radars to attack C² facilities; Tomahawk cruise missiles carrying and following their own digital maps en route to targets hundreds of miles from launch pads on ships in the Persian Gulf; "smart bombs" guided by TV cameras and lasers into air shafts and other small apertures in heavily fortified bunkers; and an array of night vision devices for turning night into day.

Thousands of commercial receivers rushed to the Gulf allowed allied forces to draw navigational support from the GPS satellites. Both DSCS III and FLTSATCOM satellites carried allied communications, and weather satellites kept watch on clouds, sand storms, and other phenomena that might impact military operations.

In terms of dramatic effects, though, nothing outscored the C^2 process that enabled the U.S. Army's Patriot missiles to intercept and destroy Iraqi Scuds. First, various sensors detected Scud launches by infrared means. They relayed data on the launches to NORAD's underground facilities near Colorado Springs, Colorado. There, Space Command analysts computed the missiles' flight paths and fed the information back to the Middle East, where Patriot crews combined it with data from AWACS and other sensor systems to derive interception points. All of this took place within the roughly seven minutes required for a Scud to go from launch to impact.[28]

THE FUTURE: ARTIFICIAL INTELLIGENCE

Most of the C^2 or "battle management" systems envisioned for the twenty-first century would rely heavily on capabilities provided by artificial intelligence (AI), a field focused on building human-like intelligence into machines. Initial AI efforts were aimed at designing systems that could replace human decisionmakers.

By the late 1980s, most of those efforts were being redirected toward a subset of AI called "expert systems."[29] An expert system consists of a data bank of "rules"—often in the form of IF-THEN statements—and a software package that meshes data on a particular problem with the rules in the data bank.[30] For example, an expert system designed to analyze engine problems might reason along these lines:

RULE 1.
IF: the exhaust is smoky, and
the car is backfiring, and
there is a lack of power,
THEN: the carburetor fuel mix is too rich.

RULE 2.
IF: there is a lack of power, and
there is a gray deposit on the spark plugs, and
the engine overheats,
THEN: the carburetor fuel mix is too weak.

RULE 3.
IF: the carburetor fuel mix is too rich, or
the carburetor fuel mix is too weak,
THEN: the carburetor fuel mix needs to be adjusted.

PROBLEM DATA: There is a lack of power.

RECOMMENDATION: Adjust carburetor.[31]

An expert human mechanic receiving this recommendation might say, "Wait a minute. The problem could be water in the gasoline. If that's the case, adjusting the carburetor could do more harm than good." In other words, a human expert's common sense might tell him there were possibilities not included in the expert system's rule base.

Whereas an expert system simply recommends and may be ignored, an earlier AI initiative might have attempted to automatically implement the recommendation without human interference. For those kinds of efforts, common sense was a stumbling block. AI researchers discovered common sense doesn't lend itself to the kind of symbolic representation required for computerized manipulation of data.[32] In more concrete terms, AI systems were unable to cope with "questions of relevance, context, and background" as intelligent people do.[33] Expert systems, by keeping people in the loop, try to sidestep that problem.

SOME AI PROGRAMS

All this is not to say more recent AI initiatives lack ambition. Indeed, expert systems attempt to extend human capabilities at every stage of the C^2 process.

The Advanced Feature Extraction System (AFES), for example, was designed to help photo interpreters establish a bank of rules for object recognition.[34] In turn, the AFES would use those rules as a basis for picking specified objects out of intelligence photos. AFES would support the *sense*, *process*, and *compare* functions in the Lawson model.

Another system, the Automated Exploitation of Large Area Surveillance Sensor (AELAS), would draw data from a variety of technologically based sensors.[35] AELAS would use the data to infer the activities of military units under observation. In this way, AELAS would support Lawson's *process*, *compare*, and *decide* functions.

The Language Access to Distributed Data with Error Recovery (LADDER) system would allow a decisionmaker to formulate natural language questions—i.e., questions in human language, as opposed to questions put in the coded form called "machine language," the traditional medium of computers—to query several data bases.[36] One proposed application of LADDER would provide the capability to track and match friendly and enemy ships and thereby support the *process* and *decide* functions.[37]

Wags accustomed to faulting the U.S. Navy for its misuse of the English language might find the Naval Onboard Message Analyzer and Disambiguator (NOMAD) especially impressive—the irony of its name notwithstanding.[38] The system would help message originators produce clear, efficient, unambiguous messages. After the originator prepared the initial message, NOMAD would feed it back, displaying alternative interpretations and phrasings. The results might look like this:

INPUT:	Periscope sighted by Constellation abt 2000 yds off port qtr, and hs helo vectored to datum. Green flares sighted after visual on periscope. Hs gained active ctc and conducted two attacks.
OUTPUT	
(first):	The Constellation identified an enemy submarine that was at 225 degrees 2000 yards from its location. A helicopter squadron pursued the enemy submarine. The helicopter squadron identified some green flares. By using an active sonar, the helicopter squadron identified the enemy submarine, and they fired twice at the enemy submarine.
(best):	(same as above, except 3rd sentence, which reads: The Constellation identified some green flares.)[39]

After the originator got the feedback, it would be up to him to decide which form of the message to send. He might decide NOMAD's output was too wordy or too redundant, or that the clarity of the NOMAD version was worth the extra words. Perhaps he'd decide to change the original message only to the extent of clarifying who saw the flares. NOMAD would have done its job in highlighting possible ambiguities and giving him options. With its impact on communications, NOMAD would be relevant to Lawson's *decide* and *act* functions.

Another initiative with C^2 implications is the Tactical Planner (TACPLAN) system which would elicit decisionmakers' plans and then highlight any conflicts with a rule base founded on doctrine, principles, "expert" experience, and mission restrictions.[40] In terms of the Lawson model, a system like TACPLAN would support the *decide* and *act* functions.

One of the most ambitious AI initiatives of the 1980s was the Pilot Associate Program which would give fighter pilots computerized sidekicks—a la R2D2 of the Star Wars movies fame—capable of monitoring the plane's systems, assessing combat threats, adjusting the current mission plan in the face of a changing situation, and proposing tactics. In some situations, the Pilot Associate might even swing into action on its own:

> For each threat and proposed response, the manager [Pilot Associate] will either wait for pilot confirmation, or, in some conditions, automatically initiate a response with the opportunity for a pilot override.[41]

In effect, the Pilot Associate could support all of the C^2 functions identified in Lawson's model: *sense, process, compare, decide, act.*

ARTIFICIAL INTELLIGENCE SHORTCOMINGS

Despite the promise of AI, reflected in these and hundreds of comparable initiatives, the field has been consistently blocked by one serious obstacle: the difficulty of making the transition from "toy" problems—the narrowly defined, artificially constrained problems of the laboratory—to real world problems. Artificial intelligence proponents and experts have remained optimistic, but most of their optimism is tied to an elusive future.[42] In the view of Stephen J. Andriole, former director of the Defense Advanced Research Projects Agency's (DARPA's) Cybernetics Technology Office, "AI hype" exceeds "the AI community's ability to produce reliable systems."[43]

Despite some success in programming rudimentary planning and targeting procedures, even the fastest computers are far too slow to make the performance of complex AI tasks practical in a combat context.

Furthermore, our "knowledge engineering" capabilities—that is, our ability to collect information from human experts and translate it into a machine code for computers—is quite primitive:

> We do not have any reliable methods for determining how deep knowledge bases need to be, how fast they must be searched to be useful, or how best to represent them in software. It is possible today to ask two knowledge engineers to estimate the size and characteristics of a knowledge base in a specific domain and receive at least two completely different answers, each of which may in fact be "correct."[44]

REASONS FOR OPTIMISM

Andriole and others are guardedly optimistic about the ability of "neural networks"—problem solving systems based on parallel processing and capable of "learning"—and advances in automated knowledge engineering to move AI toward productivity.[45] However, few AI experts seem inclined to disagree with the view of Paul Lehner, author of *Artificial Intelligence and National Defense*, that "most" initiatives of the eighties and nineties—including programs such as AFES, AELAS, LADDER, NOMAD, TACPLAN, and the Pilot Associate—"will eventually fall short as operational systems."[46]

Many believe what will sustain AI funding and research is not the potential for near-term applications, but the demands of programs focused on the future, ambitious programs like President Reagan's Strategic Defense Initiative (SDI).[47] The requirements of SDI—the full range of C^2 functions within incredible time limitations—make it a fertile context for envisioning AI applications.

Even on more conventional battlefields, technology may put victory beyond the reach of the side that doesn't turn tactical decisionmaking over to machines.[48] The modern battlefield is becoming too lethal and fast changing for men to cope with, as actions and reactions occur with a speed beyond human comprehension. One need look no further than the interplay of Iraqi Scud missiles and American Patriots during the Gulf War to see this. Indeed, what we today refer to as AI capabilities are quickly becoming necessities rather than the stuff of visionary dreams.

At any rate, while AI has generally failed to deliver on its most ambitious promises, we've already seen that's not true of other, only slightly less exotic technologies of the Information Age. Command and control technology has become an essential part of U.S. national security.

WHAT C^2 TECHNOLOGY CAN'T DO

However, we must not allow ourselves to be victimized by what might be called the "principle of gadgetry." C^2 involves more than technology, and efforts to improve C^2 will fail if we limit them to technical fixes. The best equipment in the world won't do us much good if our people don't know how to use and maintain it, or if our commanders don't recognize its capabilities or understand how to make the best use of those capabilities and to work around the equipment's limitations. Great gadgets will never make up for incapable or poorly trained users.

Looking back on American military calamities of the past fifty years, what's apparent is that in many cases our C^2 disasters occurred despite the presence of advanced technology. The radar at Pearl Harbor, for example, "saw" the enemy planes on the morning of 7 December 1941; radios transmitted the warnings. The tragic loss of lives in the *Mayaguez* incident in 1975 occurred despite good C^2 equipment.[49] And in the incidents involving the USS *Stark* and the USS *Vincennes* in the late eighties, state-of-the-art technology simply wasn't able to compensate for mistakes in human judgment: the *Stark* didn't arm its defenses until too late and lost thirty-seven crewmen as a result of an allegedly accidental missile attack by an Iraqi plane. The crew of the *Vincennes* mistakenly turned its Aegis defense system against a civilian airliner, killing 290 people. Even the best technology will not always be enough to keep us from being blindsided as a result of such mistakes or of policy errors.

We also need to remind ourselves that heavy reliance on technological solutions to C^2 problems brings with it its own risks. While it reduces uncertainty by providing more sensors and communications channels, C^2 equipment also increases uncertainty to the extent it's vulnerable. While it provides extraordinary sensors, intercept devices, communications functions, and storage capacities, modern C^2 equipment also creates the problem of information overload. While it allows commanders to do more with less, high-tech C^2 equipment also diminishes the "teeth-to-tail ratio," i.e., the ratio of combat power to support requirements. While it can stabilize a situation by bringing the power of logic to bear on a problem, C^2 equipment can also limit commanders' options unnecessarily. While it can give commanders almost magical abilities to see farther, hear clearer, and think deeper, it can also deceive commanders with illusions of timeliness and accuracy. While it can make more of the external world accessible to commanders, C^2 equipment can also deceive them with hidden flaws.

In short, C^2 technology can't do everything. It can help commanders do more, but it can't replace them. And it can't always compensate for poor human judgment.

UNCERTAINTY

Ultimately, the goal of the C^2 process is to reduce the uncertainty with which commanders must deal. We've seen that technology can support every function of the process. It's clear, therefore, that C^2 technology can help reduce commanders' uncertainty.

However, another category of uncertainty enters the picture when we think about how dependent we've become upon C^2 technology and how vulnerable that technology is. John Grimes, President Reagan's director of national security communications, cautions,

> We have become so dependent on some of these tools that when we do lose the capability under certain circumstances or for a certain function, it causes chaos. . . . In any decision process, from a corporate decision to a national decision, you can soon see that if you don't do some smart things with this technology it can get you in trouble; it's like putting all your eggs in one basket.[50]

OVERCONFIDENCE

Every military theorist and every combat veteran recognizes the unpredictable aspects of war—the "friction" and "fog" of war. Yet, American self-confidence, "can do" attitudes, and faith in our technological capabilities have promoted a view of war which allows little room for fog or friction, a view that emphasizes terms like "surgical strikes" and "zero CEP" (circular error probability).[51]

Daniel Bolger, author of *Americans at War: 1975-1983*, observes that while modern technology has made possible "a quantum improvement" in the accuracy with which ordnance is delivered, it's still misleading to compare the tools of war with those used in the operating room.[52] Addressing the 1983 U.S. bombing of Libya, which he regards as a highly successful undertaking, Bolger writes,

> It definitely did not constitute a "surgical strike," despite Secretary Weinberger's remarks to the contrary on 14 April, unless one normally does precision medical work with one-ton munitions. Bombing Libya with laser-guided weapons was akin to doing oral surgery with a drill press; it was better than a chain saw, but not as precise as a finely honed dentist's drill.[53]

Closely related to exaggerated perceptions of accuracy are unrealistic expectations about reliability. As anyone who has lost several hours of work as a result of one spark of static electricity knows, it doesn't take much "friction" to knock out a computer. The friction of war is likely to have more impact on the delicate innards of chip-based weaponry, communications equipment, and decision aids than it ever did on carbines, signal flares, or Plexiglas boards.

In addition to the threat posed by EMP effects in a nuclear attack, much of the sophisticated C^2 equipment of the Information Age would be vulnerable to more conventional threats, such as jamming, interception, and espionage. Consider the impact espionage, for example, can have on technological advantages: the actions of spies can make those advantages disappear rather quickly.

In the 1970s, the Rhyolite program gave the United States virtually unimpeded access to Soviet missile tests for several years, until two spies alerted the Soviets, leading them to begin encrypting missile telemetry.[54] The work of another spy compromised the results obtained by the KH-11 satellite; the Soviets began covering their missile sites whenever the satellite was overhead after they bought a KH-11 manual for $3,000.[55] In both cases, the spies were U.S. citizens who volunteered to sell the information. More recently, the Walker family compromised our ability to track Soviet submarines.

Countermeasures, counter-countermeasures, and counter-counter-countermeasures are always being sought and discovered. Weak, unhappy, or unbalanced individuals are always available—among the thousands of people involved in the design, production, deployment, operation, and maintenance of today's complex systems—to betray secrets. And with that betrayal comes the sudden loss of technological advantage.

Such potential loss is the kind of threat usually only the pessimistic or farsighted will consider. Our planning and exercises have tended to assume perfect information flows—without the complications of interference or interception.[56] The resulting uncertainty is particularly subtle and dangerous: an enemy weapon detonated in the right spot, an effective jamming device, or a nice piece of espionage work could suddenly blunt the leading edge of technology, leaving those dependent upon it deaf, dumb, and blind.

INFORMATION OVERLOAD

Another problem inherent in the particular strengths of Information Age technology is information overload. As one admiral puts it, "It used to be tough to find out the location of an aircraft. Now I get not only that but also the aircraft oil pressure, fuel remaining, and other aircraft in the vicinity."[57] We're very good at collecting huge amounts of data. We're good at storing that data. We're also getting better at manipulating data electronically to put it in more useful forms. These are major technological accomplishments of the Information Age.

Unfortunately, having the most data isn't necessarily a component of victory. Decisionmakers, including commanders at all levels, often need particular pieces of information rather than mountains of data. It's probably more important to know the single fact that an enemy is massing forces on our border than it is to have a vast array of detailed technical data on all the weapons systems that enemy possesses. Even if our mountain of data contains key information, that information will have no value if it isn't available at the right moment to help the decisionmaker.

We can alleviate the overload problem by putting a filter system or a fusion system between the collection point and the decisionmaker. A filter system would pull out and make available to the decisionmaker only those bits of data which would be helpful to him or her. A fusion system would, like Beal's crisis management system, "crunch" all available data into a condensed, easily digested form—e.g., pictures, pie charts, etc. One problem with such systems is that pieces that don't fit tend to get reshaped or dropped out. Inconsistencies, which might otherwise alert the decisionmaker to flaws in the information, disappear; quantitative discrepancies get averaged out. Furthermore, a potential for conscious or unconscious manipulations arises as soon as a decisionmaker tolerates the intervention of a filter or fusion system between himself or herself and the raw data, regardless of whether the intervening system is human or computer based. In bureaucratic terms, a new power center comes into being.

Overload is a problem for all decisionmakers, from the White House—where the president is confronted by over 600 high-priority messages every day[58]—to tactical headquarters, on the receiving end of "downlinks" from satellites and AWACS and linked as well with superior, subordinate, and parallel headquarters. So, the positive impact of our collection systems is undermined by shortcomings in analysis capacity.

HIGH SUPPORT REQUIREMENTS

Another paradox of C² technology concerns the impact of the technology on the "teeth-to-tail" ratio. Ideally, superior C² equipment should enable commanders to use their forces more efficiently: to develop creative strategies and tactics, to anticipate the enemy's moves and counter them, to spot critical points as they're developing, to mass forces where they're most needed, and so on. In other words, superior C² equipment should allow commanders to do more with less.

What happens in practice is the C² equipment designed to sharpen a combat unit's "teeth" also tends to swell its support "tail." Advanced C² equipment, like complex weaponry, requires extensive training of users as well as maintenance people. Ironically, while the extent of the training grows, its application narrows. According to Lieutenant General Clarence E. McKnight, U.S. Army (Ret.), former director for C^3 systems for the Joint Chiefs of Staff, "With rapid obsolescence of new electronics devices, some would say that new generations of equipment are being introduced every three to five years."[59] Military training programs are highly focused: the individual does not study communications but is trained in the use or maintenance of a particular radio, or computer, or antenna. All those "new generations of equipment," therefore, make necessary new generations of trained maintenance people and users. Furthermore, because the military services can't afford to discard an older generation of equipment every time a new one appears, they must be able to build the "interfaces" which enable old and new equipment to work together. Thus, the training, maintenance, and engineering requirements generated by C^2 equipment offset some of the capacity to "do more with less" such equipment is supposed to offer.

NARROWNESS OF VISION

Another strength of computers, as mentioned earlier, is the potential to bring a measure of stability to the chaos of the modern battleground by providing commanders with access to automated expertise—data banks of principles, doctrine, objectives, rules of engagement, current conditions, and so on. A system such as TACPLAN, for example, would sound an alarm if a commander's decision violated any of the "rules" contained in the system's data bank. With TACPLAN and comparable systems, technology could give the most junior and inexperienced commander immediate access to the wisdom of the ages.

There is, unfortunately, a downside to this boon also. The data bank of such a system could become a blinder to a commander. The primary components of such a data bank would be history and logic. History would contribute the "rules"; logic would drive their application to a battlefield or crisis situation.

Without the history, there could be no "principles" or "doctrine." Even "objectives" and "rules of engagement" are usually based on lessons from the past. But history can be misapplied. It can mislead decisionmakers who make faulty or incomplete analogies.

In the early stages of what was to become the Cuban Missile Crisis, the Central Intelligence Agency (CIA) argued that, as the Soviets had not put nuclear missiles in Eastern Europe, it was unlikely they would put them in Cuba.[60] Viewing the crisis retrospectively, analysts realized medium range missiles in Eastern Europe could be turned against Moscow, while the same missiles in Cuba would never be a threat to the Soviets. The CIA had drawn its analogy too narrowly.

Not every compromise in international relations is an act of appeasement, a replay of Munich; not every division of forces ends in a Little Bighorn.[61] And no battle-proven principle of war is necessarily applicable to the battle at hand. Thus, a tool such as TACPLAN, driven by history but lacking in intuition, could induce a commander to make decisions more appropriate to past wars than to the present one, to display "the same deficiency that generals in the past have so often been accused of—fighting the next war in the way that ended the last."[62]

Logic, also, can be misleading. Ironically, it's history which allows us to see this. Alexander's assault on Darius' much larger force didn't seem logical—but it worked. Wolfe's climb to confront Montcalm flew in the face of traditional logic—but it worked. As Anthony G. Bohannan, a former senior officer in the British Army, observes,

> Military history tells us time and again that it is the commander who has the courage to defy conventional logic and precedence and who reacts to his instincts contrary to the available information and consensus, who more often surprises his opponent and wins.[63]

The Marine Corps' manual, *Warfighting*, makes essentially the same point:

> A military decision is not merely a mathematical computation. Decision making requires both the intuitive skill to recognize and analyze the essence of a given problem and the creative ability to devise a practical solution. This ability is the product of experience, education, intelligence, boldness, perception, and character.[64]

"Conventional logic" tends to be narrow in scope. When an Alexander or a General Wolfe devises a strategy beyond the limits of that scope, the plans appear illogical to someone with a conventional perspective. One of the most impressive aspects of human intelligence is its capacity to range beyond the conventional. So far, computers have not been able to emulate that talent.

Shortly after BMEWS came into operation in 1960, computers designed to interpret the readings made by BMEWS radars reported a massive missile attack on the United States. One of the officers in a group convened to determine whether the warning was accurate happened to remember that Nikita Khrushchev, the Soviet premier, was in New York at the time. That bit of information helped convince the group the alert was false; it seemed unlikely the Soviets would attack this country while their leader was in such a vulnerable position.[65] Analysis eventually determined that the BMEWS radars, much more powerful than the ones they had replaced, had received radar echoes from the moon—a possibility not considered when the software for the computer was being written.[66]

Could a computer have reached the conclusion the humans reached? Only if it had been programmed to. And what programmer would be likely to include a search for Khrushchev's whereabouts among the commands to be executed in response to a positive radar echo? If such an omniscient programmer existed, would the computer's data base be equal to the ambitious task set for it? Would Khrushchev's location be updated every day? Every hour?

In 1960, wide-ranging human speculation led humans to override the computer's judgment. Computer-generated false alerts in 1979 and 1980 were also subjected to human judgments and overridden: the North American Aerospace Defense Command's procedures for checking and cross-checking attack warnings are reassuringly extensive and dominated by human judgment.[67] Still, computers carry an aura of authority that could overwhelm the judgment of too credulous commanders.

ILLUSIONS OF TIMELINESS AND ACCURACY

Sometimes enthusiasts confuse ideal capabilities and realities. We see this in the stereotypical "nerds" who try to use their computers to compensate for limitations in their own interpersonal skills: shy and tongue-tied in person, they are able to move glibly among the exchanges on electronic bulletin boards and believe they are developing their social skills. Presidents in their situation rooms and commanders in their control centers are liable to face analogous illusions if they equate their sophisticated graphic displays with the realities of the battlefield or crisis scene. One observer compares Richard Beal's data compression and display techniques with those to be found in the *USA Today* weather page: "You look at it, you don't have to read a thing and you can understand what that weather is just by colors."[68] But the "colors" seen by a reader in Chicago may not resemble the reality experienced by a rancher looking at the sky in Colorado. The colors are based upon indications read and assumptions made at the time the paper was being put together, but the rancher's information is "real time." Readers in Chicago would understand this distinction if they stopped to think about it, but chances are they won't do that.

John Keegan points out that Hitler in his headquarters was "deluded by the apparent instantaneities of the radio, telex and telephone" into believing technology was providing an accurate picture of reality:

> Floods of information, collected and transmitted apparently in "real time," arrived at his situation conferences with significant delay; precise and detailed orders, seemingly attuned to realities, returned from him to the point of action only after realities had moved on. The disjunction between intention and effect resolved itself in the undignified and impotent tirades to which the Fuhrer subjected his subordinates, both in headquarters and at the front when events were revealed to have escaped his directions.[69]

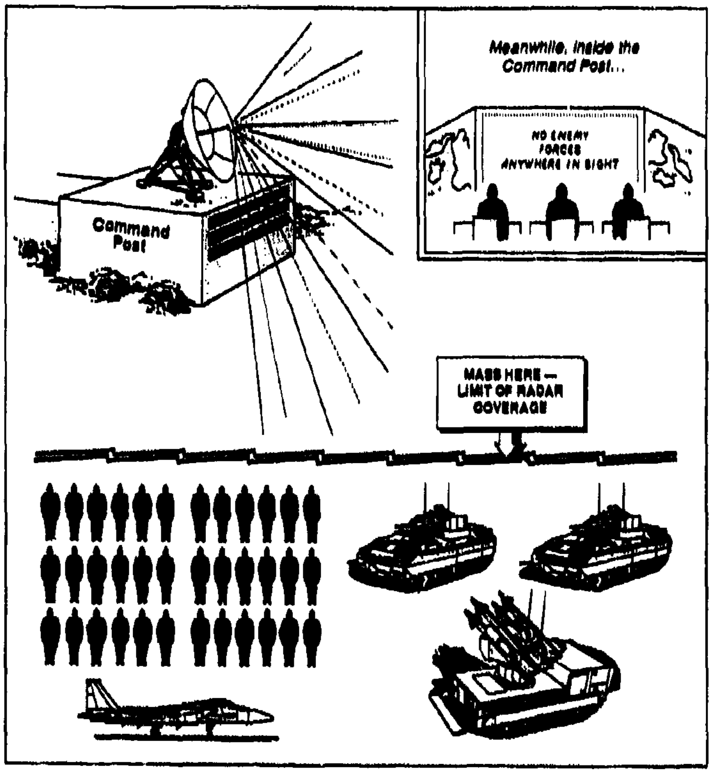
As a result, writes Keegan, Hitler's judgment was "affected by all that was and is worst about both the chateau generalship of his own youth and the elaborately mechanized or automated command centers of our day."[70]

One might argue that the pace of information collection and relay today has increased well beyond that of Hitler's day—in the time of "radio, telex and telephone"—and that the information displayed in the situation room or command post today is closer to "real time." However, the pace of change, reflected in greater force maneuverability and speedier weapons, has increased as well. Furthermore, the increased volume of collection means more time must be devoted to analysis and correlation with other sources, and that extra time is added to the delay between collection and display. Ultimately, today's graphic displays could be as misleading as Hitler's charts and force maps.

Commanders depend on information that, to a great extent, has been collected and analyzed electronically:

> Those remotely derived assessments will be presented to commanders and staff through electronic displays that suppress or mask uncertainty resulting from such factors as sensor range/resolution limitations, environmental constraints, human assumptions and bias, imprecise or ambiguous language, interference, enemy deception and countermeasures: in sum, the fog and the friction of war.[71]

As Clausewitz observed, such hidden uncertainties are especially dangerous.[72]



Sometimes electronic assessments mask uncertainty

According to Stuart E. Johnson and Alexander H. Levis, experiments suggest information "arriving in message format or displayed on a screen" has more credibility than information presented by another human being.[73] When commanders receive advice from their staffs, they usually treat it with a degree of skepticism. They know the people on their staffs, and they know those people are not perfect. They realize the information they provide may be incorrect or incomplete; their advice, flawed. The sacrifice of such healthy skepticism to an illusion of certainty is dangerous.

Future generations, raised in a computer-oriented world, may be more realistic about both the strengths and limitations of computers. They may be appropriately skeptical, less likely to be victimized by either irrational fears about computers or misguided faith in their aura of infallibility. Unfortunately, such balanced views are still rare.

HIDDEN FLAWS

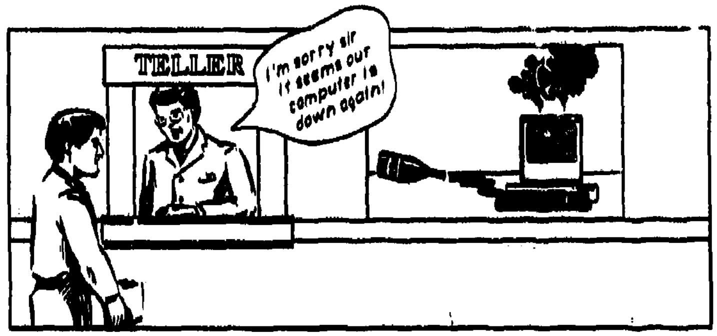
Computers and the software that drives them are designed and put together by human beings as flawed as any others. Even the best, most thoroughly tested software carries hidden glitches that can freeze the computer at a critical moment. This fact was driven home to AT&T on January 15, 1990, when a software problem at a switching center disrupted long-distance telephone service for the whole country.

One of the most popular and capable word processing programs, a program first marketed in 1982 after extensive testing, was by 1990 in its fifth edition. That's four major overhauls in seven years. And, even in the fifth edition, the company marketing the program was offering almost monthly updates. Some of those updates involved additional or improved features. Most simply fixed problems discovered by users in attempting to issue a rare and untested sequence of commands or to use the software with "standard" machines that turned out to be almost standard.

A minor engineering difference in a machine may seem completely insignificant until a particular machine meets up with a particular piece of software. Because the aspect of a program that causes a system to "crash"—that is, causes the computer to freeze and refuse to do anything else, even leave the program—can remain hidden for years, the user can never be 100 percent sure he won't encounter a glitch with the next keystroke.

This element of uncertainty applies to military computers and software at least as much as it does to the computers and software used in the private sector. While thousands of users will push a word processing program and related hardware to their limits every day, it's hard to do that with a military system once it's in use.

One big difference between military systems and privately owned systems is that while the individual or private company may decide to buy the most expensive system in order to have the most capable and reliable one available, the military is usually required to go with the lowest bidder. There are exceptions to that rule, and it would be inaccurate to say military computers are less reliable than those



"Our computer is down"

found in private companies. However, the assumption that military computers are somehow better than the ones so often "down" at the local bank or the ones that send us other people's bills is simply unwarranted.

In fact, while the bank is probably using a system marketed recently, the bureaucratic intricacies of the military procurement system ensure that many systems in use by the military are ten to fifteen years behind the leading edge of technology.[74]

DEPENDENCE

Another problem associated with technology is dependence. Some parents today worry that use of electronic dictionaries may cause their children to forget how to spell on their own. Parents ten years ago voiced comparable concerns about calculators. They were afraid a child used to pulling out a calculator when faced with any arithmetic function would soon forget how to add and subtract "in his head."

Those fears haven't been realized, and it's likely that electronic dictionaries will help build good spelling habits rather than contribute to illiteracy.

However, it would be foolish to claim that dependence on technology never causes problems. When calculators fail, we can temporarily resort to the use of fingers or a slide rule, if anyone has one and remembers how to use it. When electronic dictionaries crash, we can drag out the battered old manual dictionary. Other manifestations of "high tech" are harder to replace.

In the late 1950s and early 1960s, fighter pilots assigned to the Air Defense Command (ADC)—the command then charged with protecting U.S. skies from enemy intrusions—relied heavily on a C^2 system called the "Semi-Automated Ground Environment" (SAGE). SAGE managed their interceptions of unidentified violators of the airspace, assigning individual fighters to specific intruders, guiding the fighters to an appropriate intercept point, telling the pilots when to arm and fire their weapons, and so on. Just about the only thing the pilots had to do was take off and land. SAGE had its problems, and both pilots and controllers often cursed it. But many of them relied on it more than they realized.

This reliance became evident when former ADC pilots found themselves assigned to the Tactical Air Command (TAC) and flying missions over North and South Vietnam. Without SAGE, they felt lost. Most of the new TAC pilots made the adjustment. Some did not.

As we seek and acquire increasingly sophisticated and capable C^2 systems, we would do well to continually remind ourselves of the lesson learned by the ADC pilots: some days, it's just us and the seats of our pants. SAGE was far too big to move around. Much modern C^2 technology is a lot more flexible, but it's also likely to be a high-priority target for any enemy, as Iraqi C^2 technology and facilities were during the Gulf War of 1991. We better be prepared to operate without a system, unless we've built into it a lot of redundancy. And redundancy is expensive.

USING C^2 TECHNOLOGY INTELLIGENTLY

To be able to function independently of high-tech C^2 equipment when necessary, we have to practice doing so. Realistic training exercises must include sudden, catastrophic losses of supporting C^2 equipment. Current exercises, though infrequent, are beginning to include such scenarios.[75] Our goal should be exercises that occur frequently and with enough variation to keep all commanders aware of the support made possible by sophisticated C^2 equipment. Such exercises should also prepare commanders to compensate for the loss of such equipment.

Given the high cost of exercising—both in terms of money and capabilities revealed to alert enemies—it's often advisable to use advanced simulators to re-create combat scenarios. This use of computer-driven simulations offers a good example of technology employed to maximize human potential—the logic and memory of computers stimulating the creativity of humans.

Human flexibility and common sense transcend the realm of logic. For that reason, human minds can go where machines do not and explore possibilities that would never occur to a machine. Until the time when computers are driven by a more flexible system of logic—and there is little to suggest that time is near—AI is unlikely to deliver on its most ambitious promises.

In the meantime, however, computers offer the advantages of more thoroughgoing logic and more dependable memory searches than humans. While the human mind can go beyond the grasp of a computer, it won't always do so. Sometimes, as in the case of computer-simulated war games, computers and other types of C^2 equipment can supply the nudge human minds may require.

Today's computers aren't capable of the kind of improvisation displayed by the human crew of United Flight 242 in mid-1989 as their DC-10, crippled by the loss of all three hydraulic systems, struggled towards its crash landing in Sioux City, Iowa. Without the capacity for such skill and heroic effort, computers can't replace human commanders on the battlefield.

It's important to remember, though, that computers did fly the United plane while its human crew concentrated on the hydraulics problem. The computers took care of the standard operating procedures, while humans coped with the non-standard emergency.

Technology has its vulnerabilities; human beings have theirs. Both have special strengths, too. We may find one of the benefits of distinguishing between C^2 on the one hand, and the technology which supports C^2 on the other, is that doing so opens the possibility of discovering creative ways to draw on the best which both human minds and computers have to offer.

4

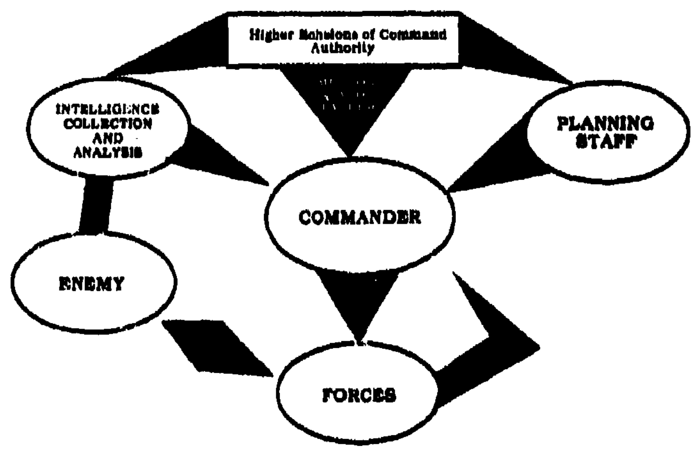
THE HUMAN AND ORGANIZATIONAL ASPECTS OF C^2

The commander is the linchpin of C^2. The commander is also human and brings to C^2 all the flaws we associate with human beings. As we learn more about human nature and cognitive development, we may be able to increase the capabilities of commanders. However, human strengths and weaknesses will always have an impact on C^2, as will the pluses and minuses of various organizational schemes.

The effectiveness of C^2 ultimately depends upon the human commander at the heart of every C^2 process and system. Genghis Khan shaped the fighting formations and established the harsh, effective discipline which made his Mongol forces legendary. Alexander the Great conceived and made work the battle plan which enabled his 30,000 troops to overcome the Persian king Darius' 200,000 plus at Issus. General Douglas MacArthur dared to engineer the Inchon landing during the Korean War.

THE COMMANDER AND THE C^2 PROCESS

Like all human beings, military commanders are complex bundles of personality, education, experience, emotion, and physical sensation. Like all human beings, military commanders have individual limitations, and no C^2 process is better than the commander running it. As General Cushman observes,



The C^2 cycle—commander as "nodal point"
Source: Robert T. Herres

sometimes the best fix for a C^2 problem is to replace the commander.[1]

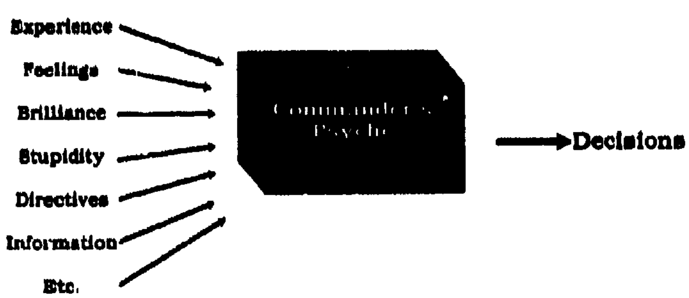
In *The Functions of the Executive*, Chester Barnard argues that the primary role of executives is to facilitate the movement of information—"to serve as channels of communication so far as communications must pass through central positions."[2] The military commander is the particular executive in whom we're interested. "War is primarily concerned with two sorts of activity—the delivering of energy and the communication of information," according to Norman Dixon, and military commanders occupy "nodal points on a complex communication network."[3]

The commander's function in this network is clear as one reflects on the list of command activities offered by General Herres: "The commander must bring together knowledge about his forces and their capabilities, combine that with a review and understanding of his adversary and select the timing, locations and force structure for engagements."[4] Not simply a communications channel, this particular "nodal point" does something to the information it receives: it transforms that information into decisions.

PSYCHE COLORS DECISIONS

The commander's whole psyche is a matrix from which those decisions derive; they cannot but be colored by that psyche.

Thus General MacArthur's enthusiasm for history influenced his plan to land at Inchon: emulating Wolfe's strategy against Montcalm, he used surprise to defeat the North Koreans whom he correctly as-



The commander's psyche colors decisions

sumed would think a landing at Inchon impossible.[5] By the same token, the obstinacy displayed by Douglas Haig, whose refusal to consider the advice of political superiors, military subordinates, and his own intelligence service led to disastrous British losses at Passchendaele in 1917, has been attributed to his "authoritarian personality."[6]

It is ultimately within the mind of the commander that all information—about goals, enemy and friendly forces, the environment, logistics, and so on—combines with the commander's own background and perceptions to provide the basis upon which decisions about force employment are made. This is true whether the commander is supported by personal knowledge only, the advice of staffs, or by complex data banks.

MODELS TOO NEAT

Considered in the abstract, the decisionmaking process sounds pretty tidy. And, when illustrated by any of the many C^2 "models," including Lawson's, it looks neat too. The problem with these uncluttered abstractions is that they can mislead us into thinking of the commander's job in clinical terms that have nothing to do with the reality.

In combat, all on-scene commanders—regardless of who they are, how much training they've had, or how rational they are under normal circumstances—will experience feelings of fear, indecisiveness, confusion, doubt, fatigue, anger, and loneliness—just like other combatants. They will also live with pain, hunger, and thirst. In addition, what they can accomplish will be limited by their own intelligence, the intelligence of subordinates and superiors, and that of the enemy.

There will be nothing abstract or clinical at all about their jobs. They will be dealing with real people and real death. Dixon observes there's a great gap between the ideal commander—"who may be viewed as a device for receiving, processing and transmitting information in a way which will yield the maximum gain for the minimum cost"—and the real one who must juggle the "incompatible roles" of "'heroic' leader, military manager and technocrat . . . politician, public relations man, father-figure and psychotherapist."[7]

And then there is the "noise." If we think in terms of a telephone or radio, noise is anything which interferes with the transmission of the signal—static, other signals, background noise, etc. Applied to the commander, noise serves as a metaphor for anything that interferes with perfect "receiving, processing, and transmitting." Noise in this sense includes the emotional and physical elements mentioned above, as well as other factors.

In the processing stage, noise may be a preconception that limits a commander's ability to accept information which contradicts his current view of the situation. The unexpected fact, while conveying more information, also is less readily absorbed than something expected.

Dixon illustrates this point with the story of three commanders, each of whom receives word from an intelligence source that the enemy is about to attack.[8] For Commander A, who has been expecting this attack, the news is easy to absorb, but not particularly useful; its information content is low because it's confirming something already anticipated. For Commander B, who is not expecting the attack, the news is full of information value, and B is soon scrambling to get ready for the attack. Like B, Commander C has not anticipated an attack. Because an attack now would completely overturn C's firmly held view of the enemy's strategy, C ignores the new data, and disaster ensues.

While it's easy to condemn Commander C, especially if C's decision has cost many lives, we should, before rushing to judgment, look at C's mistake in terms of human nature. Each of us is called upon to make various judgments in the course of any one day. Some of our judgments prove to be correct; others, incorrect. The more experience we gain in life, the more likely we are to make the correct decision (or to hedge our bets safely). But we can never eliminate mistakes.

Because commanders' mistakes can cost other people their lives, we tend to judge them by a harsher standard than the one we use to judge other executives whose errors involve only money. But commanders and corporate executives suffer from the same flaw, one they share with each of us, the flaw of being human.

The harder we have worked to accumulate the information on which we have based a decision, the more difficult it is for us to overturn that decision because of a new fact.[9] This is not a characteristic of bad people or incompetent commanders, but a characteristic of all people and all commanders. It is one of the oft cited axioms of military life that commanders should be decisive, and, while decisiveness does not require one to stick to a clearly incorrect choice, wishing to avoid the appearance of indecisiveness may make a commander slow to rescind an order once it has been issued. In other words, the institutional emphasis on decisiveness—a reasonable emphasis, generally justified by history—could become part of the noise that affects a commander's decisionmaking.

IDEAL OF THE "STRONG COMMANDER"

Our Commander C may well be an example of what Brigadier Richard Simpkin, British Army (Ret.), calls the "strong commander," a proud and self-confident leader who "burns to impose his will."[10] Such a commander can be incredibly effective when the situation and his conception of the situation match. Such was the case in the last year of World War I when events came into sync with the perceptions of the British commander-in-chief, Douglas Haig, convincing some observers he was "the driving force of the Allied armies."[11]

Never slowed by indecisiveness, the strong commander is always taking the initiative. Simpkin notes that the image of the strong commander was a popular one in the American, British, and Soviet armies of the Second World War.[12]

Being a strong commander has its drawbacks, though. Like Commander C, strong commanders may see only what they have anticipated seeing. They may impose their wills on the situation "to the extent of ignoring it."[13] That happened to Haig at Passchendaele, where Haig's stubbornness cost the

British 300,000 casualties, and at the Battle of the Somme, when the British suffered 57,000 casualties on the first day, their worst one-day loss ever.[14]

NOISE AT ALL LEVELS

Apply this complex picture of commanders and the elements which have an impact on their decision-making to all the levels in the typical command chain and you begin to understand the chancy nature of combat. As a matter of fact, this same degree of complexity may be attributed to every individual involved—directly or indirectly—in combat. Every combat soldier, sailor, marine and airman must deal with comparable "noise." While the burden of responsibility may be lessened as one proceeds down the chain of command, that burden is replaced by a felt lack of control and the awareness that one is perceived as expendable.

A study of the combat effectiveness of soldiers involved in the Normandy invasion of 1944 offers a dramatic illustration of the impact combat "noise" has throughout the chain of command.[15] During the first three to four days of the invasion, high numbers of soldiers suffered from severe anxiety. For the average soldier, that intense anxiety ended around the fifth day in combat, and the soldier entered a period of maximum efficiency which lasted twenty to twenty-five days. After that, symptoms of "combat exhaustion" increased steadily. Soldiers became subject to intense fatigue which even forty-eight-hour rest periods did not relieve. They lost their ability to distinguish between friendly and enemy fire. Their primary interest became finding cover. They ceased to show any initiative. After about forty days in combat, soldiers could no longer be counted on to perform even the simplest tasks, such as digging in, or to remember training or orders. Speculating about the impact of such conditions on C^2 effectiveness strains the imagination.

HUMAN LIMITATIONS

Once we recognize the various manifestations of combat noise, we can begin to understand, without condoning, what appear to be instances of extraordinary military incompetence. Historian William Manchester points to numerous examples among some of the most accomplished and seasoned military commanders:

> Napoleon lost at Waterloo because he was catatonic that morning. Douglas S. Freeman notes that Washington was "in a daze" at the Battle of Brandywine. During the crucial engagement at White Oak Swamp, Burke Davis writes, Stonewall Jackson "sat stolidly on his log, his cap far down on his nose, eyes shut. . . . The day was to be known as the low point in Jackson's military career, though no one was to be able to present a thorough and authentic explanation of the general's behavior during these hours." Like Bonaparte and Washington, Old Jack was unable to issue orders or even to understand the reports brought to him. . . . The puzzle may be explained by a bit of computer jargon: input overload. If too much data is fed into an electronic calculator, the machine stops functioning.[16]

Manchester observes that something like "input overload" paralyzed General MacArthur on the morning of December 8, 1941, when, in the wake of the Pearl Harbor attack, he was apparently overwhelmed by the conflicting worries and recommendations of his staff.[17] The result was "one of the strangest episodes in American military history: the destruction of MacArthur's air force on the ground, nine hours after word had reached him of the disaster in Hawaii."[18]

Some of MacArthur's most gifted Japanese opponents fell victim to the same kind of paralysis after Doolittle's bombing raid on Tokyo in 1942. According to Roger Beaumont, "Japanese Admiral Yamamoto withdrew to his quarters for several hours while Admiral Nagano stared into space, murmuring: 'This shouldn't happen; this simply shouldn't happen.'"[19]

A very concise and illuminating picture of war and its attendant noise appears in Hirsh Goodman and Zeev Schiff's report on the attack against the USS *Liberty*. The *Liberty*, an American intelligence ship, was attacked by Israeli aircraft and gunboats during the Arab-Israeli war of 1967. The resulting casualties stirred outrage in both the United States and Israel. Goodman and Schiff's article is based on detailed research of Israeli military documents, some of them still classified, and shows clearly how the noise and fog of war can be insurmountable obstacles.[20]

On the U.S. side, the story of the *Liberty* is a story of lost, delayed, and misdirected messages in one of the world's most sophisticated communications networks. On the Israeli side, it is a story of extreme tensions, misidentifications, miscommunication, misread radars, and tragic coincidences in a military organization widely deemed one of the world's most efficient. The conclusion of Israeli investigators was that the attack on the *Liberty* was "a genuine mistake," due largely to five factors: a report that El Arish, a city occupied by the Israelis, was under attack from the sea; a report that the *Liberty* was moving at thirty knots; a report from Israeli pilots that it was a ship of war; an identification of the ship as the Egyptian *El Quseir*; and the ship's closeness to a hostile shore in time of war.

The perception that El Arish was being attacked from the sea was traced to the explosion of an Egyptian ammunition depot in the city. The report that the ship was moving at thirty knots—a sign of hostility according to Israeli standard operating procedure for the 1967 war—was due either to a "radar jump," an erroneous reading, or an erroneous logging by the radar operator. The misidentifications of the ship by the pilots and gunboat crews were attributed to a series of unfortunate coincidences combined with combat tensions. The ship's position was due to failures in the U.S. communications system. As Goodman and Schiff present them, all of the mistakes are readily understood. No one or two of them in isolation would have led to the attack.

In examining two events involving U.S. forces in 1983, the bombing of the Marine barracks in Lebanon and alleged foul-ups in the Grenada invasion, we find the same kinds of errors—understandable mistakes—no single one of which would have been of consequence by itself. In Beirut, a convoluted chain of command, a mismatch between intelligence capabilities and the situation, ambiguity about the nature of the mission, and perhaps a degree of service parochialism were factors.[21] In the case of the Grenada invasion, the needs for secrecy and thorough planning conflicted, and the latter was slighted—a rational decision, though arguably not the best.[22] By most standards, the Grenada operation was a success, so we really can't say the decision was "wrong." In both cases, Lebanon and Grenada, more judicious decisions are apparent only in retrospect.

MILITARY MISTAKES

Military commanders always have and always will make mistakes. Historian Martin Van Creveld lists Napoleon's victory at Jena in 1806 as "probably the greatest single triumph in his entire career."[23] And yet, Napoleon's errors and misjudgments in that battle were extraordinary:

> Napoleon at Jena had known nothing about the main action that took place on that day; had forgotten all about two of his corps; did not issue orders to a third, and possibly to a fourth; was taken by surprise by the action of a fifth; and, to cap it all, had one of his principal subordinates display the kind of disobedience that would have brought a lesser mortal before a firing squad.[24]

Perhaps Napoleon succeeded at Jena, despite his errors, because of the way he had organized his army into independent units, or because fear of his name had caused the main Prussian army to flee right into the path of his 3rd Corps.[25]

If we conclude it was the way Napoleon organized his army which resulted in the victory at Jena, we might say he proved himself an adept at the "art of war"—a statement unlikely to stir much contention (unless we're addressing a horde of Wellington fanatics). If we conclude the Prussian fear of his prowess in war panicked them into making a mistake, we'd probably say a combination of art and luck determined Napoleon's victory.

"GENERAL'S LUCK"

"Nowadays," writes Simpkin, "luck stays with the good general who has a good system of command and control."[26] Simpkin's analysis of "General's luck" is really an answer to those who treat the "art" of war as something ultimately unfathomable, a blend of mystical knowledge and good fortune.

Such "luck," he argues,

> surely comprehends three distinct though related elements—the creation of opportunity, the spotting of opportunity, and the exploitation of opportunity. Only in the second of these does pure chance, the unpredictable whim of destiny, play a part.[27]

What Simpkin calls the "creation of opportunity" involves structuring a plan that takes potential opportunities into consideration without being dependent on their realization for success. The most effective way to do this is to get "inside the enemy's decision loop" by deceptively misleading his expectations and evoking a blunder on his part. For example, Feint A leads our enemy to think we might attack from the north; Feint B reinforces that impression, and the enemy realigns his defenses so they're oriented toward the north. Then we attack from the south. In the meantime, the force with which we're attacking from the south is strong enough to give us a good chance of victory, even if the feints have not tricked the enemy into turning his defenses.

"Exploitation of opportunity," Simpkin's third component of "General's luck," is a function of flexibility. Such flexibility, he argues, is not available to the commander whose "subordinates and their staffs, and his troops, are trained only to act on detailed orders and to obey complex SOPs [standard operating procedures] to the letter regardless of circumstance."[28] Rather, flexibility is encouraged by a command structure in which a superior makes his intention clear but does not impose detailed tasks on his subordinates. It is up to the latter to define their tasks in ways that ensure the superior's intention is supported. That's the way Napoleon worked with most of his marshals, allowing them wide discretion in the operation of corps organized to function independently for limited time periods.[29] It's an approach that saved the day for the French on October 14, 1806, when Davout's 3rd Corps beat the main Prussian Army at Auerstadt, while Napoleon and most of his forces had been engaging what turned out to be a mere flank guard at Jena.[30] Simpkin calls this approach to command "directive control"; others refer to it as the use of "mission-type orders."

"GENERAL'S LUCK" AND C^2

Whatever the terminology, the approach requires the sharing of information and point of view over several levels of command. It depends, therefore, on the availability of very capable C^2 systems. For superiors and subordinates to be able to reach a common sense of the situation—a shared sense of what's going on--they must be able to pass information up and down the chain of command freely. In order for superiors and subordinates to share the same mind-set, superiors must make their overall intentions clear. The minds of superiors and subordinates must be, as Simpkin puts it, "well-attuned to each other."[31] Capable C^2—encompassing clearly understood doctrine, thorough training, frequent and realistic exercises—is a prerequisite for such harmony.

The kind of flexibility Simpkin is talking about means that when a subordinate realizes his superior's intention will not be furthered by the carrying out of a given task, he is free to redefine the task. He does what he now believes will further his boss's intention.

A lot of mutual trust is involved in such a situation. The superior trusts the subordinate's judgment; the subordinate trusts his superior not to crucify him if he makes an honest mistake. In the words of the Marine Corps' manual, *Warfighting*, "trust is an essential trait among leaders--trust by seniors in the abilities of their subordinates and by juniors in the competence and support of their seniors."[32] According to the manual, mistakes by junior leaders are "a necessary part of learning" and should be dealt with leniently.[33]

CREATIVITY

The component of "General's luck" which demands the complicity of destiny or chance is the "spotting of opportunity." That, at least, is what Simpkin says initially. However, he goes on to say,

> what matters here is the ability to spot the possible significance of something that seems at once trivial and wholly irrelevant. This is really an aspect of the creative thinking that lies at the root of all innovation and may manifest itself in literary or artistic talent, entrepreneurial flair, management (and thus command) ability, or the pioneering spark in the driest and hardest of scientific fields.[54]

Ultimately then, skill in the art of war proceeds from professional knowledge (Simpkin calls it the "physics of war"), flexibility, and creative thinking.

As we noted earlier, what Simpkin is trying to do is admirable: to get beyond the vagueness we sense in the phrase "art of war." It's not satisfying to label something as critical as generalship "art," because that term carries with it not only a presumption of professional knowledge but also a suggestion of mysticism and intuition, of a component dependent upon the beneficence of God or Fate or Chance, something beyond our ability to give or develop.

Simpkin's interesting and appealing argument for reducing Chance to the three categories of "luck," which, in turn, reduce to a combination of professional knowledge, flexibility, and creativity, sounds good, but does it really get us anywhere? How do we foster the development of creativity in soldiers, sailors, marines, and airmen?

FOSTERING CREATIVITY

To date, no one has found a way to create creativity. There are plenty of theories flying around about nurturing creativity—from the uterus to the classroom. Many are somewhat fanciful, having to do with things like the kinds of music a mother listens to while pregnant. Some of the more rational ones link creativity with cognitive development and draw on the work of Jean Piaget and William Perry. Others derive from Henri Bergson's analysis of the intellectual and intuitive components of creativity. A considerable body of anecdotal evidence suggests that the study of literature and mathematics promotes creativity.[35]

But no one has provided evidence to contradict the poet John Keats' assertion: "That which is creative must create itself."[36] Creativity appears to be as much a gift of God, Fate, or Chance as "art" is. We can use the personality profiles developed by behavioral scientists to try to select creative people to become leaders. We can support curricula strong in literature and mathematics. But we can't create creativity ex nihilo. To guarantee the development of a creative genius comparable to a Thomas Edison, a William Shakespeare, a Frank Lloyd Wright, or a General Patton, we would have to recreate the lives, environments, and experiences of those individuals. And that, of course, is impossible.

CREATIVITY AND HIERARCHICAL STRUCTURE

Do we do things now that actually inhibit the development of creativity in soldiers, sailors, marines, and airmen? Simpkin suggests that use of the hierarchical structure of the military fosters conformity, and in a sense he's right, though he offers no alternatives.[37]

The top boss's view is likely to be reflected in the view of the individual who works for that boss; the view of that individual (which is really the top boss's view) will probably be reflected in the views of the people who work for her or him, and so on down the line. With the same view being echoed from top to bottom, not a lot of room is left for creativity.

Or is there? Picture the hierarchical chain of command. Because all individuals in that chain are human and therefore subject to the nonfelicities of human nature, all probably assume they're at least a little more creative and original than the average Joe or Josie. Many will also be disposed to think the boss is unimpressive. Being politic, they will echo the boss's ideas in public, while privately nurturing their own objections. Thus, in moving from top to bottom of the command chain, we're likely to encounter a wide range of views on any given issue. Views which differ from the going party line will be repressed until a crisis stimulates the command chain to shed the upper layers of its peacetime accretions. Such shedding takes place at the beginning of most wars.[38]

Perhaps this is an excessively cynical view, but it's likely to be the case for at least some of the nodes in a lengthy command chain. A lot of the conformity rides pretty close to the surface.

NEW CORPORATE SHAPES

Furthermore, while the corporate world talks a lot about the "bureaucratic pyramid" of traditional organization disappearing as "the distributed web of the network becomes the symbol of corporate organization in the information age," specific examples of that happening are hard to come by.[39] Sure, some intermediate levels of middle management are disappearing as chief executives discover it's faster and cheaper to do data checks themselves, through the company's computer network, than it is to maintain a staff to pull out information the old way. Functional spinoffs—Company A's security office becoming a separate company which supplies security services to companies A, B, and C—are also changing the shape of the organization.

The net effects are shrinkage and modified channels of communication, formal and informal. It's really too early to say what shape will typify corporate America in the future—the web, hub and wheel, atomic particle, or whatever. And while it's likely computer networks and technologies will combine with shrinking budgets to reduce the size of military organizations, the hierarchical, pyramid-based shape of military organizations is likely to endure for some time yet.

C² AND ORGANIZATION

There is a sense, though, in which changing technology and concepts of C² have already had an impact on the highest levels of the national security establishment. The Goldwater-Nichols Department of Defense Reorganization Act of 1986 did not alter the shape of the military hierarchy, but it did have an important impact on the way it does business.

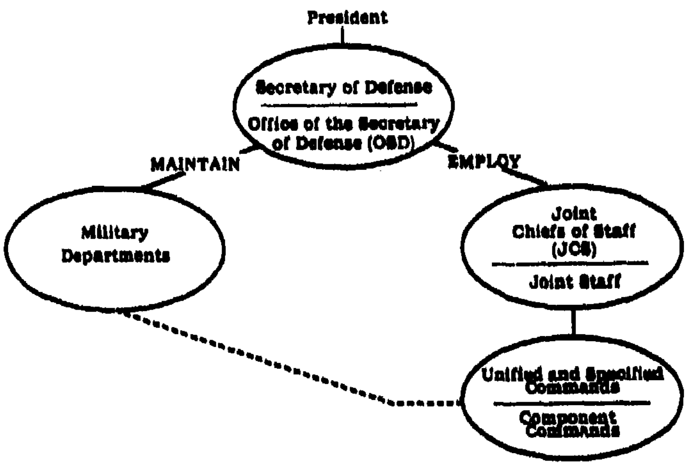
Organizational issues affect C^2 in at least two ways. The first concerns how the C^2 process is set up, both at the national level and within a combat element. Is the process adapted to the decisionmaker's style, or vice versa? How are information sources and assets protected, shared, and used? At what point does a necessary safeguard become micromanagement?

The second way organizational issues affect C^2 concerns how C^2 equipment is acquired. We've seen that C^2 is much more than a matter of equipment, but equipment is important. And the Reagan administration's emphasis on C^2 made it a matter of power, status, and budgets.

Since World War II, DoD has been set up in such a way that the Services enlist and train people, buy weapons and other equipment (including C^2 equipment), and determine weapons doctrine.

The combatant commands get their people, their weapons and equipment, and weapons doctrine from the Services. It's up to the CINCs to harmonize Army, Navy, Air Force, and Marine people, weapons, equipment, and doctrine. In the view of some critics, increasing specialization, especially in communications and other C^2 systems, and various forms of inter-Service rivalry have made the CINCs' jobs very difficult.

In the early 1980s, warnings about the inadequacies of operational C^2 helped draw the attention of the House and Senate to the issue of DoD organization. One of the most outspoken critics of existing C^2 systems was Lieutenant General John H. Cushman, U.S. Army (retired), who had commanded major combat organizations in Vietnam and Korea.



DoD Organization, 1958-1986
Source: Archie D. Barrett

General Cushman's indictments were dramatic and clear:

> Our performance in providing the full range of means necessary for command and control systems for theater forces has been, and all too likely continues to be, gravely deficient. Although the means of command and control in the hands of US and allied field forces may possibly be adequate for conditions short of war, they are seriously inadequate for war and hence for war's deterrence.[40]

Cushman and others argued that the CINCs of unified commands—commands made up of component forces of the Army, Navy, Air Force, or Marines—or combined commands—composed of U.S. and allied forces—could not count on having dependable C^2 links with their own forces. In other words, the CINCs had to deal with the fact that under conditions of combat (or even a realistic exercise) they would probably lose communications with at least some of their forces, that their forces might not be able to talk to each other—not even to coordinate covering naval or artillery fire—that some intelligence sources would become inaccessible and that they might be left unaware of the status of some or all of their own forces. In short, the CINCs had to expect to find themselves fighting blind, in ignorance of the enemy situation, the situation of other friendly forces, and the situation on other fronts.

Many argued that the inadequacies of operational C^2 were directly attributable to a power imbalance, with the military services—the Navy (and Marines), Army, and Air Force—having all the power, and the unified and combined commands having all the responsibility. For example, the military services would go through the procurement process for new systems without input from the unified and combined commanders whose forces would be employing those systems:

> For the typical senior commander, allied or US, whose forces must use these systems, they represent the largely unplanned splicing together of ill-fitting components which have been delivered to his forces by relatively independent parties far away who have coordinated adequately neither with him and his staff nor with each other. And they neither exploit the present capabilities of technology nor does the system for their development adequately provide that future systems will.[41]

As a result, commanders might find the "latest" communications equipment wouldn't mesh with equipment already in use. They might be unable to talk to subordinate or allied units, or they might be forced to use different systems for handling different kinds of data.

This two-tiered system—military services-combat commands—sometimes led to confusion or conflict over administrative control and operational control. The Marine Corps was responsible for training, equipping, and supplying a force for use in Lebanon in 1983—administrative control. The chain of command following operational control fell to an Army general. Who then was to bear the brunt of the blame when the Marine barracks was bombed? Were their inadequate defenses the result of shortcomings in their training, a matter of administrative control? That would mean responsibility would rest with the Marine Corps. Or were they the result of mistakes in deploying the force, a matter of operational control? That would put the responsibility on the shoulders of the Army general at the military top of a long chain of command. The president assumed the blame and the immediate issue went away, but the uncertainty remained.

Just as problematical were the military services' holds on component forces. Though such forces were designated to fight under the operational commander, they had to rely on their parent military services for supplies, equipment, pay, promotions, and just about everything else—a relationship sure to encourage divided loyalties.

For example, U.S. forces in Europe formed the European Command (EUCOM). The forces that made up EUCOM were the U.S. Naval Forces, Europe (USNAVEUR), the U.S. Air Forces, Europe (USAFE), and the U.S. Army, Europe (USAREUR). USNAVEUR, USAFE, and USAREUR were component commands of EUCOM; their commanders (CINCUSNAVEUR, CINCUSAFE, and CINCUSAREUR respectively) worked for the EUCOM commander (CINCUSEUCOM).

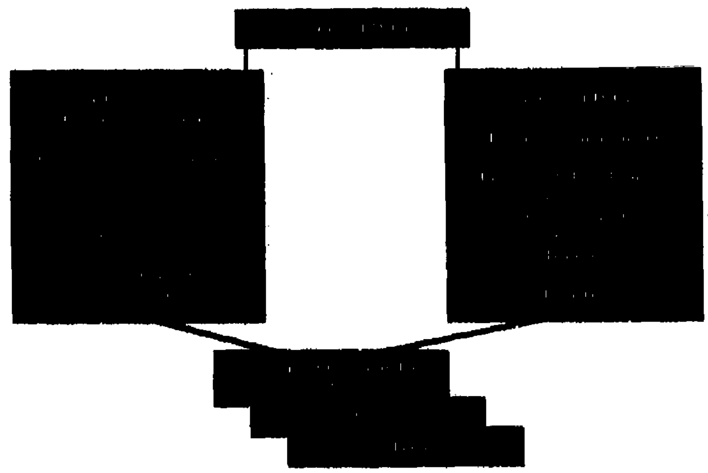
But CINCUSNAVEUR, CINCUSAFE, and CINCUSAREUR received their promotions and pay from the Department of the Navy, the Department of the Air Force, and the Department of the Army respectively. If CINCUSNAVEUR needed more ships or sailors, he had to get them from the Department of the Navy. If CINCUSAFE needed more airplanes or airmen, he had to get them from the Department of the Air Force.

The same arrangement applied to C^2 systems. For example, the radios used by CINCUSNAVEUR and his forces were radios designed, paid for, and supplied by the Navy. The radios used by CINCUSAFE and his forces were Air Force radios. The radios used by CINCUSAREUR and his forces were Army radios. CINCUSEUCOM would probably be able to stay in touch with CINCUSAREUR and his forces because both CINCs were Army commanders using Army radios. Would the CINCUSEUCOM, however, be able to communicate with USNAVEUR and USAFE forces? Maybe. Would USNAVEUR and USAFE forces be able to communicate with each other and with USAREUR forces? Maybe.

If the military services were feuding about how to best achieve the EUCOM mission, would CINCUSNAVEUR and CINCUSAFE loyally throw their support behind CINCUSEUCOM? Probably not.

Prior to passage of the Goldwater-Nichols Act in 1986, some critics also argued that inter-Service collusion, a reaction to the bloody inter-Service squabbles of the late 1940s, had diminished the value of military advice provided by the JCS. They maintained that the Service chiefs were primarily concerned with protecting the interests of their own military services, and that one of the strategies for protecting those interests was to make sure no military service lost any ground—a quid pro quo arrangement. Thus, they said, JCS advice to the nation's leaders was often determined by a "lowest common denominator" process focused on the military services' rather than the country's interests.

Those opposed to major changes to the structure of DoD argued that putting the right people in the important jobs—appointing a strong and aggressive JCS chairman, for example—would solve most problems in the existing system. Others said the weaknesses in the existing structure were intentional: "The reason is that people in this country have never wanted a strong military; we have wanted to fragment military authority."[42] Some expressed concern that if operational commanders got involved in budgets and procurement, as they might if rules were changed to allow them input regarding selection of equipment for joint (multi-Service) use, they would be distracted from their primary mission of preparing fighting forces. Some feared the move to reorganize would strengthen the hand of "purple-suiters" (people in unified or combined organizations); that military service specialization was being sacrificed for "jointness."



Defense Reorganization: The 1986 Act
Source: Archie D. Barrett

GOLDWATER-NICHOLS

The result of thousands of hours of research, hearings, and debates was the passage of the Goldwater-Nichols Department of Defense Reorganization Act in 1986.

The act made the chairman of the Joint Chiefs of Staff the principal military adviser to the president; previously, he had been spokesman for the Joint Chiefs, essentially a "first among equals." Goldwater-Nichols also made the chairman the manager of the Joint Staff and created a vice chairman to assist him.

The act extended the powers of the CINCs, giving them a voice in the assignment and evaluation of component commanders and the power to suspend subordinates. It also gave them an indirect role in resource allocation.

Finally, the Goldwater-Nichols Act emphasized the importance of joint assignments—assignments that take officers from their own military services and make them part of a multi-Service organization. It established education and experience requirements for joint duty, set up safeguards to ensure joint officers are treated equitably for promotion and assignments, and made experience in joint duty assignments a prerequisite for promotion to general or flag rank.

All in all, the Defense Reorganization Act shifted power from the military service departments and chiefs of staff to the chairman of the Joint Chiefs and the CINCs. It addressed both the administrative-operational conflicts and the acquisition-use conflicts. At the national level, it also affected how the C^2 system was set up, with the chairman replacing the Joint Chiefs as chief military adviser to the president.

PERFECT ORGANIZATION

Ironically, in the discussions that preceded passage of the Goldwater-Nichols Act, just about everyone agreed on the symptoms indicating the existence of a problem, but different parties called for radically different organizational solutions. While some called for more "jointness," others advocated more specialization; while some advocated less centralized control, others wanted more. The upshot of all this is that DoD organization is likely to continue as a hot issue, and we may see a persistent tendency for one year's solution to be perceived as part of the next year's problem. After reviewing the political and rhetorical twists which culminated in the act's passage, it's tempting to attribute an almost serendipitous quality to the deliberations that took place. However, a comment made in 1985 by Dr. Archie D. Barrett, House staffer and author of *Reappraising Defense Organization*, offers a healthy counterbalance to such temptations:

> Even if a divine presence could give us a perfect organization today, it wouldn't be perfect a year from now because changing circumstances—weapons development and those sorts of things—would blur those boundaries and you'd have to redefine them. That means Service roles and missions need constant examination and redefinition.[45]

Organizations are established, defined, and constituted by people—human beings with all their attendant flaws and complexities. No organization will ever be perfect, any more than any human being is ever perfect.

Organizations can be improved, and human capabilities such as "generalship" can be nurtured, but perfection will never be achieved—in this life at least—by organizations or human beings. Our idealizations of both will be healthy so long as they simply serve as goads to action and disturbers of our complacencies. When they become the sine qua non of national security, we're in trouble.

5

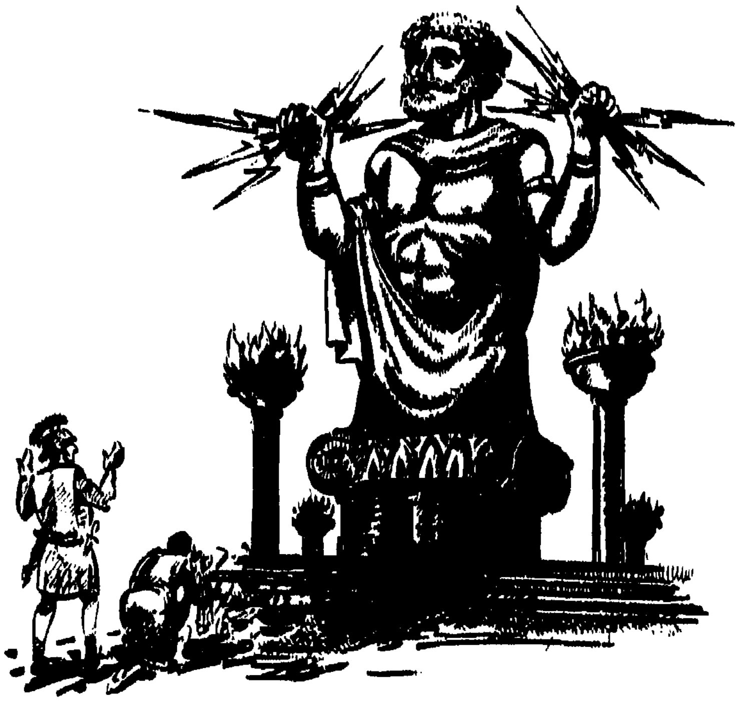
An Impossible Dream: Information that Is Complete, True, and Up-to-Date

Sometimes we sound and act as though perfect C^2 were achievable. It's not. Even defining what we mean by "perfect C^2" is very difficult. The most successful commanders are those who understand the nature of the C^2 process and recognize the flaws inherent in their own C^2 systems—those "web-like" collections of people, equipment and procedures. Commanders who wait for information that is "complete, true and up-to-date" will lose their battles.

Humanity's preoccupation with perfection is probably as old as the human race. Twentieth century anthropologists and scholars such as Sir James Frazer, Joseph Campbell, and Mircea Eliade believe primitive gods were made in humanity's image.

The gods represented human perfection, the fullest possible extension of knowledge and power. When people found themselves in trouble, they called on their gods to intervene in the normal order of things and save them.

According to Frazer, magic and science are analogous in that they both see the universe as a domain governed by "immutable laws."[1] It is that perception which distinguishes both magic and science from religion, which brings with it "an implied elasticity or variability of nature."[2] To get what they needed or wanted, people had to find the right ap-



Ancient peoples made their gods in their own images

proach to convince their gods—the anthropologists' embodiments of human perfection—to intervene in the natural order of things, to suspend the law of nature momentarily.

In the view of Severo M. Ornstein, our latest religion is founded on the computer, a new-fangled deus ex machina, a source of perfection we turn to when our salvation appears to be beyond the range of our own limited knowledge and power.[3]

Some say the computer is our deus ex machina

Ornstein, who helped develop the computer-based defense system, SAGE, mentioned earlier (see page 90), subsequently chaired a group called Computer Professionals for Social Responsibility. He argues that the "jam" we find ourselves in is the spiraling arms race, a contest that threatens to destroy humanity. Not knowing how to control the spiral, we pray to our surrogate, the computer with its perfect logic, to protect us from the results of our illogical brinkmanship, to absolve "us of the terrible responsibility for our own fate."[4] Citing a history of false alerts generated by computer errors and illustrating the types of flaws that commonly appear in computer programs, Ornstein concludes,

> Not only will computer-controlled systems fail to provide protection, but if we really persist in relinquishing our responsibilities and putting more and more higher and higher levels of evaluation and decision making into their hands, we will be sealing our fate. If we continue on this course, that fate will be richly deserved.[5]

While Ornstein's concerns are reasonable, there's no indication that the United States has yet relegated decisionmaking to computers. The false alerts cited by Ornstein and his colleagues are certainly frightening. They're frightening in the same way the shelter practices of the 1950s were frightening to children cowering under their school desks: they raise the specter of nuclear devastation, something no one wishes to confront.

But they're also reassuring because, in every case where computers warned of an attack, a Threat Assessment Conference of senior duty officers at the North American Aerospace Defense Command, SAC, and the National Military Command Center in the Pentagon was convened to evaluate the threat.[6] Human judgment intervened, in accordance with well-established procedures, and determined the alerts were false. Those procedures also call for another conference, involving the president and other senior advisers, in a case where the Threat Assessment Conference determines that a warning might be legitimate.[7] In other words, the only decision left to computers is whether or not indications are serious enough to bring in the humans. In no case do computers decide whether or how to respond to warnings of an attack. Nor should they.

Of course, a combination of a false alert by the computers and a series of mistaken judgments by people could result in nuclear war. That's something all rational human beings wish to avoid, but, until nuclear weapons are eliminated, it will remain a horrible possibility. Imperfect human beings establish imperfect procedures and develop imperfect technologies.

AMBIGUOUS WORDING

Recognizing the reality of those imperfections is probably the best safeguard we have against the kind of thinking that worries the Computer Professionals for Social Responsibility. Unfortunately, well-intentioned rhetoric can sometimes give an unintended boost to that kind of thinking. A statement by the 1987 Defense Science Board Task Force on Command and Control Systems Management, for example, contains these words:

> The ideal command and control system supporting a commander is such that the commander knows what goes on, that he receives what is intended for him and that what he transmits is delivered to the intended addressee, so that the command decisions are made with confidence and are based on information that is complete, true and up-to-date.[8]

Now, *ideal* can be used as a synonym for *standard*. If the Defense Science Board is using the word in this sense, its statement could be paraphrased this way: we must give commanders command and control systems that guarantee "information that is complete, true, and up-to-date." Ideal can also mean "beyond an achievable level." If the Defense Science Board is using the word this way, which seems likely, then "information that is complete, true, and up-to-date" is being held up as a goal beyond any possibility of realization.

"Aiming for the stars" is certainly not an unreasonable approach to take in any worthwhile endeavor, so long as everyone concerned realizes that no one is actually going to reach the stars. But a defense establishment that cherishes the use of phrases like "surgical strike" and "zero CEP" just may be the kind of outfit that responds to an exhortation to "aim for the stars" by putting out contracts for nuclear sneakers.

There is the story of the two hikers who spot a grizzly bear stalking them. One hiker sits down and takes off his hiking boots, replacing them with his running shoes. "What good will that do?" asks his companion. "You can't outrun a bear." Lacing up his Nikes, the friend responds, "I don't have to outrun the bear. I just have to outdistance you."[9]

SERIES OF ERRORS

To believe in the possibility of perfect C^2 systems—systems that provide "complete, true, and up-to-date" information—is to set the stage for policies such as "launch on warning" which give credibility to the nightmares of the Computer Professionals for Social Responsibility. Imagine being the president and being awakened to read this message from the Threat Assessment Conference:

A missile attack by the Soviet Union appears to be imminent. Missiles are likely to impact the East Coast, including the D.C. area, within five minutes of your receipt of this message. We recommend an immediate, full-scale response.

At 0243 this morning, the SAC command post at Offutt received indications of incoming ICBMs and SLBMs.

EUCOM reports urgent message regarding unidentified jet aircraft over Turkey.

At least 100 Soviet fighters have been detected in the air over Syria and have reportedly shot down a British bomber on a routine training flight in the area.

Satellites have detected movement of a large, nuclear-capable fleet through the Dardanelles. The fleet appears to be moving out of the Black Sea in preparation for hostilities.

Analysts suspect the Middle East will be the target of a massive conventional attack and that the preemptive nuclear attack on the United States is designed to preclude our interference.

Would you accept the recommendation for an immediate response? Or would you wait to "see" whether incoming missiles were actually going to hit the White House? Would a national security policy of "launch on warning" affect your decision?

A scenario in which a president receives such a message is not so far-fetched as one might imagine. This message was concocted by combining the elements of two real "incidents," the false missile alert that occurred on June 3, 1980, and the receipt of a series of reports about MiGs, the British bomber, and the Soviet fleet on November 5, 1956—right in the middle of the Suez Crisis and the Hungarian Revolution.[10]

The false missile alert was traced to a chip failure.[11] According to Paul Bracken, the unidentified jets over Turkey turned out to be swans with particularly intriguing radar profiles, the MiGs were an escort for the president of Syria, the bomber went down as a result of mechanical failure, and the fleet was on a scheduled exercise.[12]

SEEING IS BELIEVING

Clearly, a "launch on warning" policy is predicated on reliable warning. But we better be careful about how we define reliable. General Richard H. Ellis, former commander-in-chief of SAC, recalls the unreliability of intelligence data he had felt certain about as a combat pilot in World War II:

> We were engaged in low-level attack. We were right down on the targets, bombing and strafing them at treetop level. There were certain things we saw and reported, and yet it turned out, when we got the photographs back, that we were wrong. And if you think that's changed today, you're wrong, because it hasn't. What is reported about the battlefield or the airspace, and the actual fact of the case, may be two entirely different things.[13]

Based on his personal experience, General Ellis warns, "When people talk about firing on warning, or launching on warning, they're in a very risky area. It's dangerous, in my opinion—very destabilizing."[14]

DATA AND ANALYSIS

Warning, like other intelligence "products," results from gathering and analyzing data. After a satellite picks up evidence of a missile launch, for example, the launch data—which should indicate what kind of missile is involved, where the missile originated, and where it's headed—will be put in the context of other available data. Relevant data might include telemetry from previous launches, information about the usual payload carried by the kind of missile launched, evidence of concurrent launches, information about the current political situation, and so on.

Analysis requires analysts, and analysts bring with them many of the human flaws we looked at earlier, including preconceptions. Worrying about these kinds of problems is one of the things that keeps the National Warning Staff awake at night:

> You go into a problem trying to discover truth. You work your way through it, collecting all the evidence, and you put forward a brilliant exposition. Now, having gone through all that pain and soul-searching, you have become so wedded to your viewpoint that you will never question it, never go back and ask yourself what is wrong with it. I think we have all been there. It is a very hard failing to avoid. Even though we warn our analysts that this is going to happen, and not to let it happen, it happens time and time again, and I am not sure we will ever totally overcome it.[15]

Remember our Commander C?

PROMISES, ASSUMPTIONS, AND JUDGMENTS

Unrealistic promises can lead to mistaken judgments based on unrealistic assumptions. Anyone who promises a commander "information that is complete, true, and up-to-date" is promising the impossible. The danger occurs when commanders translate the promise into unwarranted assumptions about the reliability of the information they do receive. Arguments in support of a "launch on warning" policy illustrate the danger.

The things human beings make—computers, radios, software, organizations, procedures, doctrine—are imperfect. If people start talking about giving a commander a perfect C^2 system, they're promising something neither they nor anyone else can deliver. When they talk about "information that is complete, true and up-to-date," they're talking about something that is conceivable only in the abstract.

CONCEPTUAL PROBLEM

What is "complete" information? Is it the amount of information a commander needs to guarantee victory? What is incomplete information? (Maybe that would be a message that told the commander friendly troops outnumbered enemy troops but neglected to mention the enemy had massive reinforcements available two miles away.) Who defines complete or incomplete in this context?

Picture a primitive battlefield, one on which two forces come together head-to-head to fight until one destroys the other or forces the other to flee. Put a commander in the middle of the melee. How much C^2 can that commander exercise? Obviously, very little. The commander can issue instructions and exhortations to warriors in the immediate vicinity, but the range of the commander's voice, the din of battle, and direct involvement in the battle will significantly limit the commander's effectiveness as a commander.

Now put the commander in a balloon fixed two hundred feet above the battlefield. Give the commander a megaphone for communicating with friendly forces. From two hundred feet above the battlefield, the commander has a good view of all forces. The commander, being able to see the points along the battle line where one squad needs reinforcing or is getting too far ahead and risks being cut off, has some ability to make the required adjustments—to move squads forward or back as necessary. The capacity for C^2 is far greater than it was when the commander was on the ground. It's certainly not perfect, though. The commander will still have trouble making directions clear over the noise, and being an excellent target may significantly impact on the commander's decisionmaking ability. Furthermore, though the view of the battlefield is much better than it was from the ground, the commander still doesn't know what's going on over the next hill that may affect the outcome of the battle.

Let's now push our fantasy to the limit: let's give our commander an invulnerable craft that will move quickly to any point on the battlefield where the commander wants to go, will move almost instantaneously from the floor of the battlefield to a position miles above the earth where the commander can see anything, in any direction, for thousands of miles.[16] On top of all this, provide secure communications. Our commander can see the entire battlefield, staging areas any distance from the battle, supply lines, storage areas, potential reinforcements—maybe even something of the enemy's industrial and agricultural capacities; can give commands and directions and count on their being heard; and can monitor friendly and enemy status at any point on the battlefield.

Our commander's C^2 capacity at this point is excellent, but is it perfect? Perfect C^2 presupposes perfect information. Perfect information must be at least "complete, true and up-to-date." But even this commander can only be in one place at one time. So, no matter what pattern our commander uses for moving up and down and around the field and for talking to a strategically chosen sampling of subordinates, there's always going to be something missing. At no single moment will the commander's information be "complete." In this situation, the commander is better off than when on the ground or even in the balloon, but he can still lose the battle.

Now let's put our commander in a modern context. The battlefield will be unrecognizable. There's no clearly defined line of battle because massive firepower and great mobility have combined to make it inadvisable to mass great numbers of forces in any one spot. Instead, pockets of friendly and enemy forces will dot the terrain, the sea, the sky, and even space. Put our commander in an air conditioned, nuclear-hardened command post some distance from the site of the battle. Provide a wonderful array of small screens surrounding a large screen positioned directly in front of the commander; on those small screens display the sights provided by hundreds of mini-cams—some prepositioned, some fitted on remotely piloted vehicles that the commander can direct; supply the capability to display a blow-up of any scene depicted on one of the small screens. Furnish the commander with multiple, secure communications systems that allow conversations with individuals in the battle—by means of radios fitted into their helmets—as well as with peers who are directing other battles and with superiors, and which provide access to data banks of intelligence, background information, and expertise.

Could commanders ask for even more? Well, they might feel guilty about asking for more, but chances are they'd miss the "feel" for the battle that comes of being on the scene; that's something no number of high-resolution cameras will replace. We might compare watching a battle unfold on a television screen with watching a lengthy document we're writing take form on the screen of a word processor. With a word processor, there's always a part of the document hidden from sight. Though the benefits of the word processor put the old pencil and yellow pad to shame, some writers feel what's gained is not worth sacrificing the "feel" one gets for a document that's spread out over the desk.

Those hundreds of mini-cams will allow commanders to see a great deal, but not everything. To see everything that's going on they'd need an infinite number of cameras and screens. If they had infinite numbers of cameras and screens, they would be overwhelmed by the volume of information provided. In fact, they might be overwhelmed by the volume provided by a hundred cameras. How do they decide which screen to look at for a given moment? How can they know something critical won't happen on one screen while they're looking at another? What will they think if four or five of the screens suddenly go blank—that the blinding is the first step in a major initiative by the enemy, or that it's a simple mechanical failure? Might everyone become so hung up about the status of their cameras and screens that they'd miss something vital on the battlefield? Could the enemy have the capacity to intercept the genuine images and replace them with false ones? (Perhaps that's what Saddam Hussein thought when he saw CNN's pictures of his devastated forces surrendering near the close of the Gulf War in 1991.)

WHAT'S "ENOUGH"?

All of these considerations should underscore the fact that "complete, true, and up-to-date" information is conceivable only in the abstract. In reality, no commander has ever had perfect information, and no commander ever will have perfect information. On the other hand, nearly every battle has a winner, so it's not too far-fetched to say one out of two commanders has enough information—enough, that is, to win. Determining just what constitutes "enough" is part of the art of war.

Anthony Oettinger divides information "substance" into two categories: the substance known by a "Perfect Omniscience," which is the "universe of all possible discourse" ("UAPD"); and the substance known by mortal decisionmakers, a very limited piece of the UAPD.[17]

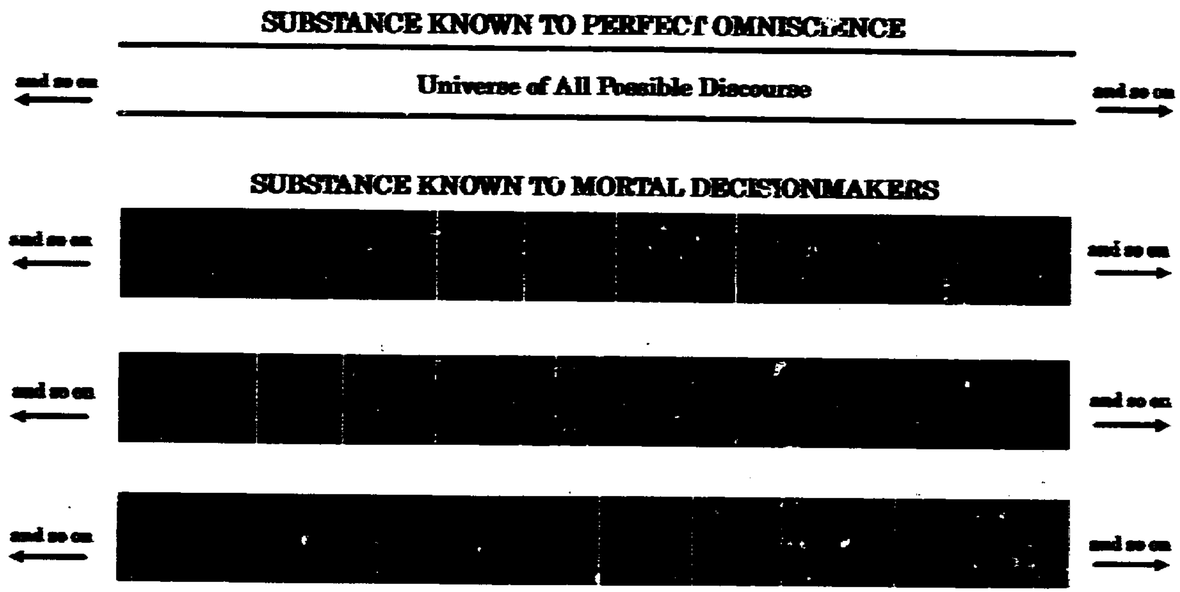
Each mortal decisionmaker's piece of the UAPD is made up of knowledge gained from inside sources, knowledge gained from outside sources, and the decisionmaker's personal knowledge.

Each decisionmaker's piece of the UAPD is surrounded by the unknown unknowns—"Unk-Unks." One decisionmaker's piece may overlap with another's piece, or there may be no overlap. In the latter case, the one decisionmaker's piece is in the area of the UAPD which to the second decisionmaker's perception is made up entirely of Unk-Unks, and vice versa. Oettinger says,

> A Perfect Omniscience might have a totally clear and coherent overview of the boundless UAPD. . . . Mere mortal decision makers, however, see only pieces of the UAPD and those only through a fog, dimly. Although capable of surmising the existence of unk unks, a mortal can't act directly on that surmise, since one surely cannot ask a pointed question about what one doesn't know one doesn't know.[18]

The existence of Unk-Unks should be apparent to anyone who has ever written a research paper. The first thing we do in writing such a paper is determine what we know and what we don't know about the topic. What we don't know becomes the object of our research. When we've completed our research and gathered our sources and the results of the research together, we sit down to write the paper. (True, it doesn't always work this way, but, for purposes of illustration, we're not taking into account the "research" papers produced in the course of "all-nighters.") In actually writing the paper, we inevitably discover some pieces of information we need but don't have, pieces not included on our initial "what we don't know" list. Those pieces of information were Unk-Unks when we started. We didn't include them on our "what we don't know" list because we didn't know we didn't know them.

The Unk-Unks by their very existence belie the possibility of information that is "complete, true, and up-to-date." Every commander needs to acquire all available information pertinent to an operation as quickly as possible and in a format that is useful. But



The Universe of All Possible Discourse (UAPD)
Source: Anthony Oettinger

there will always be information the commander doesn't even know is needed. Oettinger sums up the issue this way:

> Any organization that wants to survive must keep on getting the "right" information to the "right" people at the "right" time by whatever means are at hand, especially so while its ends are changing. All those quoted "rights" signify the almost total lack of agreement about what right information might be, who the right people are, and what the right time is. What consensus there is tends to prevail retroactively. For mortals what matters is an edge over nature, competitors or the enemy, not perfection. Armies, it is said, win wars not because they are perfect, but because they fight other armies. In business, likewise, it is not perfection that succeeds, but an edge over the competition. And knowing how to make fire gave mankind an edge long before the beginnings of scientific understanding of combustion processes.[19]

THE ART OF KNOWING ENOUGH

The ability to recognize the "right" information, people, and time is part of war's "art," akin to Simpkin's "spotting of opportunity." The lesser commander either waits too long and misses the opportunity while gathering unnecessary information or moves too quickly, failing to wait for the one essential piece of information that makes a difference. It's a matter of balances, information needs versus the need for quick action.

Inevitably, the commander who waits for perfect—i.e., "complete, true, and up-to-date"—information, perfect organization, perfect communications, perfect training, perfect doctrine, perfect standard operating procedures, or perfect anything is going to be too late; that commander will miss the opportunity. That commander will be beaten by someone whose information, organization, communications, and so on were good enough.

The perfect, to paraphrase Voltaire, is the enemy of the good. In war, business, sports, or any form of competition, the goal is not to be perfect, but to be good enough to beat the competition. More often than not, what a commander needs to get "right" are balances rather than ultimates.

6

A Matter Of Balances

The Greek concept of the "golden mean" is as old as the precepts of Sun Tzu and may be of comparable use to commanders. Finding the mean is key to a balanced approach to many questions, practical ones as well as ethical ones. When we approach C^2 issues as questions of balance, we're less likely to overlook something, such as a vital interaction among different C^2 elements.

You walk up to your front door, a bag of groceries in your left arm and a ring of keys in your right hand. Flipping through the keys with your thumb, you finally get your house key in place between the thumb and index finger, ready to be wielded against the deadbolt that defends your domain.

You insert the key into the lock but discover you can't turn it. The friction between the bolt and the outside edge of the strike plate is too great for you to overcome with one hand. You lean against the door with as much weight as you can muster and try again. Still won't budge, though the door has moved. You decide you're using too much weight, causing friction between the bolt and the inside edge of the strike plate. You gradually ease off the pressure on the door, until the bolt is between the two edges of the strike plate and the key turns easily.

Common sense has just led you to use an ancient technique for solving problems. You've found the golden mean.

A PRACTICAL MEAN

The golden mean or media via ("middle way") between extremes can be traced back to the sixth century B.C. The temple that housed Apollo's shrine at Delphi bore the motto *Medan Agan*, "Nothing in Excess," reflecting an emphasis on moderation characteristic of most Greek systems of thought.[1] It was Aristotle, though, who specifically formulated the golden mean. His treatment of the mean focuses on choices and offers us a useful way to approach choices concerning C^2.

It may seem a little strange to drag an ancient Greek philosopher into a discussion of contemporary C^2. Remember, though, that many of the principles upon which today's military tactics are based go back to Sun Tzu, who, like the Delphi shrine, was a product of the sixth century B.C. And Aristotle was, after all, the tutor of Alexander the Great and a student of physics and politics as well as first principles. Even his *Ethics* is quite practical in orientation, a down to earth approach to happiness that devotes as much space to practical and intellectual "virtues" as it does to moral ones. In the *Ethics,* Aristotle even goes so far as to say a person has to have a reasonable amount of money and goods to be happy.

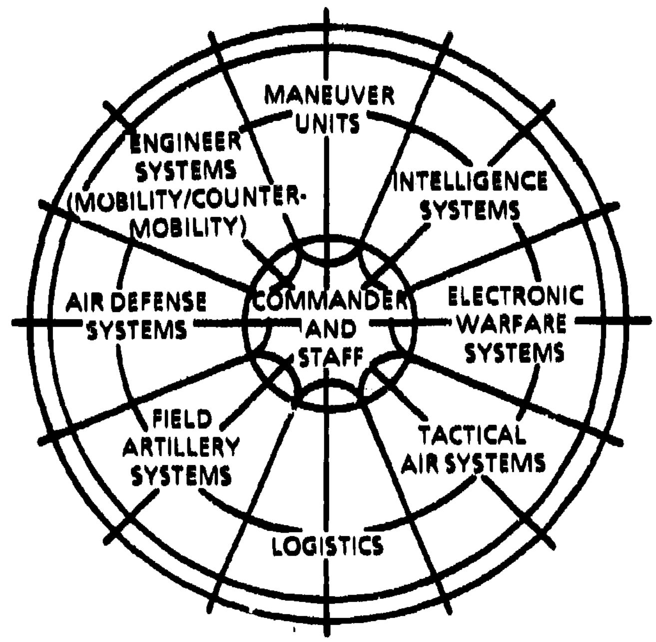
MATTERS OF CHOICE

We don't usually think of C^2 problems as matters involving choice. If the problem is a lack of data, we ask how we can collect more data. Just asking the question, though, involves making a choice: we're choosing to focus on the data problem rather than some other. If our solution to the data problem involves money, as is usually the case, and if our money resources are limited, also usually the case, we'll soon find ourselves forced to address another choice: From which area should we take the money we'll use to solve our problem?

We said in the last chapter that commanders should focus on "balances" rather than ultimates. Their C^2 must be good enough to beat a real enemy; it doesn't have to be perfect. We begin to realize that when we see every attempt to solve one C^2 problem seems to cause—or at least reveal—other problems. Just about the time we think perfect C^2 is on the horizon, we realize, "Nope. That's not perfection. It's a new day and a new set of problems."

As we've seen, in solving one problem or set of problems, we've consciously or unconsciously made choices which have an impact on other elements of C^2. Using more resources to gather more data usually involves taking those resources from some other area. Even if we somehow manage to gather more data without reassigning resources, we may discover the increased volume of data overwhelms our analysis system.

Thinking about C^2 problems in terms of balances—in the sense of temporary equilibriums or tensions between opposing elements or influences—is an acknowledgement of the complex interrelationships among the different components of C^2—interrelationships reflected in General Cushman's use of the word *web* in referring to command and control.[2] One of the most important benefits of thinking



The C^2 web
Source: Lt. Gen. John H. Cushman

about balances is that doing so makes our choices conscious ones.

HOLISTIC APPROACH

When we attempt to address C^2 problems as isolated issues, we act like the medical specialist who attempts to treat a patient without considering factors in the patient's background which lie outside the specialist's purview. If we're not careful, we may solve the immediate problem but kill the patient. What we need, in the C^2 arena as well as the medical world, is a holistic approach.

In the wake of the Second World War, the United States faced a dearth of data about Soviet capabilities. While the Soviets could sit outside almost any U.S. installation or facility and gather a mass of data by simply keeping track of what went in and what came out, the United States had no such option. The closed society of the USSR forced us to rely on either spies like Oleg Penkovskiy or overflights by high-flying aircraft such as the U-2. The fates of Penkovskiy and Gary Powers—Penkovskiy was arrested and apparently executed, Powers and his U-2 shot down—show how risky and uncertain both propositions were.

As we've seen, the technology of the space age has changed all that, with satellites and the elaborate sensing equipment they carry giving the United States much better access to the Soviet Union. But now, instead of a dearth, we have an overabundance, literally tons of data—photos, intercepted telemetry and communications, radar emissions, etc.—gathered each year. And that mass of material has overwhelmed our analysis system. Much that is gathered goes into storage without undergoing anything more than the most superficial analysis.[3] In short, we've solved one problem and created another. We've made progress, but we're no closer to perfect C^2.

The most we can hope to do is find efficient balances. Aristotle sees human happiness the same way: if you get the balances right, you've done everything you can do to win happiness. Just as Sun Tzu and Clausewitz refuse to guarantee victory, though, Aristotle refuses to guarantee happiness.

AN APPROACH

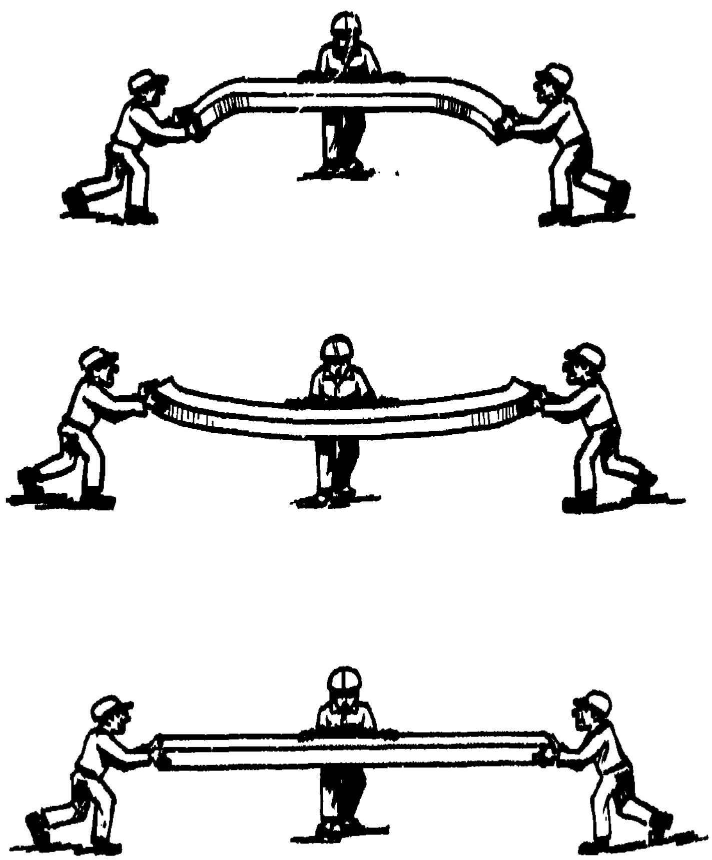
Our interest here is in Aristotle's approach to finding the right balances. While he's looking for a golden mean between such extremes as cowardice and foolhardiness, we're looking for ways to balance things like collection and analysis, or speed and deliberation, or stability and innovation. Two kinds of balancing acts—one approach.

Aristotle sees virtue as a pattern of behavior involving choice.[4] The virtuous pattern is one of choosing the mean between two extremes. The virtue of courage, for example, is a pattern of behavior between the extremes of cowardice and foolhardiness. Thrift lies between wastefulness and stinginess.

In mathematics, we find the mean between two numbers by adding them and dividing the sum by two. Thus, five is the mean between four and six; three, the mean between two and four. Unfortunately, the golden mean is not so precisely calculable. Its discovery depends on reason, good sense, and a modicum of "luck" and "art," rather than mathematics.

Equating the mean with a target, Aristotle says it can be missed in a countless variety of ways. There is, however, only one direct route to the target, and that route is hard to find. While there is no easy way to do it, he suggests the best way is to determine our present disposition and then move in the opposite direction: "By moving to a long way from going wrong, we shall come to the mean, which is what people do who are straightening timber."[5]

So, if we tend to be overcautious, we should work toward developing a devil-may-care attitude.



Timber-bending analogy for finding the media via

Clausewitz sounds as though he's echoing Aristotle when he writes about the tendency of commanders to assume the worst. He argues that once leaders have made their plans, based on the most reliable information available, they should stick to them and not let their first view of the battlefield panic them into abandoning their plans. His advice sounds a lot like Aristotle's timber analogy:

> Firm in reliance on his own better convictions, the leader must stand fast like the rock on which the wave breaks. The role is not an easy one; he who is not by nature of a buoyant disposition or has not been trained and his judgement strengthened by experience in war may let it be his rule to do violence to his own inner conviction, and incline from the side of fear to the side of hope. Only by that means will he be able to maintain a true balance.[6]

A CONSCIOUS SENSE OF BALANCE

Let's think back to our earlier discussion of the principles of war. We noted that the Japanese might have done better in the World War II battle at Midway if they had put more emphasis on the principle of security and less on the principle of cooperation, while U.S. planners of the 1983 Grenada invasion probably could have put more emphasis on cooperation. In those two cases (and we could find many similar ones in history), cooperation and security were perceived to be in opposition. The "right" balance of the two would correspond to Aristotle's mean. The Japanese at Midway and the United States in Grenada simply happened upon two of the many ways to miss the target. Perhaps just recognizing the balance involved—addressing it consciously—would have helped them cut their losses:

> Unconscious extremists look upon the golden mean as the greatest vice; they "expel towards each other the man in the middle position; the brave man is called rash by the coward, and cowardly by the rash man, and in other cases accordingly": so in modern politics the "liberal" is called "conservative" and "radical" by the radical and the conservative.[7]

Recognizing the need for balances helps us avoid the extreme positions we might otherwise slip into to our disadvantage. A conscious sense of the balances involved will, for example, help us avoid the all-or-nothing thinking that underlies debates between one group which sees national security exclusively in terms of technological prowess and another which equates sophisticated technology with vulnerability. A balanced view of national security will focus attention on brain and muscles, on people issues and equipment issues, on strategic concerns and tactical concerns.

NATURE'S BALANCES

We often see Nature engaged in a comparable balancing act. For example, when the deer population in a particular area exceeds the food requirements of local predators, the herd may begin to grow too rapidly and reach a point where population exceeds food supply. At that point, the herd will begin to die off. Or perhaps more predators will migrate to the area. In either case, we can perceive the work of Nature to restore her balances. In the natural world, the right balance is necessary for survival.

Survival is often a matter of balances in the human world, too. Gaining the edge over the opposition—be that opposition an enemy commander or a business competitor—involves, as Anthony Oettinger puts it, "knowing as much as possible about where the other guy has struck his balances, and being better than the other guy at identifying and adjusting one's own critical balances."[8]

OVERLAPS

Identifying those balances is itself difficult; adjusting them is an unending task. The balances we're talking about overlap. Every time we adjust one—by shifting money from one area to another, by introducing new technology, or by reorganizing—the change affects other balances. Changing the balance between collection and analysis, for example, will have an impact on the other pieces of the C^2 process. If we decide to reduce collection, then we must decide which kinds of collection to reduce—technical or human collection. That choice, in turn, will have an effect on the degrees and kinds of data correlation which will have to take place. And so on down the line. And every time a potential enemy makes an adjustment, our balances are also affected.

Most of what we think of as C^2 "issues" can be stated, therefore, in terms of balances. Let's look at some examples.

PRESIDENTIAL BALANCING ACTS

The president as commander-in-chief of U.S. military forces is essentially responsible for all aspects of C^2, at all levels of our national security system. So, one of the balances the president must strike is among strategic and tactical priorities. The president must decide how to apportion attention and resources among them.

Some issues are more likely than others to receive immediate attention. One of the first concerns of a new president, for example, is his or her responsibility for U.S. nuclear forces—tactical as well as strategic. As those forces are critical to our national strategy of deterrence, the president must ensure their adequacy and credibility. Because existing nuclear weapons have the power to destroy the world many times over, the president also must make sure our weapons are safely maintained and controlled. Thus, the balance between the credibility and safety of our nuclear forces is one of the president's major concerns.

The credibility side of the balance involves both weaponry and C^2 capabilities. A reasonable number of the strategic missiles sitting in silos, the nuclear weapons carried by aircraft, and the nuclear weapons carried by submarines and other ships must be perceived to be capable of surviving and responding to a pre-emptive attack by an enemy. The same is true of tactical nuclear weapons based in Europe and other "forward" areas—i.e., areas close to potential points of attack.

However, important as the weapons are, their survival of an attack would be pointless if the capacity to orchestrate and control their use were destroyed in an attack. As a former member of the National Security Council staff has noted, the vulnerability of weapons receives a lot more public attention than does that aspect of our C^2 capacity:

> What I never really understood was why that kind of vulnerability was so much analyzed when a much easier targeting problem was getting almost no public attention. Now, there are 1,054 missile silos, and people could work up enormous concern about an attack that would get them all in one snap! But I could pick for you a much smaller set of much more attractive targets—the President, the Secretary of Defense, the military operations staffs at the Pentagon and the command and control centers in the major unified commands—whose destruction would do much more perilous damage to our ability to conduct a war, or respond sensibly, or run our system.[9]

In crisis periods, particularly those that involve a heightening of tensions between the superpowers, the "football"—the briefcase containing release codes and other materials related to the use of nuclear weapons—looms large in the minds of the public. The "football" symbolizes the American president's awesome responsibility for the future of the world. The quiet but constant attendance of the military staff person assigned to carry the codes reminds the president, and the rest of the world, that a single push on "the button" could quickly bring everything to an abrupt end.

Technically, however, the pushing of a single button is not going to launch all our nuclear weapons and bring an end to the world. The real "doomsday" sequence is pretty complicated and involves the coordinated actions of a number of people. And the president won't necessarily be one of them.

If the president were the only person who could authorize the release of nuclear weapons, our nuclear capability could be lost to a "decapitating" assassination or a surprise attack on the C^2 facilities that link the president with our nuclear forces. To the degree a potential enemy believed it possible to kill or isolate the president and thereby preclude a decision to launch a retaliatory force, deterrence would be weakened.

Such concerns have led to plans to protect both the president and the C^2 facilities that support the National Command Authorities. Because fate or superior cunning could thwart the best of plans, a line of succession to the president has also been established. That line includes seventeen officials ranging from the vice president to the secretary of veterans affairs.[10] If the president is killed or otherwise prevented from making a decision to use or not use nuclear weapons, a successor assumes the decisionmaking authority.

The problem with this approach is that a small list of successors may still provide a tempting target for an enemy, while a long list raises concerns about proliferation of control—i.e., too many fingers on "the button." In the fog of war, any person on the list might erroneously believe his or her predecessors in control had been killed and it was time to act. Even a lesser "fog," such as that in evidence at the time of the attempted assassination of President Reagan, can lead to confusion about "who's in charge." So, the need to protect the president and the president's successors must be balanced against concern about proliferation of control. We've got balances nested in balances!

The safety side of the credibility-safety balance also contains nested balances. We noted earlier that, to prevent unauthorized or accidental detonation of nuclear weapons, the United States uses electronic locks called PALs. The positive control of nuclear weapons made possible by the PALs must be balanced against an ability to release the weapons for use if necessary. In effect, control and flexibility must be balanced by decisionmakers. According to a former DoD official, the only acceptable way to strike that balance is to give control the edge: "Those two kinds of things are in conflict from a technical and operational point of view. So, you have to and would want to resolve that, in our judgment, by erring on the side of safety . . . ."[11]

Some exceptions to that rule exist. There are no PALs on nuclear weapons carried on ships: "With the single exception of depth charges stored ashore, the Navy has never inserted use control devices into the command and control chain of its nuclear weapons."[12] Some critics worry about scenarios in which a ship's captain and crew launch nuclear weapons without authorization.[13] The Navy argues its own procedural checks fill the same function as PALs, which are impractical because of the unreliability of shore to ship communications. Critics respond that this argument has some relevance to submarines, considerably less for surface ships.[14]

The balance of credibility and safety leads directly to another: "micromanagement" and inadequate control. Micromanagement describes a senior manager's getting involved in something that should be handled by a subordinate. It's probably as much a cliché to accuse President Reagan of being lax on control as it is to charge Presidents Johnson and Carter with micromanagement.

In the late 1980s, during the investigations of the Iran-Contra affair, some critics said Reagan's hands-off management style tempted members of the National Security Council staff to violate the law. They said he had inadequate control of his staff.

On the other hand, President Johnson's reported agonizing over bombing targets and other details of the Vietnam war was called micromanagement by his critics; normally, the selection of targets is left to military commanders directly involved in a war. President Carter, who was probably one of the most intellectually adept presidents in history, tended to get involved in everything—from military affairs to economic concerns. Like Johnson, he was frequently charged with micromanagement.

Every president must expect to hear such charges. If an omniscient being were to appear and define the appropriate degree of presidential involvement in a particular situation, it's likely the president following those directions would be accused of micromanagement by disgruntled military leaders or of laxity by congressmen of the opposition party. Of course, omniscient beings are too smart to get involved in such contentious situations, so finding the virtuous balance between micromanagement and laxity will remain a human art.

An omniscient being would also know specific decisions about structuring the staff are as potentially controversial as styles of leadership. In the wake of the Iran-Contra affair, the investigating Tower Commission and others called for reducing the size and power of the National Security Council (NSC) staff. Within two years, critics were arguing that President Bush's new, leaner NSC staff was too small and lacking in clout.[15]

It's also up to the president to determine when adequacy of information becomes overload. Every day the White House is bombarded with far more data than is manageable by any one person. So, presidents must count on their staffs to sift through the mass, fusing (piecing together; correlating) relevant information into manageable chunks and filtering out the chaff. Being human, every staffer brings a particular set of biases to the tasks of fusion and filtering. In a sense, to the degree a staffer's biases differ from those of the president, that staffer's work may seem a hindrance or distortion more than a help. On the other hand, a staffer with different biases may help broaden the president's own perspective.

Presidents, at any rate, must ultimately determine the blend of information flow, fusion, and filtering that will best satisfy their decisionmaking needs. The same may be said for business CEOs and "middle" decisionmakers at every level. Those who habitually find themselves drowning in information or lacking information can probably benefit from Aristotle's timber straightening strategy in making the necessary adjustments to their information systems.

A related aspect of their information systems which presidents must consider is the difference between competitive and consensus analysis. Seldom are the conclusions to be drawn from a given set of facts clear-cut. In the late fifties, for example, intelligence revealed that Soviet testing of the SS-6 missile had dropped off dramatically. According to William Burrows, CIA analysts interpreted the decrease as an indication that the Soviets were having problems with the missile and its deployment would be slower than originally planned. Air Force analysts saw the decrease in testing as a sign the Soviets were ready to begin full deployment. (As it turned out, the CIA analysts were right.)[16]

A competitive analysis of the testing slowdown would present both the CIA and Air Force conclusions and the reasoning behind them. A consensus analysis would, in theory at least, reduce the report to matters about which there was agreement: in this case, to the fact that testing had been reduced.

Should analysts with different views work toward hammering out a consensus, or will the president (or another decisionmaker) benefit more from an analysis which presents competing views? In relying on consensus analysis, a president risks sacrificing vital pieces of information. On the other hand, some argue that anything other than a consensus analysis confuses busy decisionmakers. William Burrows maintains that arguments among the analysts not only cause confusion, but also "inhibit quick and appropriate responses, and undermine confidence in the collection system itself."[17] Once again, it's the decisionmaker who has to make the call.

One of the factors the decisionmaker should consider when making that call is how often the "appropriate" response will be a "quick" one. Some situations, such as attacks on the United States, its forces, or its allies, will require an immediate response—to support our deterrent posture as much as to redeem our national pride. However, in most of the situations a president faces, careful deliberation is critical. The late Richard Beal, President Reagan's Director for Crisis Management Systems and Planning, felt that, "Short of a nuclear exchange, there is no crisis that this nation ever has to respond to in very compressed time, either real or psychological."[18] Richard Neustadt and Ernest May, studying U.S. national decisionmaking in the twentieth century, observe a tendency to "think first of what to do and only second, if at all, of whether to do anything."[19]

If American decisionmakers are predisposed—as Neustadt and May suggest—to "plunge toward action,"[20] the Aristotelian remedy would be conscious restraint. That's a remedy Beal would have had no difficulty supporting: "Anytime you get in a crisis, the major thing is, let's not go too fast.... Moving too rapidly is probably the single most significant error we make."[21] Speed and deliberation, therefore, will be two more features in the president's precarious balancing act.

CONGRESSIONAL BALANCING ACTS

While the president and the rest of the executive branch are involved with one set of balancing acts, the legislative branch is concerned with another, often overlapping set. Through its control of the federal purse strings, Congress frequently gets involved in debates about C^2 issues: Do existing C^2 systems meet the requirements of national strategy? Should our present acquisition system—a system designed around weapons, ammunition, and replenishable supplies—be modified to better fit the technological complexity, small quantities, and other special aspects of C^2 systems?

A streamlined acquisition system is something most congressmen (and just about everybody else) will agree is needed at a time when complex, multilevel planning and testing requirements cause delays of twelve to fifteen years between recognition of the need for a new system of any kind—weapon or C^2—and fielding of that system. On the other hand, given the problems that have traditionally plagued military purchasing systems, it's not unreasonable to argue too much streamlining will encourage waste and fraud. As the president must find the mean between micromanagement and inadequate control of U.S. forces, Congress must balance its watchdog role with the need for efficiency.

A member of Congress is also required to serve the interests of both the constituents who elected him or her and those of the nation as a whole. This is another balancing act. If C^2 system A is built in X's district, providing thousands of jobs there, can we expect X to vote for system B, which is built in another district, just because it has a very slight advantage in weight or speed or cost? Is it fair to say X is catering to parochial interests if X votes for system A?

The requirement to balance needs and costs is one shared by the legislative and executive branches. And this is an area where C^2 systems are at a real disadvantage to weapons systems. Give the president or a member of Congress a flight in the latest fighter or a ride in the latest tank and chances are good you'll win a sympathetic ear for your argument that the plane or tank is needed.

Now, compare the selling of that plane or tank to the selling of a new radio system which is secure, jam-proof, interoperable, reliable, and about as expensive as one of those planes or tanks. There's something inherently dull about a radio—regardless of its features—when it's compared to a fighter or a tank. It's hard to get excited about the "force-multiplier" effects of a little rectangular box while visions of the fighter's loops and the tank's firepower are fresh in the mind. Having a coherent defense strategy—one that offers a clear basis for determining priorities—can help overcome the problem by emphasizing the importance of balancing "nerve" and "muscle" systems. However, human nature being what it is, even such a strategy is unlikely to make the problem disappear completely.

As noted earlier, Congress's involvement in issues concerning C^2 of military forces has been growing. The Constitution, of course, gives Congress not only the power to declare war, but also the power to raise, organize, direct, and support forces. That empowerment, combined with what vocal critics have perceived to be military bungling in places like Beirut, Grenada, and especially Vietnam, has led Congress to extend its interest beyond acquisition to organization of the armed forces.

Congress has been involved, somewhat less directly, with organizational questions before—in 1947, for example, when it passed the National Security Act establishing the DoD and in 1958 when it approved the changes to the DoD initiated by the Eisenhower administration. The 1986 passage of the

Goldwater-Nichols Defense Reorganization Act, however, marked the first time Congress actually took the initiative in reshaping the defense establishment. The act, passed over the objections of very senior officials in DoD and the Reagan administration, had the net effect of shifting some power from the military services to the combat commands. As we've seen, it attempted to balance responsibility and authority by giving those charged with responsibility for winning battles and wars—the CINCs—more say in determining the shape of their own C^2 systems.

Over the years, the powers of the military services relative to the combat commands has probably received as much political attention as any defense issue, but it's certainly not the only balancing act going on in DoD. Should the power of the civilians in the Office of the Secretary of Defense (OSD) be greater than the power of the JCS organization? In other words, when we speak of "civilian control of the military" do we mean control of the military by career civil service officials? Will such people be more responsive to the electorate than military people? Balancing the power of OSD relative to the JCS is another perennial issue.

Should we emphasize military service specialization over "jointness," the capability of the Services to figl: together in a unified effort? As we've seen, Goldwater-Nichols said "no" and moved to make joint duty—that is, duty in multi-Service organizations—more attractive to the best Service people. Chances are, though, our ideas about the proper balance of specialization and jointness will continue to evolve as our perceptions of the other balances change.

We can't, for example, forget the communications environments and needs of the people flying airplanes will differ from those of people commanding tanks, and the needs of the pilots and tank commanders will both differ from those of ships' captains. Where possible, we'll want our pilots and ground commanders and ships' captains to be able to talk to each other; however, some circumstances will force us to sacrifice such interoperability in the interest of the most efficient communications among airmen, among sailors, among marines and among soldiers.

In such circumstances we might take the F-111, a plane designed to meet the needs of both the Air Force and the Navy, as an object lesson. According to some critics, that multipurpose aircraft "turned out to be too heavy for use on carriers, too unmaneuverable for use as an air superiority fighter, and too short-range for use as a strategic bomber without a good deal of air-to-air refueling."[22] In other words, such critics see the F-111 as a case where, instead of balancing interoperability and specialized needs, we put most of our emphasis on interoperability (and saving money) and lost sight of the specialized needs that had originally led to the call for a new aircraft.

The F-4, on the other hand, met the requirements of both the Navy and the Air Force, even though it was originally designed only for the Navy. So, the specialization versus jointness issue is another for which easy, formulaic answers are not always useful.

One of the criticisms frequently heard in discussions of the Desert One and Grenada operations is that planners were more concerned with protecting military service turfs than they were with effectiveness. Richard Gabriel, for example, maintains that the Marine pilots chosen to fly helicopters to Desert One were involved because the Pentagon had to give the Marines a piece of the action and not because they were the pilots best qualified for the job. In fact, Gabriel argues that their lack of experience flying long distances over land was a central factor in the failure of the mission.[23]

According to Samuel Huntington, concern with turf protection resulted from the bitter inter-Service rivalries of the late 1940s, as the Services maneuvered to grab continuing roles in the post-war world. After the initial bloodletting, the competition became "collusion," says Huntington, an effort "to share the market, to keep others out, to maintain each other's position without running afoul of each other."[24] Under the collusion system, the Air Force votes for the Army's new tank, the Navy's new carrier, and the Marines' new amphibious vehicle in order to guarantee the other military services' votes for its own new fighter. By the same token, each of the Services counts on having a role in any important operation, even if it isn't particularly well suited for the role.

To some degree, turf protection involves the sincere belief by the leaders of each military service that their own outfit is the most critical element of national security. Thus, by protecting their Service's turf, they are acting in the best interests of the nation.

At any rate, the issue is not the simple one we sometimes assume. It's not just a case of power hungry generals and admirals sacrificing the nation's interests for their own. Oettinger sums up the complexity this way:

> If one were infinitely wise and the world were infinitely arrangeable, then maybe you could define totally non-overlapping subresponsibilities. But in the real world that strikes me as impossible, and, therefore, even if angels were in the organization they would end up fighting over ill-defined turf. It seems that folks tend to overlook that fact and believe that it requires either malice or stupidity or both for people to fight, and [they don't realize] that it's inherently impossible to define non-overlapping responsibilities.[25]

The 1986 Defense Reorganization Act attempted to minimize inter-Service collusion by concentrating the power of the Joint Chiefs of Staff in the Chairman. It's important to remember, though, that collusion, turf battles and other symptoms of overlapping responsibilities are not always the enemies of effectiveness. Many would argue the net effects of tempests stirred up by the Billy Mitchells of history have been healthy; or that the strategic triad—of bombers, land-based missiles, and sea-based missiles—besides being the product of military collusion, is a fairly effective basis for a deterrence strategy.

Some other critical balances in DoD have already been touched on. They include questions about the relative weights of changing personalities compared to changing organizational charts; of moving information upstairs to someone with the big picture relative to moving it downstairs to the soldier facing the guns; of emphasizing security compared to emphasizing thorough planning.

One whole subset of balances pertains to how DoD buys what it needs—particularly new C^2 systems. Command and control systems usually involve sophisticated technologies and, in most cases, small quantities. The complexity of such systems forces DoD to weigh its institutional aversion to buying "off-the-shelf"—i.e., buying systems or components already in commercial production—against the extreme difficulty of articulating its needs in the form of technical specifications. Very few people on active military duty have the opportunity to keep up with "state-of-the-art" developments in fields where the notion of what is or is not possible changes every day. As a result, military people—even those trained as engineers—have difficulty assessing what can or need be done.[26]

When the system needed is unique enough to justify going through the lengthy acquisition process, the producer's risks must be taken into consideration in determining the size of a reasonable profit. Developing a truly unique system for which no commercial applications exist will have few attractions if a contract doesn't cover development costs as well as some profit.

When a product that meets government specifications has been or can be marketed commercially, it's reasonable to allow market forces to determine profit levels. The same airframe, for example, might be used for both a civilian airliner and a military cargo plane. In a case like this, it might be unreasonable for the developer to try to recoup all development costs and a high profit from the government sales, with the commercial sales being just so much gravy.

However, a piece of communications gear built to withstand the conditions of the nuclear battlefield may not have much commercial application. In a case like this, the government must expect to cover both development costs and reasonable profits.[27] Otherwise, the government will be forced to create and run its own defense industries, and the experiences of countries that have tried that—notably the Soviet bloc—suggests it's a costlier and less efficient system than even the one with which we're stuck. It's just not a good idea.

Another acquisition balance involves planning and flexibility. While it becomes inordinately expensive to change requirements after a contract has been signed—any buyer of a new home will know how that works—it doesn't make any sense to refuse to change requirements if sticking to the original plan means a system will be obsolete by the time it's fielded. Of course, if the requirements are being changed constantly, the system may never be fielded.

Sometimes it's possible to develop a basic system in a relatively short period of time and then modify it after it reaches the field. Such an "evolutionary" approach to acquisition can save both time and money. The problem you run into with evolutionary development is akin to the old big picture-little picture dichotomy. A system that works fine in one little corner of the world—say, a radio used by one battalion—may cause problems when it has to function in terms of the bigger picture—when, for example, one battalion's evolutionary radio system has to communicate with another battalion's evolutionary radio system. In other words, we have to be careful evolutionary developments don't lead to the kinds of incompatibilities the concept of systems management was supposed to overcome. We have to balance systems and evolutionary thinking.

BALANCING ACTS IN THE INTELLIGENCE COMMUNITY

Those in the intelligence community have to deal with similar balances. First, there is the question of acquisition versus analysis which we've already touched on. Technical and human intelligence sources provide tremendous quantities of data—far more than analysts can convert to useful information for decisionmakers. If intelligence resources were unlimited, we could simply devote more money to analysis. Unfortunately they're not, so we must make difficult decisions about the efficiency of reducing collection and using the money saved to increase analysis, compared with leaving the acquisition-analysis balance as it is.

Debates can also rage over the relative utilities of TECHINT (intelligence gathered by technical means) and HUMINT (intelligence gathered by human sources). Some argue that TECHINT reveals nothing about enemy intentions, which are as important to identify as capabilities. Others point to examples such as the Cuban Missile Crisis to support their view that we can indeed determine intent from TECHINT. In that crisis, analysts compared missile site configurations discovered in Cuba with those previously identified in the Soviet Union. The similarities alerted the United States to the Soviets' intention to build an offensive missile capability in Cuba.

Another hot topic within the intelligence community is the line between policy and objectivity. An administration's policy will be a factor in determining what intelligence data will be useful to the president and other decisionmakers. However, intelligence professionals risk compromising their objectivity—or at least the appearance of objectivity—by establishing close ties with those decisionmakers. Does the need for objectivity necessitate that the intelligence collectors or analysts ignore the interests of the decisionmaker?

That leads us directly to another issue. If the intelligence provider is not known and trusted by the policy maker, will the latter find the information provided credible? Will the policy maker accept the information without knowing its source? Frequently, revealing a source is the quickest way to lose it, but if the provider isn't known and trusted by the decisionmaker, the credibility of the information may depend on the decisionmaker's confidence in the source.

Another question involves balancing rights with security needs. Which takes precedence: the public's right or need to know something or national security? Extremists on both sides of this issue will have little doubt about the rightness of their own answer and will be shocked by the audacity of their opposite numbers, whom they will see as undermining the constitution or lacking in patriotic fervor. The other side of the same coin is the question of when, if ever, an individual's constitutionally given right to privacy outweighs the needs of national security.

Intelligence analysts (and their bosses) must also balance the benefits of stability against the need for an unbiased perspective. If an analyst has devoted twenty to thirty years to studying nothing but the Soviet submarine base at Polyarnyy, new data pertaining to that base will probably reveal more to his eyes than they will to the eyes of any analysts who lack comparable familiarity with the base. However, there's also a chance that the Polyarnyy expert will miss something that clashes with the expectations he's been building up over the years he's been studying the base.

SHARED INTERESTS

Cushman's concept of the C^2 "web" ties together all the balances (or choices) we've been looking at. Each of the balances is important for everyone concerned about national security, even if the balance in question is the special responsibility of a particular national security element. For example, how the intelligence community balances the benefits of stability against the need for an unbiased perspective will have an impact on more than just the analysts involved; recognized or not, the decisions made about that balance will affect the analyses, everyone who uses them, and even the citizenry who will ultimately benefit or suffer from their use. In a sense, then, regardless of the balance involved, there's likely to be some overlap of interests.

Some balances, however, might be described as more generic than others. They involve choices that must be made by or for decisionmakers at most levels of our national security system, from the high level bureaucrat in the Department of Commerce to the squad leader intent on getting his troops back to friendly lines.

For example, whether the asset concerned is firepower, intelligence collection, communications systems, or what have you, decisionmakers will often have to make decisions between control and capability—between having great capabilities over which they have little control and minimal capabilities over which they can exercise complete control. The squad leader, for example, might be able to draw close air support from a flight of A-10s, but if he can't risk having that firepower drawn off at the last minute by a higher priority target, he better not be counting on more than his own and his soldiers' guns.

Another choice which can come into play at just about any level: who will run the show? At the brigade level, the question might be focused on the battalion commander and the company commander. The battalion commander hovering 300 feet above the battleground in the command helicopter has a broad view of what's happening on the field as a whole; the battalion commander may, for example, spot enemy reinforcements long before their arrival on the battlefield. However, the company commander on the ground has a more focused, detailed view. The company commander may be aware, as the battalion commander in the sky cannot be, that the troops are close to panic.

It will be up to the brigade commander to balance the focused view of the company commander—the person on the ground—against the broad view of the battalion commander—the person in the helicopter. The decision about who should run the show may be affected by the terrain on one occasion—the guy in the sky will have an advantage if the ground commander's view is blocked by rocks, trees, gullies, etc.—and relative experience levels on another.

At the national level, the president might face a comparable balancing act in deciding whether delicate negotiations with a particular country should be run by the ambassador to that country or the secretary of state. Again, the choice would probably be driven by the question, "Which is more important in the present context: focused view or broad view?"

The somewhat clichéd phrase "centralized control, decentralized execution" is said to characterize American military operations and to be vastly superior to the heavy-handed central control that guides Soviet operations. One question that needs to be asked is whether the phrase means anything or is just a rhetorical ploy for having our cake and eating it too. In the most extreme case imaginable, with the president on a radio giving the order to "fire" and a soldier 5,000 miles away pulling the trigger, we could say we're using "centralized control, decentralized execution." Would that instance be any different than a Soviet pilot with a target aircraft in his sights waiting an hour or more to get permission from Moscow to fire? Might we be using the phrase "centralized control, decentralized execution" to avoid deciding how to find the appropriate mean between centralized and decentralized C^2?

Given the kind of linkage technology makes available, avoiding a decision will probably have the same effect as opting for highly centralized C^2. When that occurs, it's only fair to remember it wasn't the technology that brought centralized control, but our failure to make a decision.

DECISION OR DEFAULT

Balances require decisions. That's really the point of this whole discussion. Shifts in contexts call for adjustments to existing balances—more decisions. Our national security depends upon our willingness and ability to be constantly making decisions about what adjustments are needed. Many of the decisions we don't make will be decided by default.

We're accustomed to thinking about national security in terms of isolated issues—in bits and pieces rather than holistically. But the elements of national security are as tightly bound together as the various organs, muscles, cells, and other elements of the human body: we can't change one without having an impact on them all.

We're also used to thinking in terms of fixes rather than adjustments. If our data collection is deficient, we focus our efforts on "fixing" that problem, on finding ways to collect all the data we can locate.

The more dramatic the fix, the more catastrophic the impact can be, especially when it occurs somewhere we're not expecting it. When we do make a dramatic change, we must be prepared to let the dust settle a little before rushing into the next change. The key, though, is constantly fine-tuning the whole, making an adjustment here and an adjustment there to minimize the requirement for wholesale changes, while recognizing that occasionally wholesale change is the way to go.

One mission is less successful than we'd like because concern for security interfered with thorough planning. The next time, we deemphasize security, practice until we're sure we've got it right, and then come close to blowing the mission because the bad guys heard we were coming. Is it time to revamp our national security organization and jump from one set of strategies and tactics to another? Probably not. It's just time to do a little fine-tuning, to adjust the planning-security balance a little.

THE POWER OF RECOGNITION

By recognizing the balances involved in national security and the web-like interdependence of the whole structure, we enable ourselves to start thinking in terms of adjustments that improve things, rather than changes or fixes that will make things perfect. By recognizing our national security structure will never be perfect, we can avoid the now-we-fixed-it-and-can-worry-about-something-else syndrome, the complacency that somewhere down the line will make dramatic changes unavoidable.

A complete list of the balances would doubtless be useful, but, given the size and complexity of our national security system, compiling such a list would be a very difficult, if not impossible, task. More important is Aristotle's "pattern of behavior involving choice."

Science, with its "dust-free" environments and "laboratory conditions," has given us a pattern for approaching the natural world of things: we stabilize the environment, bring together a number of elements, and observe the results. We call those results "facts." "Facts" are very comfortable things to deal with because they're so stable. What was a fact yesterday will be a fact tomorrow, so long as the environment stays the same.

Unfortunately, that kind of fact-oriented approach doesn't work very well when we're dealing with people and people issues. Human dynamics are simply too complex.

We can stabilize a human subject's environment by locking the person in a windowless, dust-free, clinically tested room, but that's not the same as isolating a chemical element in a test tube. The human will think about being in that locked room; he or she will respond to that experience intellectually and emotionally. Even though the person may have volunteered to be locked in the room, the experience will change the person. Furthermore, how the person changes will be the culmination of everything that has happened in his or her personal history. The experience of being locked in the room will probably have very different effects on a Mohandas Gandhi and an Allen Ginsberg. What reliable conclusions about humanity as a whole could a scientist draw from observing those two human beings? Yet the scientist's observations about the chemical element in the test tube would apply to any comparable sample of the same chemical element observed under the same conditions; the experiments and observations could be repeated and confirmed by other researchers.

In short, empirically determined conclusions and principles are not very helpful when it comes to people questions. If we factor competition into a human scenario, the already impossible complexity increases geometrically. Two atoms placed in opposition in a controlled experiment will not attempt to outwit or deceive each other the way opposing commanders on a battlefield will. To a large extent, the conflict of the atoms is straightforward; the results, statistically predictable. Human conflicts—on battlefields, playing fields, or in boardrooms—are anything but. Colonel John R. Boyd, U.S. Air Force (Ret.), puts it this way:

> When things went wrong at the Pentagon, really wrong, you'd always hear some bright guy in a business suit complaining that a country able to land a man on the moon should be able to carry out any operations on earth: raid Hanoi, drop into Tehran, whatever. I always pointed out to these smart alecks that as I recalled, the moon didn't hide, move around under its own steam, or shoot back.[28]

Thinking in terms of the media via—in terms of balances—is a practical "pattern of behavior" for making choices about the complex C^2 "web." The results aren't guaranteed; they never are when human beings are involved. But, by addressing our balances consciously, we stand to gain an advantage over an enemy—particularly if many of the enemy's "choices" are default ones—and over our present position as well.

7

FIGHTING SMART

Improving all aspects of C^2 is the key to fighting smarter. Having belatedly come to recognize this fact, we can't afford to ignore it just because defense budgets shrink. Improved C^2 will continue to be the basis for doing more with less.

In the wake of the Cold War, the importance of capable C^2 remains critical. United States defense planners confront dramatic decreases in the defense budgets at the same time the task of providing for the national security grows more complex. A world dominated for nearly a half century by the superpower rivalry finds itself menaced in the post-Cold War period by tribal and ethnic warfare from South Africa to the Soviet Union, by factionalism and revolution in places like Natal and Liberia, and by the nationalistic aggressions of leaders like Saddam Hussein. At home, our military forces have been drawn into the "war" on drugs as the potential for a superpower confrontation has diminished. And monitoring the treaties engendered by the new world situation further stresses our C^2 capacity.

Command and control is the basis for efficient operation at all times; in armed conflict, it is the basis for fighting smart. Capable C^2 is the key to the flexibility our leaders and forces need in the complicated international environment. While a particular technology—such as Stealth—may be rendered obsolete by a new development—such as a sophisticated sensor—or a new development negated by new tactics, C^2 will always be relevant to national security. The most efficient way to "do more with less"—now, as in the past—is to improve C^2, giving commanders better knowledge of what they're up against, what resources are available and how they might be best used, as well as better means for controlling their use.

As we've seen, who we are and where we fit in the defense hierarchy affects our view of C^2. Essentially, C^2 is the process by which commanders communicate with superiors and subordinates; receive their missions; learn everything they can about the enemy, the environment or battleground, and their own forces; make their battle plans; assign tasks to subordinates; monitor the battle; compare what's happening in the battle with their battle plans; decide what adjustments are necessary; make them; and, finally, evaluate the outcome of the battle. It's also the "arrangement of personnel, equipment, communications, facilities, and procedures" they use to do all these things. Command and control, in other words, is both a process and a system.

One danger in thinking about C^2 as a system is the widespread tendency to identify it with technology. Besides equipment and communications, the DoD definition of C^2 includes personnel, facilities, and procedures. Slighting any one of these elements could prove a costly mistake: the best equipment would be useless if an army didn't have people who knew how to use it.

A danger in thinking about C^2 as a process is the mistake of identifying the abstract formulations, which make such thinking possible, with reality. Our formulations can be helpful in highlighting the activities that constitute C^2, but they can also be misleading. They're too neat. We construct them by abstracting some of reality's messiness.

We can get a more accurate idea of C^2 by taking the verbs used in describing the process, jumbling them up, running them together, and repeating them countless times. Real C^2 won't have distinct phases, such as the communicating phase, or the planning phase, or the decisionmaking phase, etc. In real life, commanders find themselves looking at maps and photos and talking on the radio at the same time they're making plans and decisions; or receiving new information or orders just at the moment they've made a decision based on old information and orders—or two minutes after they've "disseminated" the now outdated order to their subordinates. To put it another way, the communicating, receiving, learning, planning, tasking, comparing, deciding and evaluating occur in a looping, indeterminate pattern, rather than a structured sequence. The process is dynamic, iterative, and messy. A formulation will never quite do it justice.

Our military history predisposes us to seek technical solutions to our defense problems. In the 1980s, increased concern about C^2 at both the strategic and tactical levels led to vast expenditures on technical "solutions" to shortcomings in C^2. Unfortunately, the melding of advanced technology and C^2 was not always an unmitigated blessing. Technology allows us to do things unimaginable in the past, but it also brings with it a whole set of problems, ranging from overconfidence to complexity and dependence. Some of these problems are so subtle they escape detection until a moment of crisis—at which point their effect can be disastrous.

Furthermore, our fascination with technology can relegate human issues of command to secondary status. We sometimes focus on the problems for which there are technological fixes, rather than on more important, difficult, or subtle issues. The fact is that most of our past failures in C^2 have resulted from poor organization or poor decisions, not technological shortcomings. When we err in policy or judgment, modern technology can actually magnify the consequences of our mistakes, enabling us to act on the poor decision or to put the flawed plan into action more quickly than would have been possible if the technology had not been available.

The human side of C^2 is probably more complex and less understood than the technology side. For example, all sorts of physical, mental, and emotional "noise" impact on the human decisionmaker. The judgment of human beings may also be clouded by preconceptions, institutional biases and norms, and convention. Organizational structures, which determine how the human components of C^2 are put together further complicate the "people" aspects of the process.

Ultimately, none of the devices or constructs of imperfect man—radios, computers, software, organizations, procedures, or doctrine—can be more perfect than their maker. It is, therefore, dangerous and misleading to promise (or even seem to promise) commanders perfect C^2 systems. Such systems can't be defined, let alone delivered. They exist only as abstractions or idealizations—just like our theoretical pictures and diagrams of the C^2 process itself.

Being able to distinguish between the ideal and the possible is a critical element of the "art" of war.

Commanders lacking in art will miss their opportunities. They'll act too late, or too soon—waiting too long for better information, organization, communications, training, etc., or moving before they have the one essential piece of information or the one communications link that makes a difference. If they've taken too literally the words of those who promise things like information that is "complete, true, and up-to-date," they'll find themselves beaten by someone whose information was good enough.

Ability to recognize the "good enough" is a sign of the artful commander. Artful commanders have much in common with the most creative writers, scientists, painters, and poets: they work intuitively as well as rationally. They balance an analytical tendency to divide, abstract, and isolate with an intuitive sense of the whole.

The complexity and dynamics of C^2 frustrate rationalistic attempts to fix or improve pieces of the process. One isolated fix—a highly capable new radio, for example—spawns another problem—in the case of the new radio, another "interface" problem.

A more creative approach to a C^2 problem combines a rational focus on the immediate issue with an intuitive sense of the whole web-like process. It considers not only proposed solutions to the problem, but also the impact a proposed "fix" will have on other parts of the process. It combines analysis with synthesis.

Aristotle's concept of the media via—of finding a good balance—offers a pragmatic way to make choices regarding C^2. By addressing C^2 in terms of balances, we frequently force to the surface choices that might otherwise go unrecognized. When we choose to buy a new system, for example, we are implicitly making other choices, consciously or otherwise. Buying the new system requires us to come up with money from somewhere else, so several choices are involved: the choice to buy a new system, the choice of which system to buy, the choice of which expenditures to cut or reduce in order to finance the new system, the choice of buying or devising new interfaces to link the new system with old systems, etc.

Thinking in terms of balances forces us to consider at least one counterweight to the proposed fix. It cuts down on the number of default choices we make by not considering the impact a change will have on the rest of the process. It points us in the direction of more holistic thinking.

Protecting the national security of the United States involves more than preventing a nuclear attack. Our most vocal critics say the material comfort of Americans is based upon economic imperialism backed by military forces. A friendlier view is that our national interests require access to world markets and sources of raw materials, and that our military forces must be strong enough to deter potential enemies from interfering with such access.

Regardless of the political context from which it is viewed, the linkage of military and economic strength is clear, and it's not going to go away just because we've declared an end to the Cold War. This means the maintenance of our military capability is going to continue to be important for large numbers of Americans.

That defense budgets will always be the targets of choice when it becomes necessary to cut federal spending is a simple fact of the American way of seeing life and the world. However, the care with which we orchestrate defense cuts can be the difference between "peace dividends" that can be sustained over the long term and those that quickly give way to hefty war taxes.

In the 1980s, defense planners with full pockets came to acknowledge that C^2 was the linchpin of defense, more critical than even the most glamorous weapons systems. They realized that neither the Strategic Defense Initiative nor the more traditional nuclear strategies would be worth having unless they were built upon capable C^2. They also recognized the central importance of tactical C^2, something previously either assumed (on questionable grounds) or completely overlooked.

Such important lessons bear frequent repetition. We've seen that C^2 involves more than technology, but it would be naive to believe our long overdue awakening to the importance of the nervous system of defense was not due in some part to the involvement of defense contractors, who recognized an enormous potential market for information technology. Money does talk, and the money available for C^2 in the Reagan military budgets caught a lot of attention. In periods when the money is lacking, it's likely the attention will be lacking.

It's up to all of us—as taxpayers, and the elected, appointed, or military representatives of taxpayers—to keep C^2 a national priority. During relatively peaceful periods, we can afford to cut down on weapons acquisitions, so long as we maintain a strong research and development effort. We can probably even reduce the money we spend to buy the latest in computers and communications equipment. What we can't afford to do is to settle for inadequate C^2.

Saying we won't buy fancy new systems isn't the same as saying we'll settle for inadequacy. Our C^2 systems don't have to be fancy. They don't even have to be new. They just have to work.

Realistic exercises—leading to evolutionary fine-tuning, clarification of operating procedures, and better training—are key to low cost improvement of C^2. Joint exercises, emulating the way we'll fight, can also generate doctrinal revisions that will reduce interoperability problems and unnecessary duplication.

In fact, the net effect of budget reductions can be quite positive: a "leaner," "meaner," more efficient military establishment. Americans are more inclined to support a force that fights "smart" than they are to support a force that counts on overwhelming an enemy with brute strength. The widespread public support for the way allied forces fought the Gulf War of 1991 offers a case in point. And command and control processes—involving strategies, doctrines, procedures, and training, as well as technology—are essential to fighting "smart."

NOTES

Chapter 1. THE BROAD VIEW OF COMMAND AND CONTROL

1. Alan D. Campen, "Information Systems," *SIGNAL*, January 1990, 79.

2. Kenneth L. Moll, "Understanding Command and Control" (Part I), *Defense and Foreign Affairs*, June 1978, 41.

3. Greg Todd, "C^1 Catharsis," *Army*, February 1986, 14.

4. Emmett Paige, Jr., "Adequate C^3I," *SIGNAL*, May 1984, reprinted in *Tactical C^3 for the Ground Forces*, ed. James M. Rockwell (Washington, DC: AFCEA International Press, 1986), 23.

5. Sun Tzu Wu, *The Art of War: The Oldest Military Treatise in the World*, trans. Lionel Giles (Harrisburg, PA: Military Service Publishing Co., 1944), 51.

6. Eberhardt Rechtin, "The Technology of Command," *Naval War College Review*, March-April 1984, 12.

7. Ibid., 21.

8. U.S. Senator Tim Wirth, "What now for peace dividend?" *The Northern Light* (Colorado Springs, CO), 15 June 1990, 4.

9. John E. Rothrock, "Theater War in the 'Information Age': The Rapid Application of Airpower (RAAP) Concept," in *Control of Joint Forces: New Perspectives* (Fairfax, VA: AFCEA International Press, 1989), 67.

Chapter 2. C^2: PROCESS AND SYSTEM

1. Joint Chiefs of Staff, *Department of Defense Dictionary of Military and Associated Terms* (Washington, DC: GPO, 1 June 1987), 77.

2. See, for example, Mike Capuzzo, "War, Football Share Longtime Alliance," (Knight-Ridder Newspapers) *Colorado*

Springs Gazette Telegraph, 20 January 1991, A5. General Douglas MacArthur was especially fascinated by the parallels between football and war. See William Manchester, *American Caesar: Douglas MacArthur, 1880-1964* (Boston: Little, Brown and Co., 1978), 480-81.

3. The National Football League has a rule requiring a team to stop using its telephones and radios if the opposition's communications fail for any reason. Unfortunately, rules to ensure "fairness" don't usually apply in war.

4. Brigadier General William A. Mitchell, *Outlines of the World's Military History* (Harrisburg, PA: Military Service Publishing Co., 1931), para. 740-14.

5. Being unaware of the U.S. success in breaking their codes, the Japanese undoubtedly thought their emphasis on security was adequate.

6. "Operation Desert Shield" and "Operation Desert Storm" were the names given to the allied military build-up and offensive operations respectively; E.J. Dionne, Jr., "On War: Ideas With a Familiar Face: Gary Hart Makes 1st Hill Visit Since '88 to Testify on Defense Reform," *Washington Post*, May 1, 1991 (LEGI-SLATE Article No. 130874).

7. Peter Townsend, *Duel of Eagles* (1971; New York: Pocket Books, 1972), 275.

8. Len Deighton, *Fighter: The True Story of the Battle of Britain* (New York: Alfred A. Knopf, 1978), 88-89.

9. Cajus Bekker, *Angriffshohe 4000* (1964); republished as *The Luftwaffe War Diaries*, trans. Frank Ziegler (New York: Ballantine Books, 1966), 199.

10. Peter Townsend, *Duel of Eagles*, 275.

11. Winston Churchill: "Never in the field of human conflict was so much owed by so many to so few." Quoted in Peter Townsend, *Duel of Eagles*, 369.

12. Len Deighton, *Fighter*, 224-26. Ironically, Dowding's perserverence cost him his job shortly after the Battle of Britain.

13. George E. Orr, *Combat Operations C^3I: Fundamentals and Interactions* (Maxwell AFB, AL: Air University Press, 1983), 19. Boyd refers to his own four-step model of C^2, the "O-O-D-A Loop" (observing, orienting, deciding, acting), and speaks of "getting inside an adversary's O-O-D-A loop."

14. U.S. Marine Corps, *Warfighting* (FMFM 1) (Washington, DC: Dept of the Navy, March 6, 1989), 69.

15. For example, Brigadier General Richard Neal, U.S. Marine Corps, U.S. Central Command Briefing, Cable News Network, Riyadh, Saudi Arabia, 15 February 1991.

16. Lieutenant General Raymond B. Furlong, "Strategymaking for the 1980s," *Parameters, Journal of the US Army War College* 9 (March 1979): 10. Quoted in George Orr, *Combat Operations C^3I*, 20.

17. President Truman writes of giving General MacArthur "complete command and control after victory in Japan" in his *Memoirs: Year of Decision* (1955); quoted in William Manchester, *American Caesar*, 439.

18. There are arguments for at least two variations on this view. One simply reverses the command/control relationship: control is strategic and command is tactical or operational. The other suggests command is a composite of leadership and control: a General Eisenhower *controls*, subordinate commanders *lead*; their joint accomplishment is *command*. Appealing as this view is in some respects—its neatness, for example—it adds further confusion to the question "Why command *and* control?"

19. According to Dr. Ruth Davis, former deputy under secretary of defense for research and advanced technology, "the phrase 'command and control' or 'C^2' . . . was 'invented' at a conference [in the 1960s] at which we were trying to describe decision making by military commanders. It did not seem to be a very significant decision at the time, but the phrase has been long lasting and has become a part of both military and technological terminology." See Ruth Davis, "Putting C^3I Development in a Strategic and Operational Context," in *Seminar on Command, Control, Communications, and Intelligence: Guest Presentations, Spring 1988* (Cambridge, MA: Harvard University Program on Information Resources Policy, 1989), 162.

20. See Peter Stein and Peter Feaver, *Assuring Control of Nuclear Weapons: The Evolution of Permissive Action Links* (Lanham, MD: University Press of America, 1987), 72-73.

21. See, for example, Rear Admiral Daniel V. Gallery, *The Pueblo Incident* (New York: Doubleday & Co., 1970), 42.

22. Robert F. Kennedy, *Thirteen Days: A Memoir of the Cuban Missile Crisis* with introductions by Robert S. McNamara and Harold Macmillan (New York: W.W. Norton, 1969), 59-60.

23. Donald Latham, "A View from Inside OSD," in *C^3I: Issues of Command and Control*, ed. Thomas P. Coakley (Washington, D.C.: National Defense University Press, 1991), 210-11. Perhaps the most useful way to look at the money spent on C^2 is in comparison with the rest of the defense budget. Between 1975 and 1988, the defense budget as a whole grew by roughly 330 percent: from 87.6 billion dollars in 1975 to 291.4 billion in 1988. During the same period, the unclassified expenditures for "Intelligence and Communications" grew from 6.3 billion dollars to 28 billion or 440 percent. The percentage of the DoD research and development allotted to the category of "Intelligence and Communications" also increased: total DoD research and development grew 270 percent between 1980 and 1988, while the "Intelligence and Communication" portion grew 408 percent (*US Statistical Abstracts, 1989*).

24. Craig Wilson, presentation to the John F. Kennedy School of Government Seminar: "Command, Control, Communications, and Intelligence," Harvard University, Cambridge, 16 February 1989 (based on notes I took on this talk).

25. Harry G. Summers, Jr., *On Strategy: The Vietnam War in Context* (Carlisle, PA: Strategic Studies Institute, 1981), 116. Published in 1982 as *On Strategy: A Critical Analysis of the Vietnam War* by Presidio Press (Novato, CA).

26. Walter Lord, *Day of Infamy* (New York: Henry Holt and Co., 1957), 220.

27. U.S., Congress, *Hearings Before the Joint Committee on the Investigation of the Pearl Harbor Attack*, vol. 39 (Washington, DC: GPO, 1946), 21.

28. Raymond Tate, "Worldwide C^3I and Telecommunications," in *C^3I: Issues of Command and Control*, 9.

29. Richard A. Gabriel, *Military Incompetence: Why the American Military Doesn't Win* (New York: Hill and Wang, 1985), 115. In *Americans At War: 1975-1986, An Era of Violent Peace* (Novato, CA: Presidio Press, 1988), 99-168, Daniel P. Bolger examines the rescue plan in detail and concludes President Carter's hope for a "surgical solution" wasn't realistic.

30. Daniel Bolger, *Americans at War*, 254.

31. General John W. Vessey, Jr., Foreword to *Tactical C^3 for the Ground Forces*, ix.

Chapter 3. C^2 TECHNOLOGY

1. Former U.S. Senator Gary Hart, for example, writes about C^2 only in terms of "command and control equipment," which he defines as "radios and other devices soldiers use to talk to each other in combat." Working from that shaky ground, he concludes, "we don't *want* command and control in combat." Gary Hart (with William S. Lind), *America Can Win: The Case for Military Reform* (Bethesda, MD: Adler & Adler, 1986), 51.

2. Robert T. Herres, "A CINC's View of Defense Organization," in *Seminar on Command, Control, Communications and Intelligence: Guest Presentations—Spring 1985* (Cambridge, MA: Harvard University Program on Information Resources Policy, 1986), 138.

3. William Odom, "C^3I and Telecommunications at the Policy Level," in *C^3I: Issues of Command and Control*, 109.

4. See, for example, U.S. Marine Corps, *Warfighting* (FMFM 1) (Washington, DC: GPO, 1989), 32, 84n (20).

5. William J. Crowe, Jr., "A Perspective on the Command and Control Agenda," in *Principles of Command and Control*, ed. John L. Boyes and Stephen J. Andriole (Washington, DC: AFCEA International Press), 27.

6. Ashton B. Carter, "The Command and Control of Nuclear War," *Scientific American* January 1985, 38; Donald Latham, "A View from Inside OSD," 146.

7. Ashton B. Carter, "The Command and Control of Nuclear War," 35; Donald Latham, "A View from Inside OSD," 148.

8. Latham, Ibid.

9. Ibid., 146.

10. Ibid.

11. Ibid.

12. Ibid., 147; Hillman Dickinson, "Planning for Defense-Wide Command and Control," in *Seminar on Command, Control, Communications and Intelligence: Guest Presentations—Spring 1982* (Cambridge, MA: Harvard University Program on Information Resources Policy, 1982), 42.

13. Donald Latham, "A View from Inside OSD," 147.

14. James W. Rawles, "MILSTAR Soars Beyond Budget and Schedule Goals," *Defense Electronics*, February 1989, 69.

15. Donald Latham, "A View from Inside OSD," 147.

16. EMP is a controversial subject. A nuclear test in the late 1950s generated a surge of electromagnetic energy that knocked out power hundreds of miles from the blast. Some experts contend that a sizable above-ground blast over the United States would cause nationwide power failures and disrupt communications. Others argue that the effects of EMP have been exaggerated; still others say they're just impossible to predict. On the hardening of the NEACP, see Richard H. Ellis, "Strategic Connectivity," in *Seminar on Command, Control, Communications and Intelligence: Guest Presentations—Spring 1982* (Cambridge, MA: Harvard University Program on Information Resources Policy, 1982), 7.

17. Steven Emerson, "America's Doomsday Project," *US News & World Report*, 7 August 1989, 28.

18. Richard S. Beal, "Decision Making, Crisis Management, Information and Technology," in *C^3I: Issues of Command and Control*, 23-50.

19. James W. Rawles, "MSE: The Army Goes Cellular," *Defense Electronics*, February 1989, 38 [sidebar].

20. Richard C. Gross, "C^3: Fewer Mixed Signals," *Military Logistics Forum*, June 1987, 25.

21. James M. Rockwell, Editor's Introduction to Part II in *Tactical C^3 For The Ground Forces*, 75.

22. James W. Rawles, "MSE: The Army Goes Cellular," 36.

23. James M. Blackwell, "The Status of Follow-On Forces Attack Technologies," *Military Technology*, October 1988, 115.

24. Norman E. Wells, "The View from the Joint Program Office: Joint Tactical Information Distribution System (JTIDS)," *Signal*, March 1982; reprinted in *Tactical C^2 For The Ground Forces*, 226-28.

25. Ibid., 229.

26. John H. Cushman, *Command and Control of Theater Forces: Adequacy* (Washington, DC: AFCEA International Press, 1985), xii.

27. Jerry O. Tuttle, "Tailoring C^3I Systems to Military Users," in *Seminar on Command, Control, Communications, and*

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28. I've pieced together this description of events from a variety of public sources, including Ed Magnuson, "High-Tech Payoff," *Time*, January 28, 1991, 30-31; Sue McMillin, "Space Commands Forge Vital War Links," *Colorado Springs Gazette Telegraph*, February 4, 1991, A1, A4; and Philip Elmer-DeWitt, "Inside the High-Tech Arsenal," *Time*, February 4, 1991, 46-47.

29. Edward C. Taylor, "Artificial Intelligence in Command and Control—What and When?" in *Defense Applications of Artificial Intelligence: Progress and Prospects*, ed. Stephen J. Andriole and Gerald W. Hopple (Lexington, MA: D.C. Heath and Co., 1988), 139.

30. Paul E. Lehner, *Artificial Intelligence and National Defense: Opportunity and Challenge* (Blue Ridge Summit, PA: TAB Books, 1989), 4.

31. Adapted from Lehner, 6.

32. Edward C.Taylor, "Artificial Intelligence in Command and Control," 140-41.

33. Terry Winograd and Fernando Flores, *Understanding Computers and Cognition* (Norwood, NJ: ABLEX Publishing, 1986); cited in Edward C. Taylor, "Artificial Intelligence in Command and Control," 142-43.

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35. Ibid., 97.

36. Ibid., 119.

37. Stephen J. Andriole, "Tools, Techniques, and National Defense Applications of Artificial Intelligence," in *Defense Applications of Artificial Intelligence*, 24.

38. Paul E. Lehner, *Artificial Intelligence and National Defense*, 122-25.

39. Ibid., 124.

40. Ibid., 152.

41. Ibid., 168-70.

42. For examples, see the essays in *Defense Applications of Artificial Intelligence* which could have been subtitled "Variations on 'Someday.'"

43. Stephen J. Andriole, "Artificial Intelligence, National Defense, and Some Practical Opportunities and Challenges," in *Defense Applications of Artificial Intelligence*, 362.

44. Ibid., 362.

45. Ibid., 365-66.

46. Paul E. Lehner, *Artificial Intelligence and National Defense*, 188.

47. Ibid., 160.

48. Stephen J. Andriole, "Opportunities and Challenges," 362.

49. Raymond Tate, former deputy director of the National Security Agency, maintains some of the people involved in the *Mayaguez* incident didn't follow security procedures; according to retired Vice Admiral Jon Boyes, inadequate procedures for tying together Navy and Marine radios caused the tragedy. Daniel P. Bolger argues flaws in the difficult operation were minimal and due to the normal friction of war. See Raymond Tate, "Worldwide C^3I and Telecommunications," 9-11; Richard C. Gross, "C^3: Fewer Mixed Signals," 20; and Daniel P. Bolger, *Americans at War*, 19-98.

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51. CEP refers to the length of the radius from the target to the circumference of a circle within which 50 percent of the delivered bombs or missiles would be likely to hit. "Zero CEP" would, in effect, be a bull's eye.

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64. U.S. Navy, *Warfighting*, 69.

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72. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret, 1984 ed. (Princeton: Princeton University Press, 1984), 117.

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74. Alan Borning, "Computer System Reliability and Nuclear War," 107.

75. Hillman Dickinson, "Planning for Defense-Wide Command and Control," 133.

NOTES

Chapter 4. THE HUMAN AND ORGANIZATIONAL ASPECTS OF C^2

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3. Norman Dixon, *On the Psychology of Military Incompetence* (New York: Basic Books, Inc., 1976), 27-28.

4. Robert T. Herres, "Equipment, Personnel and Procedures—Foundations for Future C^2 Architecture," in *Principles of Command and Control*, 414-15.

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8. Ibid., 30.

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10. Richard E. Simpkin, *Race to the Swift: Thoughts on Twenty-First Century Warfare* (London: Brassey's Defence Publishers, 1985), 222.

11. Norman Dixon, *On the Psychology of Military Incompetence*, 391.

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32. U.S. Marine Corps, *Warfighting*, 45.

33. Ibid.

34. Richard E. Simpkin, *Race to the Swift*, 206.

35. Larry Thacker, "A Defense of Literature in the Education of Defense Leaders," in *Literature in the Education of the Military Professional*, ed. Donald Ahern and Robert Shenk (Colorado Springs, CO: USAF Academy, 1982), 65-6. As superintendent at West Point, General MacArthur fought hard to bring the cadets "broader offerings in the humanities," especially English courses, according to William Manchester, *American Caesar*, 125-26).

36. John Keats, "To J.A. Hessey," October 8, 1818, letter 110 in *Keats: Poems and Selected Letters*, ed. Carlos Baker (New York: Charles Scribner's Sons, 1962), 441.

37. Richard E. Simpkin, *Race to the Swift*, 217.

38. Ibid., 218.

39. Gareth Morgan and Wayne Tebb, "Under New Management," *PC Computing*, October 1989, 110.

40. John H. Cushman, *Command and Control of Theater Forces: Adequacy*, xii.

41. Ibid.

42. Robert Herres, "A CINC's View of Defense Organization," 255.

43. Archie Barrett, "Politics and the Military: The Climate for Reform," in *C^3I: Issues of Command and Control*, 249.

Chapter 5. AN IMPOSSIBLE DREAM: INFORMATION THAT IS COMPLETE, TRUE AND UP-TO-DATE

1. James George Frazer, Sir, *The Golden Bough: A Study in Magic and Religion* (London: Macmillan, 1942), 56.

2. Ibid., 59.

3. Severo M. Ornstein, "Computers in Battle: A Human Overview," 1.

4. Ibid., 2.

5. Ibid., 43.

6. Alan Borning, "Computer System Reliability and Nuclear War," 104.

7. Ibid., 104.

8. 1987 Defense Science Board Task Force on Command and Control Systems Management, quoted in Frank M. Snyder, *Command and Control: Readings and Commentary* (P-89-1) (Cambridge, MA: Harvard University Program on Information Resources Policy, 1989), 11.

9. Benjamin M. Compaine and John F. McLaughlin, *Management Information: Back to Basics* (Cambridge, MA: Harvard University Program on Information Resources Policy, 1986), 4.

10. Alan Borning, "Computer System Reliability and Nuclear War," 109.

11. Ibid., 105.

12. Paul Bracken, *The Command and Control of Nuclear Forces* (New Haven: Yale University Press, 1983), 65-66.

13. Richard Ellis, "Strategic Connectivity," in *C^3I: Issues of Command and Control*, 18.

14. Ibid.

15. David McManis, "Warning as a Peacekeeping Mechanism," in *C^3I: Issues of Command and Control*, 317.

16. If this particular fantasy sounds far-fetched, consider the results of a study done in the mid-1970s to determine the National Command Authorities' wish list for capabilities in the

Worldwide Military Command and Control System. As Robert L. Edge points out, the officials responding were clearly influenced by the facilities of modern television. They asked for "zoom" shots, "color commentaries" by experts, "historical monographs," "face-to-face" interviews with major players, etc. See Robert L. Edge, "C^2 in the Year 2000 (Remembering the Future)," *Principles of Command and Control*, 453.

17. Anthony G. Oettinger, *The Information Evolution: Building Blocks and Bursting Bundles* (Cambridge, MA: Harvard University Program on Information Resources Policy, 1989), 55.

18. Ibid.

19. Ibid., 57.

Chapter 6. A MATTER OF BALANCES

1. Will Durant, *The Story of Philosophy: The Lives and Opinions of the Great Philosophers of the Western World* (New York: Simon and Schuster, 1926), 61.

2. John H. Cushman, *Command and Control of Theater Forces: Adequacy*, 24.

3. B.R. Inman, "Issues in Intelligence," in *C^3I: Issues of Command and Control*, 311-12.

4. Aristotle, "Ethics" in *The Philosophy of Aristotle: A New Selection*, trans. A.E. Wardman and J.L. Creed (New York: New American Library, 1963), 309.

5. Ibid., 319.

6. Clausewitz, 51.

7. Will Durant, *The Story of Philosophy*, 61.

8. Anthony G. Oettinger, *Whence and Whither Intelligence, Command and Control : The Certainty of Uncertainty* (Cambridge, MA: Harvard University Program on Information Resources Policy, 1989), 6.

9. William Odom, "C^3I and Telecommunications at the Policy Level," 110-11.

10. Steven Emerson, "America's Doomsday Project," *US News & World Report*, 7 August 1989: 27.

11. Donald Latham, "A View from Inside OSD," 144-45.

12. Peter Stein and Peter Feaver, *Assuring Control of Nuclear Weapons*, 70.

13. "Water Bombs," *The New Republic*, 3 October 1988, 20-21.

14. Peter Stein and Peter Feaver, *Assuring Control of Nuclear Weapons*, 77.

15. Gerald F. Seib, "White House Wonders If Downsizing Has Hurt National Security Council," *Wall Street Journal*, 23 October 1989, A-11.

16. William E. Burrows, *Deep Black: Space Espionage and National Security* (New York: Random House, 1986), 98.

17. Ibid.

18. Richard S.Beal, "Decision Making, Crisis Management, Information and Technology," 35.

19. Richard E. Neustadt and Ernest R. May, *Thinking in Time*, xvii.

20. Ibid., 32.

21. Richard S. Beal, "Decision Making, Crisis Management, Information and Technology," 36.

22. William E. Burrows, *Deep Black*, 158.

23. Gabriel, *Military Incompetence*, 110-11. Daniel P. Bolger disagrees, saying it was the extraordinarily complicated nature of the Desert One plan that doomed it to failure (*Americans at War*, 133, 156.).

24. Samuel P. Huntington, "Centralization of Authority in Defense Organizations," *Seminar on Command, Control, Communications and Intelligence: Guest Presentations—Spring 1985* (Cambridge, MA: Harvard University Program on Information Resources Policy, 1986), 6.

25. Archie Barrett, "Politics and the Military," *Seminar on Command, Control, Communications and Intelligence: Guest Presentation—Spring 1985*, 69. Professor Oettinger's remarks were made during Dr. Barrett's presentation.

26. James M. Osborne, "Meeting Military Needs For Intelligence Systems," in *C^3I: Issues of Command and Control*, 176.

27. Of course, in the case of something like the $600,000 nuclear-hardened fax machine mentioned among the horror stories of 1990, somebody ought to spend some time deciding whether such extreme capability—at such extreme cost—is really necessary. To whom would one situated on a battlefield awash with radiation wish to fax something?

28. Colonel John R. Boyd, U.S. Air Force (Ret.), "Remarks to USMA Department of History/Department of Military Instruction Art of War Symposium," 29 April 1987; quoted in Daniel P. Bolger, *Americans at War*, 443.

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With *Command and Control for War and Peace,* Thomas Coakley has done great service to those who aspire—or dare—to peer into this mysterious world and get at its basics. His delineation of the basic principles of command and control is as thorough and comprehensive as I have seen on the subject. While he orients his treatment of the subject toward the operational practitioner, I would recommend it as fundamental reading for any of the specialists in the wide variety of fields that pervade the command and control world, from the technical architect to the operational manager and the ultimate user. It adds measurably to the body of knowledge that must eventually emerge from scholarly treatment of the business and take an enduring form for future and aspiring practitioners to study. Senior commanders as well as novices on the threshold of a new career will benefit from the time they spend reading this material and reflecting upon how it all must play together.

—General Robert T. Herres, U.S. Air Force (Ret.) *former Commander-in-Chief, U.S. Space Command and North American Aerospace Defense Command and former Vice Chairman, Joint Chiefs of Staff*

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