

NATIONAL DEFENSE UNIVERSITY

NATIONAL WAR COLLEGE

**QUIET TRANSFORMATION:
THE ROLE OF THE OFFICE OF NET ASSESSMENT**

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2 MAY 2003

Report Documentation Page

*Form Approved
OMB No. 0704-0188*

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE 02 MAY 2003	2. REPORT TYPE	3. DATES COVERED 02-05-2003 to 02-05-2003	
4. TITLE AND SUBTITLE Quiet Transformation: The Role of the Office of Net Assessment		5a. CONTRACT NUMBER	
6. AUTHOR(S)		5b. GRANT NUMBER	
		5c. PROGRAM ELEMENT NUMBER	
		5d. PROJECT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) National War College, 300 5th Avenue, Fort Lesley J. McNair, Washington, DC, 20319-6000		5e. TASK NUMBER	
		5f. WORK UNIT NUMBER	
		8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited		11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
		13. SUPPLEMENTARY NOTES The original document contains color images.	
14. ABSTRACT see report			
15. SUBJECT TERMS			
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified	18. NUMBER OF PAGES 35
			19a. NAME OF RESPONSIBLE PERSON

“What if you could fly a stealthy UAV over Baghdad, or wherever, and it drops a small remote or autonomous vehicle that homes in on Saddam himself, crawls under his door or flies through his window and gets him? ... We have to have the confidence to make the next steps intellectually and technologically.”¹

Has the work of the Office of Net Assessment (ONA), and that of its only Director, Andrew Marshall, significantly influenced U.S. defense and national security policy? Are their assessments responsible for “derailing” cherished Service programs such as the Crusader? Judging by the press coverage of the development of the Quadrennial Defense Review (QDR) in the spring and summer of 2001, this debate exercised just about everyone in the Defense establishment. Given the facts on the ground, it was a peculiar debate - one of form over the substance of the transformation, as it seemed more important to keep Andrew Marshall’s name off the final product than his thoughts out of it. In fact, DoD and the services have been and are pursuing research, training, and systems *ad infinitum* consistent with ONA’s own work and their sponsored studies. Ample documentation of the latter is available from the same period, and most of it never figured in the debate over the strategic review. Furthermore, although neither the 2001 Quadrennial Defense Review (QDR) nor the National Security Strategy appear to have Marshall’s *imprimatur*, they both enshrine a principle central to the ONA studies available for review: a capabilities-based force is a more powerful tool than a threat-based force.

Based on an examination of how recent research and program implementation correspond with ONA’s studies, the answer to the questions above is “yes.” This paper looks at three of the many areas addressed by ONA over the last few years to illustrate the point that the services are moving towards acquiring highly flexible capabilities: military use of space, biotechnology and bioscience that are consistent with the “transformation” playing out in DoD. The other half of the story - the hullabaloo in the press (one observer described it as “an end run on the QDR,”²) over Andrew Marshall’s participation in the strategic review is also important because the apparent resistance to Marshall’s ideas may have been a proxy for the very real resistance to changes Secretary Rumsfeld wants to see in the Department of Defense, including much stronger civilian

control over the services, especially the leadership. Paradoxically, Andrew Marshall's reputation informs both discussions, but the internecine conflict in the Department is beyond the scope of this paper.

Whither Andrew Marshall?

After completing graduate work at the University of Chicago, Marshall joined RAND in 1949 to work on nuclear policy and intelligence issues. Henry Kissinger brought him onto the National Security Council Staff in 1972; in 1973, President Nixon appointed Marshall head of the ONA and "charged him with 'rating' the threat to national security posed by the Soviet Union."³ The apparently alarming results of this report enabled then-Secretary of Defense Schlesinger to "bludgeon Congress into allocating more money to counter the Russian bear."⁴ Marshall has been head of ONA ever since. This alone gives him an extraordinary advantage. Rather like the Queen of England who has seen ten Prime Ministers and as many governments and loyal oppositions come and go, Marshall has served - and survived - Secretaries of Defense across seven presidents and nine administrations.

The ONA cuts a wide swathe, as well. Its core mission, as articulated in the Department of Defense Directive series 5111 is to

Develop and coordinate net assessments of the standing, trends and future prospects of U.S. military capabilities and military potential in comparison with those of other countries or groups of countries so as to identify emerging or future threats or opportunities for the United States. This shall include, as required, net assessments of:

Current and projected U.S. foreign military capabilities by theater, region, function, or mission; and

Specific current and projected U.S. and foreign capabilities, operational tactics, doctrine and weapons systems.⁵

While ONA's initial work dealt with intelligence and information technology and was pivotal to the genesis of the "Information Revolution" that gripped the government, including the Department of Defense from the mid-70s, their subsequent work is much broader. In the 1980s, Marshall was among the first to identify AIDS as a destabilizing factor in terms of its effect on a

state's political and military viability.⁶ In 1991, ONA turned to the threat posed by North Korea.⁷ The next year, Marshall's most well-known protégé, Andrew Krepinevich, authored *The Military-Technical Revolution: A Preliminary Assessment*, which, with the 1993 study *Some Thoughts on Military Revolutions* established "transformation" as part of the defense vocabulary.⁸ In 1995, ONA's wide-ranging study, *Asia: 2025*, concluded, among other things that the United States should consider shifting its primary strategic focus to Asia.⁹

Most recently, Krepinevich's independent policy research institute, The Center for Strategic and Budgetary Assessments (CSBA), published "The Military Use of Space: A Diagnostic Assessment," (February 2001) and addressed how biotechnology might be exploited to support the armed forces. Krepinevich published his February 2001 testimony before Congress as a monograph titled, *Strategy for a Long Peace*. In July 2002, ONA released *Military Advantage in History*, a series of essays on the lessons to be learned from the Macedonians, Romans, Mongols and Napoleon.

The above, merely a sample, along with ONA's sponsorship or participation in countless other studies, assessments and futurist war games,¹⁰ and their position as one of the very few agencies able to analyze blue and red data together, established Marshall and ONA, and eventually, many associated with them who later moved to the private sector, as virtually unchallengeable experts¹¹. This reputation later fuelled speculation about how seriously Secretary Rumsfeld would take ONA's 2001 strategy review.¹²

Expertise alone does not account for ONA's reputation. Interviews with senior ONA staff members¹³ suggest there are three other critical factors. First, as Marshall and his office are, by directive, personal – even confidential - advisors to the Secretary of Defense, they appear to be able to avoid much political infighting. Harold Brown, Richard Cheney and Donald Rumsfeld are three who particularly benefited from their association with Marshall. Others, like Secretaries Weinberger and Cohen, preferred to draw on other sources for strategic analysis.¹⁴ ONA personnel, including the military officers, consider themselves a "self-selected"¹⁵ group,

privileged to work with and for Mr. Marshall,¹⁶ and happy for Marshall to be the public face of ONA (something of an oxymoron), so closely do they identify with his philosophy.¹⁷ DoDD 5111.11 establishes the parameters of ONA's interaction with the DoD and other government agencies, authorizing the Director of Net Assessment to

Coordinate and exchange information with other OSD officials, Heads of the DoD Components, and other Federal officials having collateral or related functions¹⁸

but, as the Director "Report[s] directly to the Secretary of Defense and the Deputy Secretary of Defense"¹⁹ ONA products are intended primarily for the Secretary and other distribution is extremely limited.²⁰ With reference to the turmoil over the "strategy review", it is important to note that it would not have been unusual either for Marshall to pursue any strategic assessment independently of the military establishment, or for the 2001 assessment not to be generally available.

Secondly, the ONA staff view their relations with the rest of DoD as cordial, even collegial, but the nature of ONA's work makes it prudent to maintain a polite distance to avoid giving the impression that Mr. Marshall and ONA advocate specific programs that may come to be associated with ONA assessments. They describe themselves as primarily interested in the long term, thinking in terms of generations. The operative words in the ONA staff lexicon are "could" and "might;" their motto "experimentation combined with hard experience."²¹ Operations Enduring Freedom and Iraqi Freedom provided just such laboratories. The likely organizational and technological lessons learned will do as much as anything to decalcify attitudes in high places and drag the defense establishment into the 21st century. Having said that, the ONA staff does not consider their assessments prescriptive, even though ONA includes descriptions of platforms, systems, *et cetera*, that the various authors consider appropriate. In their view, it is up to someone else to act on these observations, but given Marshall's eminence, clearly many believe that his lightest musings tap into the cosmic strategic wisdom.²²

Thirdly, while the Secretary of Defense may task ONA to perform assessments, and others may suggest areas of investigation, ONA is also a self-directed organization. Staff

members concur that Marshall rarely tasks his staff, giving them a great deal of scope for their own work, which facilitates the ability to think “out of the box.”

It is difficult to believe Marshall and ONA could have achieved such stature had their efforts lacked credibility with the military establishment, or been viewed as a threat to service agendas. Certainly, ONA’s studies addressing the role of information technology, particularly those associated with the revolution in military affairs (RMA) and transformation, were the underpinning of many of the changes effected by the services over the last ten years, such as the move towards “net-centric” warfare. Why then, should the Services appear to react so strongly to Secretary Rumsfeld tasking Marshall to prepare a strategic review as part of the QDR process?

The “End Run” on the QDR

The starting point may have been in the mid-90s and the beginning of the readiness battles.²³ There was much apprehension across the Services in the early years of the first Clinton administration as to whether the White House would support adequate funding for minimum operational requirements, let alone the infrastructure recapitalization and equipment and systems modernization desperately needed to give the armed forces any chance at all of achieving the “transformation” being presented as critical to operational viability in the 21st century. This was complicated by the struggle among the Combatant Commanders, the Joint Staff, the Services and their OSD staff counterparts over whose assessments and estimates of requirements and priorities would prevail in strategy, policy and budget battles. The Unified Command Integrated Priority Lists and Joint Requirements Oversight Council became battlegrounds. Documents such as the Defense Planning Guidance, which should have provided cogent guidance, languished in the review process, the integrity of the final product diluted by the need to represent the unreadiness of the force in an encouraging way, and be convincing as to the ability of the U.S. armed forces to meet any challenge (for example, 2 MTW). The 1997 QDR suffered from this affliction, as did the annual Readiness Report Congress required of the Secretary of Defense.²⁴ Quite apart from the challenges of the review process, all the participants assessed, measured and reported readiness status differently. As discussed below, the services were often enthusiastic supporters

of the work being done by futurists such as Mr. Marshall. At the time, they felt they had no choice, as they waited for guidance and money, but to rely on tried and true platforms, modernizing and transforming on the fringes. The Navy's Vision documents²⁵ are a case in point.

Congress was not blind to the problems. In addition to directing the QDR, in 1997, the House National Security Committee allocated 95 per cent of additional procurement funds available to the Pentagon budget or Service unfunded requirements. They chartered panels to assess emerging missile threats. Nodding at the future, they took the U.S. Navy to task over the latter's failure to "mature and incorporate new technologies into the 'pre-competitive' phase of the transition attack sub," directing \$100M to be sent straight to the shipyards to ensure the work was done. Further, the Committee addressed Military Technology and Doctrine Reform by

Recogniz[ing] both the need and the opportunity to support *nascent* efforts within the military services to pursue innovative concepts and technologies as a *hedge* against an uncertain future and a rapidly changing global security environment.²⁶

The Committee also

Endorsed a number of initiatives to accelerate the pace of technology development and doctrinal and organizational innovations to better position the U.S. Armed Forces to meet the future. *These new technologies should not be viewed as substitutes for traditional concepts of military power and tactics. Rather, they represent an opportunity to leverage the effectiveness and adaptability of U.S. military forces into the next century,*²⁷

authorized about \$294 million for new initiatives such as

...field trials [for the Army's Force XXI and Army After Next, and the Marine Corps Commandant's Warfighting Laboratory] to determine the *promising possibilities for lifting the 'fog of war' from land warfare*²⁸,

and finally, authorized \$10 million for the establishment of a Concept Development Center under

ONA, which

...like the RAND Corporation of the early 1950s,...would pursue and encourage *intellectual breakthroughs in operational concepts, military systems and organizations needed for future warfare...and assess the impact of innovation on Pentagon restructuring, service roles and missions, alliance relationships, defense structures and budgeting processes.*²⁹ (Emphasis added in italics)

Congress also established the National Defense Panel, staffed with ten established experts in defense and national security experts (including Andrew Krepinevich and Richard Armitage) to perform an assessment in parallel with the QDR, to include an actionable agenda for Congress as part of an integrated product. In a briefing to National War College students, Mr. Fred Downey, a member of the Senate Appropriations Committee staff who worked at ONA while in the Army, observed that neither the QDR nor the NDP had lived up to Congress' expectations, but the NDP at least emphasized that joint experimentation and training was sorely needed, and that it was absolutely necessary to protect research and development funding from bill-paying raids.³⁰

The embarrassing spectacle of the Joint Chiefs admitting they had underplayed force readiness sparked a flurry of efforts to provide Congress with the unvarnished truth. The Chief of Naval Operations directed program managers to identify “unconstrained” requirements, but as one Navy program analyst, describing the elimination of critical requirements data from a much “massaged” program submission, put it, “My claimant isn’t ready to take the truth about the true requirement.”³¹ Back to business as usual, many believed, until the unthinkable happened: a Republican president who had promised, “help was on the way,” conditioned that this help was dependent on the results of a “stem to stern” strategic review.³²

The Secretary of Defense initially proposed the core study be undertaken by Andrew Marshall, the hub of whose operational universe was not twelve carrier battle groups, the F-22 or the Abrams tank³³ -- or Crusader. Marshall was believed to think the Services were not preparing for the next likely theaters of war. There was no reason for them to think his strategic review would do anything other than reiterate that, and possibly include an unflattering assessment of existing states of readiness.

Perhaps Secretary Rumsfeld’s reported selection of Marshall spooked the military leadership because it had not been obliged to pay much attention to ONA during the Clinton Administration. Secretary Cohen had rarely consulted with Marshall or ONA, had realigned ONA under the National Defense University and significantly reduced its influence in a

September 2000 revision of DoDD 5111.³⁴ There was no pressure from Secretary of Defense Cohen to make the radical reprogramming effort Marshall's assessments would entail,³⁵ or to incorporate the complementary analyses current in the national security community, particularly with regard to the threat posed by China. Perhaps fearing for his bases and political support for U.S. forward presence in Japan and Korea, Admiral Dennis Blair, then Commander, U.S. Forces Pacific, characterized ONA's assessment of the China threat as "overstated,"³⁶ but rather avoided dealing with Marshall's view that access to those bases is by no means assured. The Air Force, too, pushed back. Chief of the Air Staff, General John Jumper, responded to reports that Marshall recommended acquisition of B-2s over other aircraft, by saying, "I think we've proven that we've got not only the right airplanes, but pretty much the right mix."³⁷

A review of press reports from February through August of 2001 reveal the consternation of the Services about the review generally and their apparent inability to eliminate ONA's assessment from the final review. A leaked description of a Tank meeting at which the Service Chiefs complained they had not been given the opportunity to contribute to or review Marshall's assessment,³⁸ sparked a retort from the Secretary that none of them had asked for a copy.³⁹ A senior Marine general, who asserted he had participated in several discussions on strategy with Marshall, and conventional forces with David Gompert, countered their complaint that the military leadership had not been consulted.⁴⁰ The Services had plenty of friends in the press willing to air their view that service views were being systematically excluded.⁴¹

In an effort to defuse the situation, Secretary Rumsfeld downplayed the significance of the report,⁴² leading Inside Pentagon to assert that the "top secret strategy study" had "...gone the way of the Loch Ness monster and Elvis sightings – during a July 5 press conference, RADM Craig Quigley told journalists it had never existed" and that while Andrew Marshall's assessment would be "near the top" if ranked, there was not and would not be a document titled "Rumsfeld's Strategic Review."⁴³ And then the story disappeared from the headlines...⁴⁴

The durable evidence of ONA's influence lies elsewhere. As noted earlier, ONA's assessments are aimed at long-term, structural transformation. ONA sponsored the three studies

discussed below: a Center for Strategic and Budgetary Assessment (CSBA) study on military uses of space from February 2001; a January 2002 study by the Information Assurance Technology Analysis Center on biotechnology; and ONA's own 2002 Summer Study on the Bio-sciences. Some elements of these assessments, for example, genetic engineering to produce a super soldier, are more controversial than others, but the activity associated with the ones examined here are more valid measures of the impact ONA has had on the defense establishment, judging by references in the QDR⁴⁵ and reports in defense and industry trade publications.

One of Secretary Rumsfeld's imperatives is to foster strong public-private ventures, leverage private sector advancements and avoid big-ticket, 20-year development and acquisition cycles. The Achilles heel of this approach is that without significant Congressional appropriations, research and development in any of the areas discussed below may not always track with DoD mission requirements.⁴⁶

Biosciences

ONA's 2002 Summer Study considered "Recent Findings in the Biosciences" and their implications for DoD.⁴⁷ Hierarchical relationships, interpersonal communications, cross-cultural interactions, and cognition and decision-making were the focus of this study; the implication being that DoD will have to change the way its hierarchies function (for example, controversial proposals to completely restructure the DoD civilian work force) and its population processes information and communicates. This point of view is clearly reflected in the way the government is being reorganized to deal with homeland defense and is key to a capabilities-based threat response, which necessarily relies on tailored force packages. Vertical organizations are being stretched sideways to accommodate new mission elements, information sharing and new staff from across the federal government, for example, as evidenced in the parade of briefings presented on joint operations and transformation at the National Defense University this year.

Biotechnology

The Biosciences Study complemented a January 2002 study produced for ONA by the Information Assurance Technology Analysis Center (IATAC) titled, “Exploring Biotechnology Opportunities for the Department of Defense.”

At the time the study was published, IATAC noted that

DoD must grasp new bio-capabilities and address the ethical [and] legal issues before conflict...[and] avoid strategic surprise from an unethical adversary.⁴⁸

The ethical complexities associated with human performance enhancement linger as evidenced by the media consternation over the Air Force’s hitherto little-remarked use of “go pills,” which many believe were a factor in a friendly fire incident in Afghanistan. One suspects more cutting edge programs such as genome-altering enhancements, transitory genetic enhancements, genetic screening for program or mission eligibility and physical implants will engender similar concern.⁴⁹

Great strides are evident in the areas of biotechnology, notably advanced military medicine, information technology, robotics, nano-technology, sensors, non-lethal weapons bio-computation and biology-based power supplies.⁵⁰ The military bio-tech industrial complex may be immature (The Defense Advanced Research Projects Agency (DARPA) plays the biggest role), but elsewhere the bio-tech sector is exploding with opportunities for the sort of leverage Secretary Rumsfeld favors.⁵¹

Sensibly, DoD is actively supporting development of higher power systems – such as those required for directed energy systems such as lasers and microwaves, as well as advanced battery systems capable of meeting silent watch requirements and powering fleets of hybrid vehicles,⁵² including unmanned vehicles envisioned for battlefield use.

DoD is also invested in other energy production initiatives such as the Department of Energy’s National Renewable Energy Laboratory in Golden, Colorado. Of particular interest is their work in the area of biomass, now the largest U. S. source of renewable energy due to bio-

power combustion of timber industry or municipal solid waste, and ethanol production. The most important bio-technology advance in this field may be the bio-refinery. Using biomass feedstocks, such a system would generate liquid transportation fuels, primary heat or electrical energy to be sold or consumed on-site or hydrogen for distribution.⁵³

ONA has consistently supported interagency co-operation in such areas (DoD support, through DARPA, for example).

A more immediate biotech application is the work of the Institute for Soldier Nano-technologies at the Massachusetts Institute of Technology (MIT), which is working to create a new uniform for the infantry soldier. Constructed of lightweight molecular materials, it would

Make the clothing as hard as metal, act as a case when a soldier breaks a leg and apply medicine to wounds... alert soldiers to the presence of poison gases or biological agents and transmit soldiers' locations to a command post... change color to imitate the outside environment making the soldiers nearly invisible... with spring-loaded combat boots that will let soldiers leap over 20-foot walls... and recover and distill a soldier's sweat to use as drinking water, and integrate sensors into the fabric of [the] uniforms.⁵⁴

Wound healing therapies available now include Low Level Laser Therapy (LLLT) and Low Energy Photon Therapy (LEPT), photo-therapies involving the application of light or monochromatic infrared energy, which penetrate the skin's surface to the underlying tissue and triggers normal cellular functions that lead to surgery-free, pain-free and drug-free wound healing. The Food and Drug Administration (FDA) approvals are already in place for some applications making them ideal for public-private partnerships, given the huge market potential (\$1.1 billion in the United States) and thus, very little requirement for DoD research and development funding.⁵⁵

Similarly, in 1999, DARPA committed the first allotment of a \$10 million appropriation to Advanced Biosystems toward the development of a universal immune booster that “[harnesses] the power of the body's innate immunity.”⁵⁶

Controversy surrounds some aspects of human performance endurance, such as “go pills” and “no-go pills” – effectively, stimulants and sedatives used to “manage” pilot rest. “Better warriors through chemistry” is a “radical approach” to making it possible for special operations personnel, particularly, to go without sleep for up to a week.⁵⁷ DARPA documents describe this as “a 21st century revolution in military affairs that results in operational dominance across the whole range of potential U.S. military employments.”⁵⁸

Bio-computation is a vast area. Many of its disciplines – behavioral ecology, optimization theory, game theory, analog devices and sensors, and robotics, for example – are critical to many of the initiatives supported in the ONA assessments.⁵⁹

Biocomputation, particularly, exemplifies the sort of rapid experimentation that may revolutionize the way in which DoD acquires and fields new technologies. Some, like IBM’s “autonomic computing,” i.e., computers that heal themselves,⁶⁰ still seem like science fiction. Others, like sensor fusion, critical to automated highways and intelligent vehicles, have immediate military applications – from support base to the battlefield – but all aimed towards optimization of personnel⁶¹ as warfighters.

Science fiction has a way of becoming current technology...already in testing is the Low Cost Autonomous Attack System (LOCASS). Powered by a miniature turbojet, LOCASS uses an inertial navigation system and GPS receiver to navigate to two waypoints, before searching for its target.⁶² DARPA is also overseeing development of the Army’s Future Combat System (FCS) Mule, Soldier and Armed Reconnaissance Vehicle robots – which, had they been in service, could have performed the mission of the doomed 507th Maintenance Company in Iraq.

Military Use of Space

The military use of space is also being transformed – although not quite as ONA envisioned in the February 2001 CSBA study ONA sponsored to

“...assess the evolving capabilities of nations and other actors to exploit near-earth space for military purposes over the next 20-25 years[,]”⁶³

which anticipated there was

“...a better-than-even chance...[the] predominant military use of near-earth space will remain force enhancement” as long as “no other nation acquires both the resources and the strategic imperative to field space-based weapons.”⁶⁴

The force enhancement mission central to SPACECOM’s own Mission Statement⁶⁵ and the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies notwithstanding, the trend of current research appears to be tipping toward force application.

The *Columbia* tragedy may well increase attention to another area emphasized in the CSBA study, that is, the need for development of a reusable launch-to-orbit vehicle to replace the shuttle. As with information technology development, success in this arena will depend on the government’s ability to sever itself from institutional baggage and legacy systems.⁶⁶

We are all becoming intimately familiar with DoD’s ability to exploit information from space-based systems. This is one area where the organizational and institutional changes, particularly in terms of human investment, are very clear: “space smart” officers are firmly in the Combined Air Operations (CAOC) saddle thanks to the rapid implementation of Secretary Rumsfeld’s Space Commission recommendations. The Air Force Space Command (AFSPC) is now fully focused on a capabilities-based approach, spearheaded by the work of the Space Situational Awareness Initiative Office (SSAIO) in the “growing mission area of space control...[including] offensive and defensive counterspace.”⁶⁷ AFSPC has also absorbed the Space and Missile Systems Center (SMC) bringing the Air Force’s satellite-and-launch vehicle procurement under an operational umbrella – an end-to-end approach.

Fused information from space systems were the critical enabler in Afghanistan and are indispensable in Iraq where “MILSPACE is now delivering on decades of promise and potential.”⁶⁸ Secretary Rumsfeld is in the enviable position of facilitating his own “massive” recommendations; notably, wringing more capability from existing systems, promoting career and leadership development to build and retain a strong professional cadre within the National Space Security (NSS) community and establishing an NSS Architecture Office to examine near-term transformation issues.⁶⁹

It seems that not a week goes by without an announcement of a new information fusion or strike system, space-based or otherwise:

DARPA’s Affordable Moving Surface Target Engagement program, currently in testing, seeks ways to use data from two or more airborne radars to produce a radar track good enough to guide an inexpensive, seekerless bomb to a moving target...⁷⁰

Lockheed Martin, Northrup Grumman and Boeing have all opened network-centric warfare (NCW) centers showcasing information technology modeling, simulation, integration management and security systems...⁷¹

The National Hypersonics Strategy is examining the potential of manned and unmanned hypersonic vehicle concepts to provide “cheap and efficient” access to space and improve long range strike and reconnaissance missions...⁷²

Force XXI Battle Command Brigade and Below (FBCB²) was installed in the Doha HQ and with most U.S. and U.K. land forces, bypassing formal Initial Operational Concept (IOC) testing, and connected to the Army’s \$20 billion Army Battle Command System providing access to artillery, missile warning and intelligence information...⁷³

The Joint Battle Infosphere (JBI) would help U.S. troops around the world pluck relevant data from the flood of information collected by U.S. military and government agencies.

Eventually, JBI will create a fully integrated environment composed of thousands of sensors and strategic and tactical military assets.⁷⁴

Leaving aside the question of whether missile defense is also an offensive capability, the Bush Administration has gone a step beyond the CSBA Study in proposing \$54 million in the 2003 budget to develop space-based, kinetic kill vehicles; \$50 million to develop technologies

related to space-based laser weapon;⁷⁵ \$88 million for space control initiatives; and \$5.4 million for space modernization programs including space-based radar.⁷⁶ The space control initiatives include satellite swarms, i.e., using the principles of swarm intelligence (complexity science, dynamic modeling and evolutionary computation, etc.) to develop the capability for groups of satellites, or any other complex task distribution system, to control themselves.⁷⁷

Directed energy (DE) weapons such as the Airborne Laser (ABL) and Space-Based Laser (SBL) could be exploited to “weaponize” space, but the extraordinary versatility of these technologies makes them ideal platforms for a capabilities-based force. “The scalability of DE systems will provide for the first time a single technology capable of spanning the full range between peaceful tool and lethal strategic weapon...with a single laser...capable of many different roles depending on scalable power and optics.”⁷⁸

Since the United States withdrew from the Anti-Ballistic Missile (ABM) Treaty, space-based laser missile defenses are on a fast research, if not testing, track, particularly the Space-Based Laser Integrated Flight Experiment (SBL-IFX). SBL-IFX may be the first step in the development of a global network of space-based interceptor satellites.⁷⁹

Similar design “psychology” may be applied to targeting by Unmanned Aerial Vehicles (UAV). for example, when one UAV recognizes a target, it could send an electronic signal alerting other UAVs to “swarm” on a target, destroy it and then return to normal patrolling.⁸⁰

Echoing earlier efforts to force the pace of transformation, the 108th Congress saw the introduction of several bills supporting the types of research advocated by the ONA assessments. These include H.R. 238, “Energy Research, Development, Demonstration and Commercial Application Act of 2003,” which identifies over two dozen separate areas of exploration; H.R. 766 providing for a National Nano-technology Research and Development Program and over \$2

billion in funding through 2006; H.R. 1282 authorizing the Department of Energy to cooperate in the International Magnetic Fusion Burning Plasma Experiment and over \$2 billion in funding; H.R. 1041, the Distributed Power Hybrid Energy Act; and S.189, which authorizes appropriations for nano-science, nano-engineering and nano-technology research.⁸¹

Nevertheless, while the QDR recommended 3 per cent of the total defense budget be earmarked for science and technology, only 2.68 per cent of the \$379.9 billion defense budget was allocated.⁸²

Indicators of Success for Strategic and Technology Transformation

Quite apart from investment, the ONA assessments identify some indicators of success applicable to both the strategic and technological transformation tracks – principally institutional advocacy and organizational capacity.

The most fundamental of these involve changing the DoD mindset – a task Secretary Rumsfeld has apparently undertaken with determination, “pushing the right issues and raising many of the right questions at the Pentagon.”⁸³ His priorities, “creating an agile information-age force capable of defeating more elusive adversaries anywhere on the globe” and “reasserting civilian control over a military establishment that had grown autonomous over the Clinton years”⁸⁴ are being tested in the crucible of war, and it is now clear that the risk-averse, tradition-worshipping, inflexible mindset the Secretary has fought for the last year and a half will not find a seat at the post-Iraq war table. If anything, the war on terrorism and the wars in Afghanistan and Iraq do “not supplant the need to transform DoD; instead, we must accelerate our organizational, operational, business and process reforms.”⁸⁵ Assuming the next generation of military leadership is already in sympathy with this view, this guidance represents a top down

push complementing the bottom-up revolution that will squeeze out those who cannot or will not adapt to meet the challenge.

Secretary Rumsfeld's legislative priorities respond exactly to ONA's primer for organizational change – and even more than the encouraging language of the QDR demonstrate how thoroughly the Secretary identifies with the “Marshall” philosophy.⁸⁶

Beyond the QDR, the just-published “Transforming the Defense Industrial Base: A Roadmap” abandons conventional measures of military capabilities in favor of changing planning, budgeting and acquisition processes and assessing technology needs to match five operational effects-based sectors: Combat Support, Power Projection, Precision Management, Homeland and Base Protection and Integrated Battlespace.⁸⁷

Further, 2002 testimony by STRATCOM, Admiral James O. Ellis, strongly supports information fusion, advanced C4ISR and the Space-Based Infra-Red System (SBIRS) High and Advanced Extremely High Frequency satellite systems as critical to the 21st century strategic infrastructure.⁸⁸

The evidence that ONA's advocacy of a capabilities-based force has had an impact is also reflected in full-spectrum wargames designed, for example, to investigate in a 21st century environment, the desired operational capabilities required to satisfy the Focused Logistics challenges of information fusion, joint deployment and rapid distribution, force protection, medical support, multi-national logistics, joint theater logistics management, and agile infrastructure.⁸⁹ Beyond that, “the Joint Staff J-4 is authoring wargame scenarios [spanning 2004-2009] and the full-spectrum conflict from small humanitarian operations to major theater warfare.”⁹⁰

Another avenue of institutional advocacy – as well as organizational capacity – may be the Defense Acquisition Challenge program. Created under the 2003 Defense Authorization Act, it “allows anyone to propose innovative products and technologies that could rapidly improve defense.”⁹¹ Broad Area Announcements (BAA) in Federal Business Opportunities solicited proposals for rapid, cost-effective improvements to existing programs at the component, sub-system or system levels. Those proposals that pass a rigorous, two-stage review process encompassing key performance parameters, test plans, acquisition/transition strategy, cost estimates, certification, protection of intellectual property rights, etc., will be funded for test and evaluation in the same fiscal year as submitted – a revolution in itself.

The Air Force has implemented acquisition reforms tested during the Pathfinder effort including collaborative requirements for development, seamless verification by the development group, spiral development allowing improvements to be introduced during the production process and technology transition initiative.⁹²

The Navy is accelerating work on carrier technologies that were originally on the drawing board for 2010 – the CVN-21 – leaving room for developing or yet-to-be-imagined technologies. “You have to have an architecture that can handle transformation,” said VADM Philip Balisle, Commander, Naval Sea Systems Command.⁹³ In effect, the Navy will skip a generation of technology with CVN-21, as it will with the reworked capabilities of the new Littoral Combat Ship.⁹⁴

The test of institutional advocacy will be whether the defense establishment itself can be restructured – preliminary signs are encouraging, at least to those who believe Secretary Rumsfeld’s transformation vision. 9/11 galvanized his efforts to focus on transformation, quieting those, for the moment, who wondered why transformation was necessary, and

effectively “[changing] the way the knight thinks.”⁹⁵ War has proven an effective, if undesirable, alternative laboratory to the long periods of experimentation with new technology that typically acclimates the services to the edge of the “abyss” of change.⁹⁶

The two new combatant commands – STRATCOM and NORTHCOM – exemplify the “new” joint organizations, structured around capabilities rather than response to specific threats. NORTHCOM’s initial, critical contribution to homeland defense will be a joint intelligence and information fusion center effecting a truly free interchange of data among government and civilian agencies – the critical step to interoperability.⁹⁷

The reorganization of STRATCOM will also force resolution of who is “in charge” of space by forcing the services, particularly the Air Force to bring their priorities into line with a single authority.⁹⁸

Elsewhere, the transformational mentality has taken hold in the curriculum of the Combined Arms Center. Under LTG James Riley, the officer education system is undergoing its first wholesale revision since 1978. The goal is to shape a transformational force envisioned to include any number of advanced and legacy systems and organizations in a fully interoperable environment.⁹⁹

The changing DoD mindset was also clear in public remarks by the Chief of Naval Operations and the Chairman of the Joint Chiefs of Staff at the National Defense University during the 2002-2003 academic year. Both hammered home the need for public-private sector, service and agency interoperability – at the expense of service agendas, if need be.

Conclusion

It is very much a matter of opinion whether Andrew Marshall’s influence or Donald Rumsfeld’s determination will effect the transformation they envision, but there is no backing

away from ONA's – and therefore Andrew Marshall's – influence on the systems and processes of transformation. Reports of the death of the Marshall review, or those with which he is associated, however, were probably exaggerated. On August 22, 2001, for example, Deputy Secretary of Defense Wolfowitz signed out DoDD 5111.11 restoring Net Assessment and its Director to their former roles.¹⁰⁰ In September 2001, the QDR, embodying many of the concepts associated with ONA, was issued without undue fanfare. In February 2002, the Secretary of Defense announced his intention to terminate Crusader. The debates over increased procurement of the B2 continue. And in September 2002, Andrew Marshall reissued *The Military-Technical Revolution: A Preliminary Assessment*. In his foreword¹⁰¹, Marshall noted that the four most important strategic management issues addressed in the original report were how to identify appropriate innovations, foster innovation, change the acquisition process to support field experimentation and involve allies. His conclusion in the reissue was that “[we] have not yet fully exploited and adjusted to developments in information and communications technologies” let alone resolved the strategic management issues in a manner which would allow DoD to absorb the space and biotechnological challenges discussed above. It seems a gentle suggestion that much remains undone, but judging by the services' enthusiastic embrace of the sort of innovation Marshall himself advocates, the ONA is much more of a fellow traveler than a threat.

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ENDNOTES

¹ Kent Kresa, Northrup Grumman Chairman quoted in *Defense News*, March 24, 2003, p. 22.

² James M. Ludes, "An End Run on the QDR," *Defense News* [Electronic Version], February, 2001, retrieved at <http://www.defensenews.com> (12 January 2003).

³ Ken Silverstein, "The Man from ONA," *The Nation* [Electronic Version], 2, 25 October 1999, <http://proquest.umi.com> (3 January 2003). *The Nation*, for reasons not entirely clear, writes of Mr. Marshall and ONA in a tone bordering on contempt. In discussing the way ONA is presented in the media with the staff, mention of *The Nation* elicited a somewhat exasperated sigh. Nevertheless, this article includes the most complete discussion of Mr. Marshall's career.

⁴ Silverstein, p.2.

⁵ Department of Defense Directive 5111.11 of August 22, 2001. This directive was issued at the height of the debate over Marshall's "strategy review" associated with the QDR and the decision to plus-up the FY-02 defense authorization. Whatever the fate of the latter, the broad authority and autonomy granted the Director of Net Assessment remains.

⁶ Silverstein, p.1. These studies were not available for review.

⁷ Silverstein., p.2.

⁸ A useful working definition is contained in the CRS Report for Congress on Naval Transformation. "Defense transformations are defined as infrequent, large-scale changes in weapons and concepts of military operations that lead to major changes in the structure and organization of the military forces and ways in which wars are fought. In contrast to incremental or evolutionary military change brought about by normal modernization efforts, defense transformations are more likely to feature discontinuous or disruptive forms of change. Such transformations are usually brought about by the emergence of key new technologies that permit the creation of new kinds of military forces and approaches to warfare." Ronald O'Rourke, "Naval Transformation: Background and Issues for Congress." Congressional Research Service, 6 June 2001, pp. 1-2.

⁹ John Dillin, "U.S. military tries to plan for rise of Asia," *Christian Science Monitor*, 30 March 2001, p. 3 retrieved at <http://proquest.umi.com> (3 January 2001). Dillin summarizes Marshall thus: "Assuming [he] is right about Asia, [the] arsenal assembled to fight the Soviets will be inappropriate," referring here to the Abrams tanks, carrier battle group and short range fighter aircraft, for example, FA-18, F-22 and the Joint Strike Fighter. "The U.S. should emphasize a maritime strategy in Asia with a 'premium' on both naval and air forces." Marshall doesn't advocate scrapping entire inventories, however.

¹⁰ Per "Critical Intelligence," *Inside the Pentagon* [Electronic Version], 26 June 1997, <http://a762:ndulib@insidedefense.com> (3 January 2003), these included a "special series of war games aimed at stimulating new concepts for the RMA...approaching [it] from a different angle than most [by looking at its] two primary and contending definitions. The first sees the revolution as solely the result of technology...The second holds that the RMA is a simulation-related revolution: because the military can now do so much in training and simulation environments, it is better prepared." Also, Gail Kaufman, "Net Assessment Office's 'Future War Games 20XX Reveals Risks in Using Unmanned Platforms,'" *Defense Alert*. [Electronic Version], 1, 19 December 2000, <http://a762:ndulib@insidedefense.com> (3 January 2003). Significantly, this exercise, involving 30 mid-grade officers and policy organization reps from the U.S., Canada, Australia, Germany and Sweden was built around two tactical vignettes: one dealing with "power projection into the Sea of Japan past a Large Peer Competitor's anti-access capabilities;" the other with the "evacuation of hostages from an urban area under a Large Peer Competitor's control."

¹¹ As the debate gathered steam, William Safire commented that Marshall is "the most unknown forward thinker in America today... a shatterer of shibboleths [tolerated by] two generations of Pentagonians...on the off chance he may be right." Quoting Secretary Rumsfeld, "Andy...is still up at 20,000 feet." William Safire, "Octogenarian Futurist," *New York Times*, April 16, 2001, p A19, retrieved at <http://proquest.umi.com> (3 January 2003).

¹² Silverstein, p. 2. Quoting Paul Gigot in the Wall Street Journal in reference to Secretary Cohen's move to transfer ONA to NDU, "Americans don't go to sleep at night worrying about how we'll win the next war. Andy Marshall does, which is why Americans ought to worry about his being banished to outer Siberia by a witless and bureaucratic Pentagon."

¹³ Dr. Dmitry Ponomareff and CAPT Jan van Tol, interviewed by CDR Debra Maddrell, January 8, 2003, hereafter, ONA interview.

¹⁴ ONA interview.

¹⁵ ONA interview

¹⁶ Nevertheless, the staff's qualifications and range of experience are on a par with those found in more well-known think tanks.

¹⁷ The extent of this self-effacement, in an organization riddled with egomania and ambition is extraordinary. As an example: Mr. Marshall brought Dr. Andrew May into ONA to write its history. Having worked on the project for many months, I hoped Dr. May would be able to shed some light on the ONA's evolution, point to the pivotal events or analyses that established Mr. Marshall's and ONA's pre-eminence. It was a bit of a rude shock to discover that such a document formed no part of the plan. Dr. May is preparing what is best described as an intellectual history, focusing on those themes that have intrigued and engaged ONA over the years. There is no intent to identify individual contributions, or presumably, to comment on how these themes have been received. So far as I could tell, once completed, it may never be circulated outside ONA!

¹⁸ Department of Defense Directive 5111.11 of August 22, 2001, p.3. Hereafter, DoDD 5111.11.

¹⁹ DoDD 5111.11

²⁰ Studies sponsored by ONA, for example, the CSBA study, "The Military-Technical Revolution: A Preliminary Assessment," often receive wider distribution, which is probably why many conclude such studies are an alternative forum for Mr. Marshall.

²¹ Dr. Dmitry Ponomareff, interviewed by CDR Debra Maddrell, 8 January 2003.

²² Ludes, p. 1. "People who know him well speak of him with tremendous reverence. Those who know him only remotely speak of him with great deference."

²³ Except as noted, the observations in this section are drawn from my direct involvement in the policy and budget process, first as a J1 staff officer and branch head at Headquarters, U.S. European Command (1996-1999) and then as the Program Manager for Navy's port and airfield requirements on the Staff of the Chief of Naval Operations, Ashore Readiness Division.

²⁴ This is not to suggest that officers at the Service and Joint staffs had any problem articulating requirements and courses of action - bald truth rarely survives the "packaging" process as anyone who has ever had to produce a "5x8" will attest. See also, Jeff Erlich, "Officers Propose Counter to QDR," Defense News [Electronic Version], 19 May 1997, retrieved at <http://www.defensenews.com> (12 January 2003). The report from Transformation Strategy Game II, organized by Andrew Marshall, was that "If colonels ran the Pentagon, the [QDR] might have recommended the U.S. military shelve the two-war strategy, cut three Navy aircraft carriers, three Army divisions, and six Air Force fighter wings and use the savings to invest heavily in radical new systems."

²⁵ "...From the Sea," "Forward...From the Sea." etc.

²⁶ House National Security Committee (HNSC) report on the FY-97 Presidential Budget, quoted in "Modernization," Inside the Pentagon [Electronic version], 3 May 1996, p. 5, retrieved at <http://a762:ndulib@insidedefense.com> (January 3, 2003).

²⁷ HNSC, 6.

²⁸ HNSC, 6.

²⁹ HNSC, 6.

³⁰ Remarks by Mr. Fred Downey, Senate Appropriations Committee Staff -D, December 9, 2002. Downey made similar comments to The Washington Post. Vernon Loeb, "Billions, and It Can't Make Change; Theorist Behind Pentagon Transformation Says Glass is 'Not Empty,'" The Washington Post, 13 September 2002, p. A37, retrieved at <http://proquest.umi.com> (3 January 2003).

³¹ Comment to CDR Maddrell during POM-04 development. I was program manager for U.S. Navy port and airfield operations support in the Office of the Chief of Naval Operations, Shore Installation Support Division, 2001-2002.

³² "Reshaping the Pentagon," Christian Science Monitor, 14 February 2001, p. 10, retrieved from <http://proquest.umi.com> (3 January 2003). Also, Andrea Stone, "Military review to help plot new course strategy; nukes, structure, pay all fair game," USA Today, Abstract retrieved from <http://proquest.umi.com>, (3 January 2003). Rumors about which weapons Bush might want to cancel were rampant given Administration comments about "skipping a generation of weapons." Also, John Dillin, "Pentagon braces for a makeover; Bush has assigned a big-picture review of the military to an iconoclastic analyst who may file his report this week," Christian Science Monitor, 12 February 2001, p. 1, retrieved at <http://proquest.umi.com> (3 January 2003).

³³ "Defense Missile Maverick Is Asked to Swiftly Size Up Military," Los Angeles Times, 9 February 2001, p. A16, retrieved from <http://proquest.umi.com> (3 January 2003). "Marshall, a controversial figure in defense circles for his

outspoken criticism of some of the traditional pillars of U.S. strategy and procurement policy [and questioning] of the usefulness of the new F-22, the crown jewel of the Air Force's current acquisition program. [Has] called the Army's heavy tanks and the Navy's aircraft carriers possible death traps that ought to be phased out before they prove to be the horse cavalry of the 21st century." Not to put too fine a point on it... Frank J. Gaffney, Jr., "Marshall's plan is road map to military readiness," Washington Times, March 12, 2001, pp. 44-45, retrieved at <http://proquest.umi.com> (3 January 2003) is more restrained. Marshall "often recognizing before the rest of the military establishment the declining utility of existing weapons systems and the need to develop and field new capabilities suited to a changing world." Also, Dillin, p.1.

³⁴ Elaine M. Grossman, "Senators Doubt Value of Cohen Moves to Reorganize C3I, Net Assessment," Inside the Pentagon [Electronic Version], 27 November 1997, <http://a762.ndulib@insidedefense.com> (3 January 2003). According to a Senate staffer, ONA was an "alternative voice within the Pentagon...shedding the office makes it appear DoD leadership didn't 'want to be bothered.'" See also DoDD 5108.1 of 27 September 2000.

³⁵ Interestingly, Merrick Casey writing in Proceedings in August of 2001, makes the argument that *Strategy for a Long Peace* (and by extension), Marshall's assessment, are nothing more than "traditional liberal arguments for defense spending reductions," speculating, "It is likely that a Gore administration would have implemented this kind of transformation strategy, as many of the leading transformationists are Democrats." Presumably, he refers to Charles Robb and Joseph Lieberman, both long-time supporters of Andrew Marshall. As is John Warner This position rather stands conventional wisdom on its head. Merrick Casey, "Transformation is a Trap," Proceedings, August 2001, pp. 2-9, retrieved at <http://proquest.umi.com> (3 January 2003). Loeb, p. A37, finds that Krepinevich's work makes "for a case study of inertia inside the \$1 billion-a-day U.S. military establishment and a roadmap...for how little has changed."

³⁶ Greg Jaffe, "Defense Plan Could Hit Budget Wall – Rumsfeld Will Face Cabinet Competition for Funds after 2002," Wall Street Journal, 5 June 2001, p. A28, retrieved at <http://proquest.umi.com> (3 January 2003). ADM Blair's concern was that the study's call for greater reliance on long-range weapons at the expense of military bases close to the action could hurt political support for U.S. military facilities in Japan and South Korea."

³⁷ James Dao and Eric Schmitt, "New Pentagon Debate Over Stealth Plane," New York Times, 11 December 2001, p. A24, retrieved at <http://proquest.umi.com> (3 January 2003). General Jumper's vision relies heavily on permissive access to forward bases and I have yet to find someone in the Air Force who can make a persuasive argument for the Air Expeditionary Force in the absence of such bases...or the MOB.

³⁸ Elaine M. Grossman, "Dearth of Access to Rumsfeld Review Prompts Misinformation Flurry," Inside the Pentagon [Electronic Version], 1 March 2001, <http://a762.ndulib@insidedefense.com> (3 January 2003). According to Grossman, much of the firestorm could be traced to a ubiquitous Army PowerPoint commentary on a Center for Strategic and Budgetary Assessment (CSBA) monograph *A Strategy for a Long Peace*, by Andrew Krepinevich, which was suspected to be a Marshall strawman. As anyone who has ever worked with the Army will attest, however, they are notorious about producing Army versions of other organizations' briefings, which purport to explain what the originators REALLY mean and what the implications are for the Army.

³⁹ Thomas E. Ricks, "Rumsfeld, Joint Chiefs Spar Over Roles in Retooling Military," Washington Post, 25 May 2001, p. A2, retrieved at <http://proquest.umi.com> (3 January 2003).

⁴⁰ Elaine M. Grossman, "Senior Marine counters reports that military is shut out of review," Inside the Pentagon [Electronic Version], 18 May 2001, <http://a762.ndulib@insidedefense.com> (3 January 2003). MajGen Robert Magnus described a "robust dialogue," but acknowledged that his counterparts likely suffer "high anxiety when they don't have situational awareness."

⁴¹ Elaine Grossman, writing for Inside the Pentagon, gathered these observations (paraphrased) from unnamed sources in the Pentagon on a report by David Gompert at RAND, which, like the CSBA monograph discussed above, was seen as another trial balloon. [The] lack of service input "evident" as the report lacked a full understanding of the Services plan and allocate forces... "Ideas are coming up from people who haven't been in the real world." On Rumsfeld's approach: "You pull in the military as you need them, suck information from them, and then shut them out." Elaine M. Grossman, "Rumsfeld's Conventional Forces Panel Proposes Joint Response Units," Inside the Pentagon [Electronic Version], 3 May 2001, <http://a762.ndulib@insidedefense.com> (3 January 2003). An oblique reference also appeared in a Wall Street Journal article on May 17, 2001, i.e., "Early drafts [of the Marshall review] mentioned some programs, such as aircraft carriers, that might be vulnerable to attack. But complaints from the services prompted Mr. Rumsfeld to strike those references." Which begs the question: If the Services had not seen the text, how did they know what was in it, and if the Secretary didn't care what they thought, why strike the offending references? Greg Jaffe, "Rumsfeld Focused on Review of Defense Strategy," Wall Street Journal, 17 May

2001, p. A4, retrieved at <http://proquest.umi.com> (3 January 2003). Writing in the New York Times, James Der Derian notes that, "...fearing loss of platforms, each Service has launched public and private protests." James Der Derian, "The Illusion of a Grand Strategy," New York Times, 25 May 2001, p. A23, retrieved at <http://proquest.umi.com> (3 January 2003).

⁴²Thomas Ricks, describing Secretary Rumsfeld as distancing himself from Marshall's review with this comment, "It's the strategy paper. It doesn't mean it's the strategy. Think of it not as conclusions, but as part of the process." Thomas E. Ricks, "Possible Military Overhaul Outlined; Personnel Policy May Be Targeted," Washington Post, 18 May 2001, p. A1, retrieved at <http://proquest.umi.com> (3 January 2003). A month earlier, William Safire, op. cit., says, "...when asked what the new strategic approach would be named, Rumsfeld told the octogenarian futurist, Andy Marshall, "If it's good, we'll call it the Bush Doctrine, if it's not, it's Marshall Plan Two." Safire, p. 2.

⁴³Sidney E. Dean, "The Review That Never Was: Pentagon Disowns Andrew Marshall's Strategy Study," Pentagon Brief, 15 August 2001, p. 4, retrieved at <http://proquest.umi.com> (3 January 2003).

⁴⁴Until the publication of the National Security Strategy.

⁴⁵Quadrennial Defense Review, September 2001, pp. 4 (Asia); 6-7 (Military technology); 13, 15, 31 (Capabilities); 26-27, 42-45 (Space); 35, 62-64 (Experimentation); 38-39 (Nanotechnology); Section VI – Revitalizing the DoD Establishment. [National War College Student Issue]

⁴⁶Colonel Jerry Warner, U.S. Army, *et al.*, Exploring Biotechnology: Opportunities for the Department of Defense, Information Assurance Technology Analysis Center, Washington, D.C. 2002, p.143.

⁴⁷"Recent Findings in the Biosciences: Implications for DoD," OSD Net Assessment 2002 Summer Study, Office of Net Assessment, Washington, D.C., 2002.

⁴⁸Ibid., p. 145.

⁴⁹Ibid.; David Appell, "Getting Under Your Skin," Scientific American, January 2003, pp. 18-20. This article discusses the implantable VeriChip manufactured by Applied Digital Solutions, which could be used to track people on the battlefield.

⁵⁰Ibid., p. 146, 148.

⁵¹Web searches reveal dozens of companies participating in research and conferences in this field.

⁵²"Battery Technologies for Military Hybrid Vehicle Applications," from a briefing presented to the Committee on Assessment of Combat Hybrid Power Systems, National Research Council, San Jose, CA, August 26, 2002.

⁵³"Bioenergy – The Nature of Things to Come," Center for Strategic and International Studies Biofuels Seminar on National Security and Our Dependence on Foreign Oil – Is Biofuel an Option for the Future?, June 20, 2002.

⁵⁴Ellen Sorokin, "Army fatigues to get makeover," Washington Times, 6 May 2002, p. 32 retrieved at <http://proquest.umi.com> (19 March 2003).

⁵⁵"Phototherapy – The Healing Nature of Light", MedX Health Corporation website, retrieved at <http://medxhealth.com/whatIs.asp> (9 March 2003). And if this sounds too much like Star Trek...I received a catalog from Walter Drake advertising a light-therapy device intended to relieve arthritis pain and stiffness, and referencing the same FDA approval cited here. A steal at \$249.95.

⁵⁶The program director used to be in charge of the Soviet bioweapons production program.

⁵⁷Brad Knickerbocker, "Military looks to drugs for battle readiness; As combat flights get longer, pilot use of amphetamines grows, as do side effects," The Christian Science Monitor, August 9, 2002, p. 1, retrieved at <http://proquest.umi.com> (19 March 2003).

⁵⁸"Brave New Soldier?," The Christian Science Monitor, January 17, 2003, p. 10, retrieved at <http://proquest.umi.com> (19 March 2003).

⁵⁹"What is biocomputation?," Liverpool Biocomputation Group Website, retrieved at <http://www.csc.ir.ac.uk/~biocomp/areas/whatis.html> (9 March 2003).

⁶⁰Kevin Maney, "Thanks to IBM, we may soon say: 'Computer, heal thyself,'" USA Today, November 6, 2002, p. B03, retrieved at <http://proquest.umi.com> (19 March 2003).

⁶¹Robin R. Murphy, "Sensor and information fusion for improved vision-based vehicle guidance," Intelligent Systems & Their Applications, November 1998, pp. 49-56 retrieved at <http://proquest.umi.com> (19 March 2003).

⁶²Chris Gaudet and Michele Savage, "Weapon Locates Target on Its Own," Defense News – Random Notes, March 31, 2003, p. 18.

⁶³Barry D. Watts, The Military Use Of Space: A Diagnostic Assessment, Center for Strategic and Budgetary Assessments, February 2001, p.1.

⁶⁴Ibid.

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- ⁶⁵ Ibid., p.2. Elements of force enhancement include military satellites, navigation aids (for example, GPS), threat warning and attack assessments, environmental monitoring, collection of geospatial and classified information, surveillance and reconnaissance.
- ⁶⁶ Ibid., p. 9.
- ⁶⁷ General Lance W. Lord, Commander, Air Force Space Command, quoted in William B. Scott, "Milspace Will Be a Major Player in 'Gulf War 2'," Aviation Week & Space Technology, retrieved at <http://www.aviationnow.com/avnow/news/> (9 March 2003).
- ⁶⁸ William B. Scott, "Milspace Comes of Age in Fighting Terror," Aviation Week & Space Technology, April 5, 2002, retrieved at <http://www.aviationnow.com/avnow/news/> (9 March 2003). See also "USAF Chief Call For Space-Based Weapons," Aviation Now – Military, August 1, 2001 retrieved at <http://www.aviationnow.com/avnow/news/> (9 March 2003).
- ⁶⁹ Scott, "Milspace Comes of Age in Fighting Terror." Also, Robert Wall, "Rumsfeld Revamps Space, Pushes 'Black Projects'," Aviation Week & Space Technology, June 17, 1995 retrieved at http://www.aviationnow.com/content/publication/awst/200105/avi_news.htm (9 March 2003).
- ⁷⁰ Glenn W. Goodman, Jr., "Pinpointing Elusive Targets," Defense News – Technology Watch, March 24, 2003, p. 24.
- ⁷¹ "Net-Centric Centers," Defense News – Technology Watch, March 24, 2003, p. 24.
- ⁷² Amy Svitak and Gail Kaufman, "DoD May Shift Science Spending Priorities: Hypersonics Studied," Defense News, March 24, 2003, P. 14.
- ⁷³ Frank Tiboni, "U.S., U.K. Troops Carry Force Trackers," Defense News, March 24, 2003, p. 6.
- ⁷⁴ Gail Kaufman, "U.S. Lab Aims to Tailor Data Feeds," Defense News, , March 17, 2003, p.30
- ⁷⁵ Gopal Ratnam, "DoD Proposes Modest Hike for Missile Defense," DefenseNews.com, February 11-17, 2003 retrieved at http://www.defensenews.com/pgt.php?htd=budget_783842.html&tty=budget (9 March 2003).
- ⁷⁶ Jeremy Singer, "Pentagon Requests \$8 Billion for Unclassified Space Systems," DefenseNews.com, February 11-17, 2003 retrieved at http://www.defensenews.com/pgt.php?htd=budget_783842.html&tty=budget (9 March 2003).
- ⁷⁷ Derrick Story, "Swarm Intelligence: An Interview with Eric Bonabeau," The O'Reilly Network, February 21, 2003, retrieved at <http://www.openp2p.com/lpt/a/3256> (9 March 2003).
- ⁷⁸ David Atkinson, "Flexibility Is Key For Directed Energy Weapons," Defense Daily, July 30, 1998 retrieved at <http://proquest.umi.com> (19 March 2003).
- ⁷⁹ Sandra I. Erwin, "Killing missiles from space: Can the U.S. Air Force do it with lasers?" National Defense, June 2001 retrieved at <http://proquest.umi.com> (19 March 2003).
- ⁸⁰ Tom Walsh, "Military locks on to firm's concept," BusinessToday.com, February 18, 2003 retrieved at <http://www.businesstoday.com> (9 March 2003).
- ⁸¹ Texts of all legislation cited retrieved at www.thomas.gov 12 January 2003.
- ⁸² Amy Svitak and Gail Kaufman, "DoD May Shift Science Spending Priorities: Explaining Priorities," Defense News, Vol. 8, No. 13, March 24, 2003, P. 14.
- ⁸³ Vernon Loeb and Thomas E. Ricks, "Rumsfeld's Style, Goals Strain Ties in Pentagon," Washington Post, October 16, 2002, p. A01.
- ⁸⁴ Ibid.
- ⁸⁵ Donald A. Rumsfeld, Secretary of Defense Memorandum, "Legislative Priorities for Fiscal Year 2004," September 17, 2002.
- ⁸⁶ Ibid. Proposed top ten priorities for FY-2004 were: Successfully Pursue the Global War on Terrorism; Strengthen Joint Warfighting Capabilities; Transform the Joint Force; Optimize Intelligence Capabilities; Improve Force Manning; New Concepts of Global Engagement; Counter the Proliferation of WMD; Homeland Security; Streamline DoD Processes; and Improve Interagency Process, Focus and Integration.
- ⁸⁷ Gopal Ratnam, "DoD Industry Study: Focus on Capability," Defense News, February 24, 2003, p. 8.
- ⁸⁸ Statement of Admiral James O. Ellis, USN, Commander, U.S. Strategic Command Before the Senate Armed Services Committee Strategic Subcommittee on Command Posture, March 20, 2002, [National War College Student Issue].
- ⁸⁹ "Focused Logistics Wargame (FLOW)," USAF Logistics Policy Insight, Vol. XXIII, Number 1, p. 39.
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- ⁹¹ Colonel Linda Palmer, "How to Innovate Faster: Acquisition Challenge Wants Ideas," Defense News, March 24, 2003, p. 29.
- ⁹² Gail Kaufman, "Pathfinder Ends; USAF Unveils Reform," Defense News, March 24, 2003, p. 29.

⁹³ Jason Sherman, "U.S. Navy Nears Decision: \$11.7 Billion Concept Ship Could Get Nod This Summer," Defense News, March 24, 2003, p. 14.

⁹⁴ "U.S. Unveils LCS Needs," Defense News – In Brief, February 24, 2003, p. 5.

⁹⁵ Secretary of the Air Force James G. Roche in Colin Clark, "The 9/11 Effect: What Changed, What Didn't Around the World," DefenseNews.com, Summer 2002 retrieved at http://www.defensenews.com/pgt.php?htd=911_1095495.html&tty=special (12 January 2003).

⁹⁶ Andrew Krepinevich, "The Future of War," *PBS Frontline* Interview, 2000, p. 13, retrieved at <http://www.pbs.org/wgbh/pages/frontline/shows/future/interviews/krepinevich.html> (12 January 2003).

⁹⁷ Dan Caterinicchia, "Defense office brings together intell experts," Federal Computer Week, September 16, 2002 retrieved at <http://proquest.umi.com> (19 March 2003).

⁹⁸ "Air Force Shows True Colors on Space, Critics Charge," Defense Daily, September 8, 1999 retrieved at <http://proquest.umi.com> (19 March 2003).

⁹⁹ Frank Tiboni, Interview with LTG James Riley, Defense News – Newsmakers on the Record, February 24, 2003, p. 54.

¹⁰⁰ DoDD 5111.11

¹⁰¹ Andrew F. Krepinevich, Jr., The Military-Technical Revolution: A Preliminary Assessment (Washington D.C.: Center for Strategic and Budgetary Assessments, 2002), pp. i-ii. Relevant text:

"This net assessment of the military-technical revolution, issued in July of 1992, is perhaps the best-known assessment prepared by the Office of Net Assessment. It has, I believe, held up well over time. The strategic management issues it raised should still be of interest to top-level Department of Defense officials.

Why was the assessment undertaken in the first place? During the mid- to late-1970s... it was the United States that was laying the groundwork for the revolution, but it was the Soviet military theorists, rather than our own, that were intellectualizing about it and speculating on the longer term consequences of the technical and other changes that the American military had initiated...

Later, as part of the Commission on Integrated Long-Term Strategy..., the *Future Environment Working Group*...look[ed] ahead twenty years and provid[ed] and assessment of the geopolitical and technical changes on which the United States military planners ought to focus their attention. We recommended three likely changes for special attention. One was that the next twenty years would be a period of major change in warfare.

...[S]hortly after Andrew Krepinevich...joined the [ONA,] I asked him to undertake an assessment to decide still more clearly if we really believed that the Soviet theorists were correct in their belief that technological developments would lead to major changes in warfare. I believed that if we were in such a period, then senior Defense officials would be faced with new, important strategic management issues. The purpose of the assessment, then, was to clarify and highlight what we thought were the most important of these strategic management issues. The assessment raised four questions:

How to identify appropriate innovations? (Perhaps, by means of future-oriented war games, field exercises, forming experimental units, etc.)

How to foster innovation? (Perhaps by changes in career programs – introducing new career paths – military education, protecting and promoting innovative officers, etc.)

How to change the DoD acquisition process better to support field experimentation? (Perhaps by facilitating procurement of small numbers of new equipment for experimental or prototype units, etc.)

How to involve our allies? What role would they play? What would be the new division of labor between us?

...We have not yet fully exploited and adjusted to developments in information and communications technologies; the next wave of change-producing developments is coming out of the biological and human sciences, which are likely to become significant sources of change in military operations and organizations. These developments only reinforce the importance of the strategic management issues that were raised in this assessment.”