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WARFARE IN THE INFORMATION AGE: ADDING CAPABILITY MULTIPLIERS

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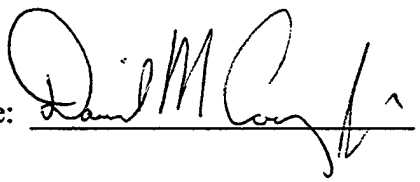
A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

Signature: 

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15. Abstract: One recurring theme in military writings since the end of Desert Storm is that the American military is on the cusp of a new Revolution in Military Affairs (RMA). Proponents of this viewpoint cite major changes in business and society brought on by the personal computer and the Internet. They view these changes as part of a new information age and predict that the explosive technological growth in the speed of microprocessors and networks will lead to whole new ways to wage war, with information superiority being the key ingredient to assure victory.

Critics argue that war as a rough, brutish, and frequently irrational business, and that no network will eliminate either the fog or friction of war. They see many of concepts being put forward as not respectful of the enduring principles of war.

This paper argues that regardless of whether revolutionary changes occur in the way wars are fought in the information age or whether developments will continue to follow a more evolutionary path, the military needs to look beyond technology and begin the process of accelerating its ability to assimilate the changes technology brings. This paper presents five capability multipliers for warfare in the information age: (1) assembling and maintaining the intellectual capital to operate in the future networks; (2) developing information as a true discipline; (3) improving human computer interaction; (4) seeking greater understanding of how people process information and make decisions; and (5) furthering the cultural, organizational, and operational concepts to support the technological change.

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ABSTRACT

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PREFACE

There are three important background concepts that readers need to have at the beginning of this paper.

First, throughout this paper the term "warfare in the information age" is used in lieu of already existing terms like "system of systems" and "network-centric warfare." This convention is intended to allow the reader to think big picture on the issue of warfare in this new age without the baggage that existing program names may carry with them.

Second, this paper could have easily been sidetracked by getting into the merits of concepts like network-centric warfare or debating whether a revolution in military affairs (RMA) or a more evolutionary path of development of systems is in the offing. This paper touches on these issues in several places but only when necessary to demonstrate that the capability multipliers being proposed will have payoffs regardless of the outcome of this high profile debates.

Third, the concept and name capability multipliers is the author's invention. The list of capability multipliers in this paper are by no means a comprehensive list, nor are discussions of them exhaustive or prescriptive. They are offered as strawmen concepts for broadening the discussion of achieving information superiority in warfare in the information age from a discussion on technology to a discussion that includes assimilation of technology.

Introduction

"We must not believe that new concepts or capabilities will negate the fundamental nature of war. Friction together with fog, ambiguity, chance, and uncertainty will dominate future battlefields as it has in the past."[2] Williamson Murray

"While the friction and the fog of war can never be eliminated, new technology promises to mitigate their impact."[3] *Joint Vision 2010*

The American military is in a paradoxical position at the close of the 20th Century. On one hand, it is the dominant world power, with no near-term peer to threaten its position; its defense spending relative to any potential adversary is high, and that spending is supported by the world's largest economy. On the other, it is stuck in a cycle of intractable presence/show of force operations that are accelerating the departure of people with critical skills and draining national treasure that might be better spent on future forces. As a result, the American military ends the century with mixed emotions: pleased that it is a force that is envied the world over; proud of the contributions it makes daily to support democracy and stability; concerned that it cannot extract itself from costly operations that are bleeding current and future capability; and nervous that cost of this hemorrhaging may be that it will be vulnerable to future technological breakthroughs that a smaller, more agile, less deployed force might be better positioned to embrace.

The last emotion is responsible for many of the most intense debates in today's professional military journals. Of those debates, perhaps none has sparked livelier exchanges than the conduct warfare in the information age. Boiled down to essentials, the debate pits a group of "futurists" who believe that technology will not only solve the problems we face today but will also generate revolutionary new applications and processes, and "traditionalists" who belief technology will continue along an evolutionary path but point out that as technology solves old problems it often creates new ones.

The futurists include an impressive who's who of naval leadership in the 1990s: former Vice Chairman of the Joint Chiefs of Staff, Admiral Owens, whose work discussed what he called the system of systems;[4] Commander in Chief of the Pacific Fleet, Admiral Clemins, who is the champion of Information Technology 21st Century (IT-21);[5] and the President of the Naval War College, Vice Admiral Cebrowski, who is the chief spokesman for network-centric warfare (NCW).[6] Each officer predicts that the ever greater capability of command, control, communications, and intelligence (C4I) systems will fundamentally change the way wars are waged and will lead to a revolution in military affairs (RMA).[7]

NCW generally occupies center-stage in futurists' writings and appears to be the navy's official warfare strategy for the information age. Despite its growing legitimacy, NCW is viewed by traditionalists as having serious flaws. One critic suggested that NCW relies on an adversary to behave in a way that NCW planners consider rational and that an adversary can win simply by choosing to behave in a way they consider irrational. He points to the difficulty that American military planners have had in calculating how much punishment Iraqi leadership has been willing to accept before acquiescing to United Nations' demands as an example of how difficult this process is.[8]

Regardless of the outcome of the debate between futurists and traditionalists, there is no denying that rapid growth in information technology is causing fundamental changes in the way the military does business. Two examples of this are the way video teleconferences have made forward-deployed operational staffs more accessible to the rear echelon, and how electronic mail has all but replaced the naval message for many pieces of routine day-to-day correspondence.

As new technological capabilities spin off new ways of doing business, warfare in the information age will have an impact on operational art. The two operational art disciplines most impacted by these changes are operational functions and operational factors.

Operational command and control (C2) underpins all other operational functions: operational intelligence, operational logistics, operational maneuver, operational protection, and operational fires. A quantum leap in C2, therefore, has the possibility of dramatically improving all other operational functions. Since operational functions are used to compensate for one's own areas of weakness and capitalize on one's strengths, information age tools will offer whole new approaches to operational planners.[9]

The operational factors – force, space, and time – also need to be reviewed as the military buys its *Joint Vision 2010* force structure. Trends in force mixture are already becoming apparent. American forces in the information age will emphasize stealth, range, speed, precision weapons, and robust information networks. [10] This new kind of force, with its range and mobility has the capability to shrink space, and with its C2 tools, speed up decision-making, thereby compressing time.

Success for the navy in the early years of the information age may be measured by its ability to field a *Joint Vision 2010* force in the next ten years with the finite resource it will have to accomplish the task. Achieving this goal will be difficult, if the navy focuses on technology as the only means to achieve its ends. For the navy to have the agility to be able to recognize and rapidly assimilate technologic innovations that will support its ability to fight and win in the information age, it must develop capability multipliers.

Capability Multipliers

For years, the military has talked about force multipliers, things like intelligence, logistics, and C2, that enable a given military entity to mass either forces or effects quicker and more efficiently without adding more weapons or trigger-pullers to a given battlespace. Capability multipliers are a concept for the information age that parallels force multipliers in a traditional military framework. They are approaches for solving problems technologically driven problems with means other than technology.

In the case of C4I systems being fielded as the tools for information age commanders to conduct warfare, capability multipliers could include such things as: (1) a comprehensive navy corporate strategy for the information age that addresses both manpower and acquisition issues; (2) a formalized discipline for dealing with information; (3) an improved approach to human computer interaction; (4) a better understanding of how people process information and make decisions; and (5) a doctrine for conduct of warfare in the information age that addresses the cultural, organizational, and operational components of this technology driven era.

Navy Corporate Strategy

There is an old saying, "If you don't know where you are going, any road will get you there." That saying captures the essence of where the navy is today as an information age organization. Despite having progressive, well informed leadership and some extraordinarily talented and dedicated people working on the future, the navy is still not unified in where it is headed. What is lacking is a unifying corporate vision that all navy people can understand and work in parallel to achieve, a corporate vision statement derived from careful strategic planning. At a minimum, this corporate vision statement

needs to address what the navy is buying, how the navy is buying it, and how it will maintain and operate its acquisitions.

Today, the navy is fielding Global Command and Control System Maritime (GCCS-M) as the centerpiece of its C4I program. To the uninitiated, the importance of the "-M" in GCCS-M is missed, but to those who work in the field, it should be viewed as a scarlet letter. Maritime in the navy acronym does not mean that the navy had to make changes to GCCS to put it on ships but that the navy chose to buy equipment that cannot run the Department of Defense (DOD) standard operating system. As a result, instead of getting software produced by other DOD agencies for free, the navy must pay contractors to rewrite the software to run on its chosen operating system. This is expensive, imposes delays in fielding, and often creates interoperability problems.

Further, although the Chief of Naval Operations (CNO) N6 is the key player in C4I systems for the navy, he is not the only player. CNO N88 fields systems on aircraft carriers. These systems, often with little coordination, are installed side-by-side with N6 fielded systems. N88's Joint Services Imagery Processing System – Navy required expensive ship alterations on *NIMITZ* Class carriers because its requirement for power, uninterrupted power supplies, and air conditioning were never integrated with similar requirements levied by the N6.

The navy needs to have one person in charge of the whole process, and that person has to be charged by the CNO with fielding systems regardless of the source of the funding line for developing that system. That person should be charged with fielding systems that are interoperable with the joint community and other services, not philosophically similar which is what the navy did in fielding equipment that met the

requirements of DOD's common operating environment (COE) without being interoperable.

The second key piece of the corporate strategy needs to be manpower. Navy leadership is acutely aware of the shortfall in people with the skills to operate networks or to perform maintenance on network components, and it has made efforts to address these shortfalls. Merging ratings and changing education and training programs are positive steps, but the demand for these same skills in a healthy information driven economy still leaves the navy short in all areas. Attempts to develop an information technology driven officer community have likewise met with mixed success and need much work.

Two less well documented, but equally important manpower areas, are engineers and skills that work with the data. Few engineers in the development process have the background to blend their technical proficiency with an understanding of how the end users of the equipment they design will employ it. Most are civilians with no military experience and little understanding of the operational navy. The data ratings are those that work in places like combat information, weather, and intelligence centers. Failure to recognize that the skills required to operate terminals, input data, and do analysis are of equal importance to the skills required to maintain and operate the networks will not get the navy to where it needs to be to achieve information superiority.

The navy needs to model its efforts on achieving manpower stability for the information age on what it did when it established communities to support the new forms of warfare embodied in aircraft carriers and nuclear submarines. In those cases, the navy identified key officer and enlisted requirements and developed careered progressions and pay programs that make them sustainable. It developed engineering duty officer

communities and specialists to support its new operational communities. For warfare in the information age, this means developing a corps of savvy network operators and administrators, supported by a Systems Engineering Duty Officers community, and robust data input and analysis communities.

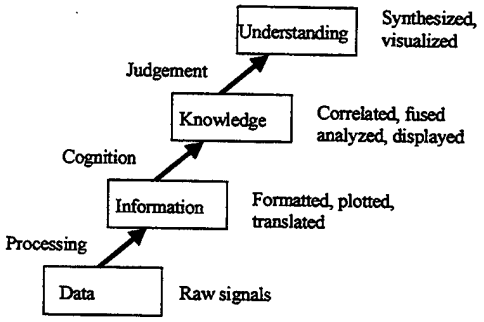
Information as a Discipline

Developing a common set of accepted norms and vocabulary for communicating about information is a requirement for progress in any field associated with the information age. Throughout the body of military writings on conduct of warfare in the information age, there are inconsistencies in the basic vocabulary. The term "information" is frequently used interchangeably with "data," "intelligence," "awareness," and "knowledge." This lack of precision detracts from the arguments being put forth and is perhaps symptomatic of the maturity of information as a discipline.

Each word in the list above does have an agreed upon definition within the military lexicon. One need look no further than *Joint Pub 6-0* or *Naval Doctrine Publications 6 (NDP-6)* to see that the people working joint and naval doctrine have laid the groundwork for an information discipline. They have developed a "cognitive hierarchy" through which raw data evolves into understanding. (See Figure 1.)[11]

The air force, under its Study 2025, develop Man-machine interface ed a model for information warfare in 2025 under the name of "wisdom warfare." In their hierarchy, they define wisdom as "knowledge coupled with good judgement." Interestingly, their definition comes not from *Joint Pub 6-0* but from Webster's Dictionary; thus wisdom and knowledge end up with the same definition. [12]

Figure 1



The Cognition Hierarchy

The term most commonly used by navy commanders is situational awareness. In most cases, if information does not contribute to a commander's awareness of the situation, it is ignored. Awareness is not addressed in *Joint Pub 6-0*, but *NDP-6* makes the statement that "understanding equates to situational awareness."[13] The air force study defines awareness as "what is happening" and states that wisdom is awareness plus the why and what to do.[14] This may seem a minor point, but this kind of inconsistency contributes to confusion.

Perhaps the best communication from a commander concerning his needs for clarity of information came from General Colin Powell, "Tell me what you know . . . tell me what you don't know . . . tell me what you think . . . always distinguish which is which."[15] While directed toward his intelligence personnel, it clearly expresses what constitutes useful information. That same clarity needs to be codified into joint and service doctrine.

Man-Machine Interactions

For the purposes of this paper, man-machine interactions occur at two separate levels: man-machine interface (how the human inputs and extracts information from the computer), and what this paper will refer to as information mapping (understanding of what the network does to a given discrete sampling of data from its collection to its storage or display).

Man-machine interface is an important area of work in the commercial and academic worlds. Depending on which Internet search engine one uses, the term "man-machine interface" will generate between 3500 and 4500 links on the worldwide web.

Man-machine interfaces include any number of either input or output peripheral devices one can connect to a computer. Examples include such things as: dictation programs that may one day replace the QWERTY keyboard; sensors that read human optic movements that have the potential to replace pointing devices like the mouse and the trackball; and virtual reality devices, offering high resolution, wrap around, three-dimensional displays that have many potential applications. By extrapolating current trends in the proliferation of embedded sensors and the explosive growth in networks, it seems likely that the computer, as a recognizable box, will disappear. Buildings, ships, and airplanes will become self-contained local area networks. As the navy acquires truly smart ships and planes, the devices it will sail or fly them by need not resemble anything used today to perform those functions.

Because the commercial sector is developing most of what is used in the navy, improvements in man-machine interface will arrive without any great effort on the navy's

part. Its role should be that of an educated consumer, choosing what technologies to buy and when to buy them.

Information mapping, however, is something that the navy needs to weave into its culture in the information age. The mere act of entering data into a computer can change that data, and as the network transports it to its human users, components of the network act on the data at various points. If the network user does not understand what has transpired between collection and display, then the incoming data stream could be misinterpreted, thus processed into incorrect information.

Examples of this abound throughout the fleet. Contacts entered into the fleet over-the-horizon tactical commander's database with speed and direction information can appear on the screen of a watchstander many days later, thousands of miles away because the computer was instructed to continue to move the contact using dead reckoning. Incorrectly fusing multiple source contacts to a Link-11 track can cause all the data on the track to disappear as soon as the contact is no longer reported in the link by the datalink-reporting unit. Exercise data can corrupt real-world databases and cause problems for watch teams trying distinguish what information on their screen actually exists in the temporal world, and what is "cyberchaff."

This is a particularly important area, because one of the realities of warfare in the information age will be a subset discipline called information warfare (IW). Algorithms of systems that automatically correlate data become very important in IW. A well informed adversary could use knowledge of algorithms to teach a correlator to ignore radars that he or she would use in a war, or alternatively design his or her threat radars so American systems will identify them as American or as belonging to an ally. The navy

must train its operators to understand the algorithms in their systems to be able to counter this kind of attack.

Human Information Processing and Decision-making

Of all of the capability multipliers, this area is probably the most important. The tremendous growth in C4I systems' processing capability and the supporting bandwidth has created a deluge of information. ABC News reported in a recent story on "information overload" that the average office worker processes, "30 e-mails, 22 voice-mails, 18 pieces of regular mail, 15 faxes and 11 Post-it notes everyday."[16] People are becoming so overwhelmed by the amount of information they receive that many are unable to switch their brains out of the receive mode and make time to process what they receive. In other words, data remains data because there is insufficient time to process it into information.

In a recent survey of 1300 managers from the United States, Great Britain, Australia, Singapore and Hong Kong by Reuters, one in four respondents admitted to suffering from stress related maladies which fall under a new collective title of information fatigue syndrome (IFS). "Symptoms include paralysis of analytical ability, feelings of overwhelm and loss of control, increased anxiety and decreased self-confidence, and an increasing tendency to blame others."[17]

Current design philosophies for navy C4I systems have established a direct correlation between volume of data the system can process and display and the system's value to decision-makers. This is not an appropriate measure of effectiveness, however, if the goal is for the decision-maker to be able to achieve awareness or knowledge. The goal needs to be to produce a system that will enable a commander (with some degree of

preexisting awareness) can walk into a command center, look at a display, and arrive at sound, actionable decisions rapidly.

To reinforce this, all one has to do is go to the worldwide web and look up the navy's Joint Maritime Communication System (JMCS). Displayed in complete detail are the navy's technical and program strategies for fielding the communications equipment and infrastructure for the *Joint Vision 2010* force of the future. Nowhere is there any discussion of how these systems will actually be used to support the commander's decision-making process.

As a culture, the navy must recognize that sometimes more information is not better, it is just more, and more should not the metric of choice for measuring effectiveness. The systems the navy is fielding may be contributing to what the Reuters study labeled IFS. This should be a disconcerting conclusion. If the navy's primary tools to aid information age decision-makers cause paralysis in analytical ability, anxieties, feelings of overwhelm and decreased self-confidence, they are a failure.

The navy needs to study not just how people make decisions in stressful situations, but how people interpret data being presented to them via different media. Evaluating a metrics like mean time required to recognize that a new threat has appeared on the screen might be a start. Does making it flash, changing its color, or having an audible alarm help, or do those things contribute to information overload? Once the threat contact is there, what else needs to be displayed? Do range rings help or add clutter? Is there some way for the system to display information that would indicate that the displayed system cannot threaten one if given conditions are not met? Could this be supplemented with a stop light chart of the status of those conditions? Could it prompt

that an existing rule of engagement or weapon's condition might constrain a unit's ability to deal with a situation?

Again, *NDP-6* is ahead of its joint counterpart publication. It has a two and a half page discussion of decision theory. Although brief, it is well thought out and should be mandatory reading for systems developers. In a lucid description of the decision-making process, *NDP-6* points out that at some point in the process, additional information can actually "cloud the situation, impede understanding, and cause the commander to take more time to reach the same decision he could have reached with less information."[18]

Culture, Organization, and Operations

This final capability multiplier is the least prescriptive of the group. It came about after reading assessments of RMAs. Although no two authors could agree on what historical events actually constituted RMAs, those writing on the subject have crafted a fairly consistent operational definition for the term. An RMA is a dramatic increase in military capability (at least by an order of magnitude) caused by the combination of some number of components. Most definitions have identified technological, organizational, and operational changes as all being necessary. Historian Williamson Murray suggests that there are 13: cultural, technological, financial, architectural, tactical, organizational, administrative, social, conceptual, ideological, scientific, political, and operational.[19] While an information age RMA would probably not require 13 components, it seems logical that the navy will need to address culture, organization, and operations along with technology to achieve an RMA.

As evidence that technology alone does not bring about an RMA, here are some interesting historical examples. Although Roger Bacon's recipe for gunpowder dates

back to 1267, it took European armies until the 1420s to develop artillery organization and tactics to the point where the cannon doomed traditional European fortifications.[20] Napoleon's *levee en masse* required the social and ideological transformations of the French Revolution as well as the existence of the modern nation state to be successful. Napoleon's French Armies, were not only bigger than the other nations of Europe, they were manned by people who felt they had a personal stake in the war. They were fighting for their country, not for some member of the aristocracy.[21]

The cultural component of change in the information age will be difficult for the navy. Some of the earlier capability multipliers have touched on this already. Changes in the way the navy carries out manning decisions or imposes measures of effectiveness are part of the cultural landscape. Other issues such as whether cyber warriors should be restricted or unrestricted line officers will also be cultural.

Organizational issues are all closely tied to culture as well. Questions like which skilled people will actually deploy on a smart ship in the future and which will remain ashore are critical to what the navy may look like in 2010 or 2020. Does the navy need damage control parties on ships that are designed to repair themselves? Does one need to know how to fly an airplane (be a pilot) to fly an unmanned aircraft? If the community in the navy that is best equipped (i.e. greatest mastery of required skill sets) to lead the navy in information age warfare is cryptology, intelligence, or public affairs what then?

Operational issues abound. Spectrum management and decisions whether to take out an enemy's network with a hard kill or a soft kill, or just leave it and exploit it are the critical decisions information age warriors will debate. Target discrimination and weapons selection decisions will increase in complexity. Procedures to coordinate

information age warfare processes with more traditional forms of warfare need to be refined.

Conclusion

No paper dealing with operational art is complete without some discussion of desired end state. This is a difficult concept to identify in an environment as dynamic as our evolving vision of what warfare in the information age is today. Perhaps the best approach is to go back to *Joint Vision 2010*. Whether one accepts *Joint Vision 2010* as a future warfighting model or considers it the centerpiece of a long-term procurement strategy, it is the one document that is quoted whenever a question of buying future systems is discussed.

Joint Vision 2010 identifies four pillars for the future military: dominant maneuver, precision engagement, focused logistics, and full dimension protection. These pillars are supported by information superiority. It is worth noting that this vision of the future is in reality just an update of the operational functions covered in the introduction. Maneuver becomes dominant maneuver; operational fires become precision engagement; operational logistics become focused logistics; and operational protection becomes full dimension protection. Just as operational C2 is the enabler for the operational functions, information superiority, which now includes "improved intelligence and command and control," is the enabler for the *Joint Vision 2010* version.[22]

The military is at a critical point in the process of trying to field the kinds of forces it envisioned in *Joint Vision 2010*. Failure to put in place the capabilities required for the requisite level of information superiority will, by definition, doom the four pillars and force a complete rework of *Joint Vision 2010*.

Up to this point, most of the people in the navy who are working on information superiority for the future have been focused on technical solutions, but technical solutions alone will not be enough. The navy must develop capability multipliers. It needs manpower programs to ensure it has the talent to build and maintain its networks, input and process data, and convert the network and its resident data into something useful to the conduct of naval warfare. It must develop information as a scientific discipline to ensure understanding and enable unity of effort. It must emphasis human factors. How people input and retrieve data, and how the network acts on that data must be understood. The navy must also learn more about how its information age leaders perceive, think, and make decisions. The navy must also figure out how it is going to organize train and fight in this new age with its new tools. Finally, the navy needs to do all these things in concert with the joint community, the other services, and the civilian world: there is no room for stove-pipes in the information age.

These are all great challenges, but they are achievable. The most difficult step may be for the navy, with its tradition of heavy reliance on engineering, to recognize that technology is an enabler, but it is not the solution. To get this point across, the navy might start by changing the name of its preferred information age strategy from network-centric warfare (emphasis on the network, the tool set) to knowledge-centric warfare (emphasis on knowledge, the product it is trying to maximize). This is just a matter of perceptions, but understanding the impact of perceptions on what people think and how they react, needs to be a key consideration for the navy in the information age.

Endnotes

[1] Colonel T.X. Hammes, "War Isn't a Rational Business," US Naval Institute *Proceedings*, July 1998, 23.

[2] Williamson Murray, "Thinking About Revolutions in Military Affairs," *Joint Forces Quarterly*, Summer 1997, 76.

[3] U.S. Joint Chiefs of Staff, *Joint Doctrine 2010* (Washington, D.C.), 1.

[4] Admiral William A. Owens, "The Emerging System of Systems," US Naval Institute *Proceedings*, May 1995, 35.

[5] Admiral Archie Clemins, "IT21 Moving to the Third Stage," US Naval Institute *Proceedings*, May 1997, 51.

[6] Vice Admiral Arthur K. Cebrowski and John Garstka, "Network-Centric Warfare: Its Origins and Future," US Naval Institute *Proceedings*, January 1998, 29.

[7] The concept of RMA is particularly interesting at this time in our military history if for no other reason than it was an analytical concept at the corps of all "scientific analysis" of war by our failed peer power, the Soviet Union. There is a certain irony to RMA's emergence to prominence as an idea with merit in the post-Cold War U.S. military when it might otherwise have been rejected as a concept that contributed to the downfall of the Soviet military. The Chairman of the Joint Chiefs of Staff's professional journal, *Joint Forces Quarterly* has published a dozen article on RMA in its first five years in business. See Antulio Echevarria J. II, "Dynamic Inter-Dimensionality: A Revolution in Military Theory," *Joint Forces Quarterly,* Spring 1997, 29-36; James R. Fitzsimonds, and Jan M. Van Tol, "Revolution in Military Affairs," *Joint Forces Quarterly,* Spring 1994, 24-31; Colin S. Gray, "RMAs and the Dimensions of Strategy," *Joint Forces Quarterly,* Autumn/Winter, 1997-98, 50-54; ArsenioT. Gumahad, III, "The Profession of Arms in the Information Age," *Joint Forces Quarterly,* Spring 1997, 13-20; Michael R. Lwin, "General Tzu's Army: OPFOR of the Future," *Joint Forces Quarterly,* Spring 1997, 44-49; Thomas G. Mahnken, "War in the Information Age," *Joint Forces Quarterly,* Winter 1995-96, 39-43; Kenneth F. McKenzie Jr., "An Ecstasy of Fumbling: Doctrine and Innovation," *Joint Forces Quarterly,* Winter 1995-96, 62-68; James K. Morningstar, "Technologies, Doctrine, and Organization for RMA," *Joint Forces Quarterly,* Spring 1997, 37-43; Williamson Murray, "Thinking About Revolutions in Military Affairs," *Joint Forces Quarterly,* Summer 1997, 69-76; James J. Schneider, "Black Lights: Chaos, Complexity, and the Promise of Information Warfare," *Joint Forces Quarterly,* Spring 1997, 21-28; Ajay Singh, "Time – The New Dimension in War," *Joint Forces Quarterly,* Winter1995-96, 56-61; and James Stavridis, "The Second Revolution., *Joint Forces Quarterly,* Spring 1997, 8-13.

[8] Colonel T.X. Hammes, "War Isn't a Rational Business," US Naval Institute *Proceedings*, July 1998, 23.

[9] Milan Vego, *On Operational Art*, (Third Draft) (Newport: 1998) 14.

[10] U.S. Joint Chiefs of Staff, *Joint Doctrine 2010* (Washington), 11-14.

[11] See Department of the Navy, *Naval Doctrine Publication 6: Naval Command and Control* (NDP-1)(Washington, D.C.: 19 May 1995), 21; and U.S. Joint Chiefs of Staff, *Doctrine for Command, Control, Communications, and Computer (C4) Systems Support to Joint Operations* (Joint Pub 6-0) (Washington, D.C.: 1995), I-4..

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[13] See Department of the Navy, *Naval Doctrine Publication 6: Naval Command and Control* (NDP-6) (Washington, D.C.: 19 May 1995), 23.

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