Leveraging Naval Technologies: The Case of the DDG-1000

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Ninety years ago, British strategist and inventor Major General J.F.C. Fuller understood that "Tools, or weapons, if only the right ones can be discovered, form 99 percent of victory…. Strategy, command, leadership, courage, discipline, supply, organization and all the moral and physical paraphernalia of war are nothing to a high superiority of weapons – at most they go to form the one percent which makes the whole possible."[i]

The "right" tools or weapons described by Fuller have become critical as the United States—as well as most of the Western world—faces a long period of both asymmetrical, low-technology "irregular" warfare and the potential of high-technology warfare posed by peer competitors, technology transferred from peer competitors to developing states or to deal with hybrid warfare combatants drawing upon high-technology options as well.

However, the link between the invention of a new technology and its impacting warfare is never a straight line. What *has* proven crucial has been how aggressively nations develop, test, improve, manufacture and field these technologies as weapons of war. In *Global Trends 2025*, the National Intelligence Council addresses the importance of shepherding new technologies to the point where they transition to the end-users, noting; "The pace of technological innovation will be key. Major technologies historically have had an 'adoption lag'."[ii]

And technological innovation increasingly rests on the ability actually to manufacture systems. The United States has a nagging problem: when it reaches the point where it can manufacture an advanced system, too often the program gets cancelled. The F-22 ended up costing $142 million a copy and could replace three F-15s but got interpreted as a "waste" of defense dollars. Positioning a system to where it can get manufactured is a core part of innovation that really affects deployed capabilities. Power Point presentations kill only audiences, not adversaries.

As the pace of global technological change has accelerated, the United States has been especially adept at inserting new technology to pace the threat. As Bruce Berkowitz points out in *The New Face of War*, "Recent experience suggests that the right technology, used intelligently, makes sheer numbers irrelevant. The tipping point was the Gulf War in 1991. When the war was over, the United States and its coalition partners had lost just 240 people. Iraq suffered about 10,000 battle deaths, although no one will ever really be sure. The difference was that the Americans could see at night, drive through the featureless desert without getting lost, and put a single smart bomb on target with a 90 percent probability."[iii]

The U.S. military establishment understands the profound impact innovation and technology can have on the future of warfare, and the need for continuous technological experimentation and insertion, and the "unknown unknowns" regarding what future technologies will be needed for America's military decades hence. For example, the U.S.

Joint Forces Command *Joint Operating Environment 2008* addressed the issue of technological uncertainty by describing the astounding changes in just the last quarter-century:

> One might also note how much the economic and technological landscapes outside of the military have changed…. On the technological side, the internet existed only in the Department of Defense; it's economic and communications possibilities and implications were not apparent. Cellular phones did not exist. Personal computers were beginning to come into widespread use, but the reliability was terrible. Microsoft was just emerging from Bill Gates' garage, while Google existed only in the wilder writings of science fiction writers. In other words, the revolution in information and communications technologies, taken for granted today, was largely unimaginable in 1983.[iv]

The U.S. Navy has a rich history of technology innovation and insertion, embracing both evolutionary and revolutionary changes. The totality of evidence suggests one navy's ability to carry out its missions effectively has often depended on who inserted the best technology the fastest and most effectively.[v] As a Chief of Naval Research noted, "The Navy/Marine Corps of today and tomorrow are and will remain critically enabled by the power of science and technology put to work for our Sailors and Marines."[vi]

The U.S. Navy has supported scientific and engineering-development efforts throughout its history. Often, technological innovation and development has reached "closure" as the Fleet or the Fleet Marine Forces bring an operational requirement to the Navy and Marine Corps R&D and Acquisition communities, the requirement is met by inserting new technology, and, except for incremental, evolutionary, improvements to that technology, the enterprise moves on to solve the next technology challenge.

But at times the Navy has employed one platform to insert and develop a "bundle" of technologies – many dependent on each other – to test breakthrough, leading-edge technologies that have the potential to alter the face of naval warfare, precisely what is occurring in the case of the DDG-1000 *Zumwalt*- class destroyers.[vii] For example, the first U.S. surface-to-air missile ships were the 8-inch gun cruisers Boston and Canberra converted to the world's first guided missile warships (CAG-1 and CAG-2), and the submarines *Barbero* and *Tunny* were converted to launch the Regulus land-attack missiles, making them the world's first operational missile submarines.

<u>Leveraging the DDG-1000</u>

Once again, the Navy has the opportunity to take emerging technology to sea, not in a "test ship," but in a front-line, battle force major surface combatant, the DDG-1000 destroyer.[viii] In announcing his decision to truncate the DDG-1000 program at just three ships, the Chief of Naval Operations chose words that emphasized the importance of this ship as a technology incubator. Admiral Roughead noted, "That's why I was more interested in truncating than terminating, so we can get a couple of ships out and see what

they can do…see if the technologies we put on [DDG-1000] are going to pay off for us."[ix]

Indeed, the Congress is seeking for the USN to leverage the technologies of the DDG-1000 in shaping the future fleet. The language in the 2010 Defense Authorization Act underscores the leveraging challenge.

Not later than 120 days after the date of the enactment of this Act, the Secretary of the Navy shall develop a plan to incorporate into surface combatants constructed after 2011, and into fleet modernization programs, the technologies developed for the DDG-1000 destroyer and the DDG-51 and CG-47 Aegis ships, including technologies and systems designed to achieve significant manpower savings.

The "bundle" of technologies embodied in the DDG-1000 destroyer – as well as those future innovative technologies that will easily find a "home" in this ship – represent many of the most cutting-edge and transformational technologies adapted for military use: the integrated power system (IPS); integrated electric drive; a stealthy tumblehome hull and integrated topside (InTop)[x] design; 155-mm Advanced Gun System (AGS); the Mark 57 Peripheral Vertical Launching System (PVLS); the S-band Volume Search Radar (VSR) and the X-band AN/SPY-3 Multi-Function Radar (MFR); and a host of other advances related to network-centric warfare, stealth, and survivability. In brief ,the DDG-1000 destroyer represents one of the most ambitious technology leaps that the U.S. Navy has undertaken since steam-driven, iron-hulled ships replaced wooden-hull sailing ships.

But as cutting edge as the technologies currently embodied in the DDG-1000 destroyer are, it is the potential to host game-changing technologies in this ship as the Navy evaluates these and other technologies for the "Navy-After-Next" that makes the DDG-1000 arguably one of the most exciting naval vessels ever fielded.

For example, the Office of Naval Research recognized, "Among the possibilities inherent in all-electric ships are the new weapons that become feasible when virtually unlimited electric power is available on board."[xi] The advanced DDG-1000 propulsion plant can enable such weapons to be used without significantly drawing down the ship's electronic surveillance and weapons control systems, or speed, a critical factor because of the high electrical demands of these cutting-edge, weapons.

These weapons are generally classified under the general heading of Directed-Energy Weapons (DEW) and include high-energy lasers, radio frequency weapons (high-power microwaves or ultra-wideband weapons), and electromagnetic rail guns.[xii] Far from futuristic weapons that may-or-may-not-be feasible, the Office of Naval Research is already developing and working to scale up the power of free-electron lasers, chemical lasers and their associated beam directors, radio-frequency weapons, and full-scale electromagnetic rail guns capable of launching precision-guided hypersonic projectiles at supersonic speeds.[xiii] Indeed, independent assessments outside government have concluded that solid-state lasers (SSL) "are capable of making unique and important contributions to U.S. military effectiveness."[xiv]

While some reports have criticized the Navy for "cramming" too many advanced technologies into the DDG-1000 destroyer,[xv] it is this perceived "weakness" that can be leveraged. If all of the technologies working together are too challenging to build a fleet of deployed ships, these technologies can be "unbundled to determine which technologies are mature for manufactured outcomes.

The DDG-1000 can perform ideal host platform for the technologies that will accelerate the Navy's revolutionary leap to the Navy-after-Next.[xvi] As the DDG-1000 destroyer technologies continue to be tested and mature, the DDG-1000 will serve as a credible platform to evolve these technologies for the Navy's entire family of new surface combatants.[xvii]

It is the prospect afforded by directed-energy weapons that promises to revolutionize naval warfare and will represent for the Navy and Marine Corps a dramatic paradigm shift on how the two services – as well as the Joint Force – will conduct operations on and from the sea in the 21st Century. As the *only* feasible host platform for directed-energy weapons for at least the next decade, the DDG-1000 destroyer is *the* ship that will move these technologies out of the laboratory and ground test sites and to sea where they offer the potential to revolutionize warfare at the tactical, operational, and strategic levels.

Hosting these directed-energy technologies on the DDG-1000 offers the promise of accelerating the development and refinement of these weapons in the operational environment and in so doing, not only identify "the art of the possible" for what the Navy-After-Next can look like, but if these emerging technologies deliver merely a portion of their enormous potential, the DDG-1000 destroyer will become the prototype for the entire high-end of the Future Surface Combatant family of ships.[xviii]

With a defense budget under increasing stress, any new military technology must do more than just offer the *potential* to reshape how the military fights in the future – it must also have the ability to close current warfighting gaps *today*. And given the especially high cost of naval vessels, any ship the Navy deploys must have an impact today. In the case of the DDG-1000, this ship will immediately close important warfighting gaps.

A Cooperative Strategy for 21st Century Seapower, the Navy, Marine Corps, and Coast Guard's first new maritime strategy in a generation, lists six missions for U.S. maritime forces, four "traditional missions" (Forward Presence, Deterrence, Sea Control, and Power Projection), and two new missions (Maritime Security and Humanitarian Assistance and Disaster Response).[xix]

While the DDG-1000s destroyer will be capable of supporting all six-mission areas of the maritime strategy, it is the power projection and sea-control missions that serve to define the primary focus of this ship and its "bundle" of new technologies. This is emphasized in the *Navy Program Guide 2009*, which, in many ways, represents the Navy of the FYDP (Future Years Defense Plan).[xx] This publication provides a window on the way the Navy

is allocating its procurement dollars for the five years beyond the President's current year budget. It shows how the Navy is dealing with the "known knowns," that is, addressing current warfighting gaps by procuring the sensors, systems, platforms, and weapons to close extant gaps and pace the threat.

In supporting a wide-array of Navy missions, the DDG-1000 will bring important capabilities to the fight, especially in the littorals. It is beyond debate that most of the areas of instability and strife are located in major cities and urban areas easily accessed by seaward approaches. The emergence of potential threats in these areas, coupled with the nation's dependence on the world market and support for regional allies, demand increased U.S. presence in the littoral regions.[xxi] This is not a "futuristic" concern, but a near- and mid-term warfighting requirement. The DDG-1000 is optimized to operate at the land-sea interface, supporting the Navy and the Marine Corps combined arms mission.

It is anticipated that the USN will procure a significant number of new littoral combat ships for operation in the littorals. There are key technologies on the DDG-1000, which will prove to be important compliments to the LCS ships and their supporting aircraft and unmanned systems. Notably the radar systems and defensive suites on the ship will provide to important assets added to the new destroyer or cruiser class to be built and deployed with the LCS in the future.

A Cooperative Strategy for 21st Century Seapower states the power projection requirement clearly, "Our ability to overcome challenges to access and to project and sustain power ashore is the basis of our combat credibility."[xxii] The gaps in the Navy's ability to dominate this littoral battlespace are significant – and growing. The ship is optimized for this mission and many of its other features – especially its radar, stealth, and survivability – are *specifically* designed to enhance its ability to project power and defend it effectively in the littorals. Sensors – radars in particular – are crucial to success in the littorals.

And the new destroyer class will be working with several new littoral assets, the F-35, unmanned systems and the LCS. It can form the lynchpin for the enduring littoral maritime presence mission.

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[i] Max Boot, *War Made New: Technology, Warfare, and the Course of History 1500 to Today* (New York, Gotham Books, 2006).

[ii] *Global Trends 2025: A Transformed World* (Washington, D.C., National Intelligence Council, November 2008), p. viii. Accessed at: www.dni.gov.nic/NIC_2025_project.html.

[iii] Bruce Berkowitz, *The New Face of War: How War Will be Fought in the 21st Century* (New York, The Free Press, 2003), pp. 2-3. Berkowitz does not restrict his examples to just one conflict, noting further; "The same thing happened when the United States fought Yugoslavia in 1999 and the Taliban regime in Afghanistan in 2001. Each time experts feared the worst; each time U.S. forces won a lopsided victory." But like Boot, he stresses that it is the possession of better technology alone is not enough, saying; "And simply having better technology does not guarantee success. Victory goes to the side that understands how to use technology more effectively." (p. 3)

[iv] *Joint Operating Environment 2008: Challenges and Implications for the Future Joint Force* (Suffolk, Virginia, Untied States Joint Forces Command, 2008). Accessed at

https://us.jfcom.mil/sites/J5/j59/defaultr.aspx. This publication, commonly referred to as "The JOE," serves as the "problem statement" regarding what challenges the U.S. military and its coalition partners will face in the future and informs all subsidiary Joint publications, beginning with the *Capstone Concept for Joint Operations*.

[v] *War Made New*, pp. 1-473. Boot does not present technology as the only element determining victory or defeat, giving full acknowledgement to a host of other factors, from geography, to demography, to economics, to culture, to leadership. However, he is firm in his contention of technology's huge impact, noting; "Some analysts may discount the importance of technology in determining the outcome of battles, but there is no denying the central importance of advanced weaponry in the rise of the West….The way to gain military advantage, therefore, is not necessarily to be the first to produce a new tool or weapon. Often it is to figure out better than anyone else how to utilize a widely available tool or weapon."

[vi] *Science and Technology for the 21st Century Warfighter* (Washington, D.C., Office of Naval Research, 2004).

[vii] See, Ron O'Rourke, *Navy DDG-1000 and DDG-51 Destroyer Programs: Background, Oversight Issues, and Options for Congress*, CRS Report to Congress RL 32109 (Washington, D.C. Congressional Research Service, October 22, 2008), for a concise background on the precursor names for this program; "The Navy initiated the DDG-1000 program in the early 1990s under the name DD-21, which meant destroyer for the 21st Century. In November 2001, the program was restructured and renamed the DD(X) program, meaning a destroyer whose design was in development. In April 2006, the program's name was changed again, to DDG-1000 meaning a guided missile destroyer with the hull number 1000. The first DDG-1000 is to be named *Zumwalt*, so the program is also referred to as the *Zumwalt*-class program." (p. 2)

[viii] While some have questioned whether the DDG-1000 will deploy, the CNO has been unambiguous in stating this ship will be a deployed asset. See, for example, Geoff Fein, "DDG-1000 Will Deploy, CNO Says," *Defense Daily*, April 28, 2009. This article quotes CNO Roughead, "There is no question we will employ…deploy [DDG-1000]. I see them in deployment. I would use them in carrier strike group or expeditionary strike groups…in cooperation with other ships."

[ix] Geoff Fein, "DDG-1000 Will Deploy, CNO Says," *Defense Daily*, April 28, 2009.

[x] The Integrated Topside (InTop) Design was developed via the Innovative Naval Prototype Program managed by the Office of Naval Research. The ONR website (www.onr.navy.mil) defines InTop as; "An integrated, multi-function, multi-beam top-side aperture construct that has a modular open RF architecture, software defined functionally, and synchronization and optimization of RF functions for mission support and EMI mitigation." In defining the attributes of InTop, this description further states; "InTop plans to reduce the number of topside apertures o Navy ships through the use of integrated, multi-function, multi-beam arrays. In the past, the topside design approach was based on developing separate systems and associated antennas for each individual RF function which led to significant increases in topside antennas. This increase has led to problems with Electro-Magnetic Interference (EMI), Radar Cross Section (RCS) and the overall performance of critical ship EW and communication functions.

[xi] *Science and Technology for the 21st Century Warfighter*, p. 25.

[xii] George Galdorisi and Lynn Pullen, *Leveraging Directed-Energy Weapons to Accelerate Naval Transformation: Prospects and Issues* (Arlington, Virginia, Center for Security Strategies and Operations, December 2004), p. 15.

[xiii] *Science and Technology for the 21st Century Warfighter*, pp. 25-26. See also, *Leveraging Directed-Energy Weapons to Accelerate Naval Transformation: Prospects and Issues* and William McCarthy, *Directed Energy and Fleet Defense: Implications for Naval Warfare* (Maxwell Air Force Base, Alabama, Air War College Press, May 2000). The fact that Directed Energy Weapons have not been written about extensively in the defense media over the past several years can be traced *directly* to the uncertainties surrounding the DDG-1000 *Zumwalt*-class destroyer program. Without a "host" platform having an integrated power system and integrated electric drive, directed energy weapons will remain land-bound.

[xiv] Thomas Ehrhard, Andrew Krepinevich, and Barry Watts, "Near-Term Prospects for Battlefield Directed-Energy Weapons," *CSBA Backgrounder*, January 2009, accessed at www.CSBAonline.org. The authors note, among other findings, that "Lasers have long been considered a technology that could give rise to a new RMA. As a December 2007 Defense Science Board on directed-energy weapons (DEW) observed, lasers promise to be transformational "game changers" in military operations…Recent advances in solid-state laser technologies suggest , however, that directed energy weapons in the 100-kilowatt (kW) range with power sources dense enough to provide "deep" magazines could be fielded in the near future…In sum,

the technical challenges that have long delayed the fielding of directed-energy weapons for battlefield use finally appear to be giving way to technical and engineering progress." See also, Andrew Krepinevich, Tom Ehrhard, and Barry Watts, "Solid-State Laser Weapon Systems: Bridging the Gap – or a Bridge Too Far," Center for Strategic & Budgetary Assessments (CSBA) briefing, May 20, 2009. The briefers, all highly-respected defense experts who authored the study cited here, conclude that the key impediments to the development of solid-state lasers are not technical, but are cultural and institutional.

[xvxv] See, for example, *Navy DDG-1000 and DDG-51 Destroyer Programs: Background, Oversight Issues, and Options for Congress*; Government Accountability Office, *Defense Acquisitions:* Zumwalt-*Class Destroyer Program Emblematic of Challenges Facing Navy Shipbuilding*, Statement of Paul Francis, Director Acquisition and Sourcing Management, Testimony Before the Subcommittee on Seapower and Expeditionary Forces, Committee on Armed Services, House of Representatives, July 31, 2008 (GA)-08-1061T); Ron O'Rourke, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, CRS Report to Congress RL 32665 (Washington, D.C. Congressional Research Service, June 10, 2008); and Robert Work, *The U.S. Navy: Charting a Course for Tomorrow's Fleet* (Washington, D.C., Center for Strategic and Budgetary Assessments, December 2008). While the overwhelming majority of the defense and open media criticism of the DDG-1000 *Zumwalt*-class destroyer program has focused on the costs of the ship, more thoughtful analysis conducted for Congress or by respected "think tanks" has questioned the Navy's decision to "package" so many new technologies into one ship, opining that this increases the risk that the ship will not be an effective surface combatant. The July 31, 2008 GAO report was especially critical of the ship's technical risk, noting, in part, "The DDG-1000 program has from the onset faced a steep challenge framed by demanding mission requirements, stealth characteristics, and a desire to reduce manpower levels by more than half that of predecessor destroyers. These requirements translated into significant technical and design challenges. Rather than introducing three or four new technologies (as is the case of previous surface combatants), DDG-1000 plans to use a revolutionary hull from and employ 11 cutting-edge technologies, including an array of weapons, highly capable sensors integrated into the sides of a deckhouse made primarily of composite material – not steel, and a power system designed for advanced propulsion as well as high-powered combat systems and ship service loads. This level of sophistication has necessitated a large software development effort – 14 million to 16 million lines of code."

[xvi] See *Zumwalt DDG-1000 Multi-Mission Destroyer: Strategic and Operational Context* and David Maurer et al, *Comparative Analysis of Surface Warfare Designs*, Report prepared for the DDG-1000 Program Office (PMS-500), PEO Ships, 4 September 2008, pp. 1-43.

[xvii] The current Navy Future Surface Combatant (FSC) Program includes the DDG-1000 *Zumwalt*-class Destroyer, the CG(X) Cruiser, and the Littoral Combat Ship (LCS). This FSC program is the evolutionary successor to the Navy's mid-1990s program called the SC-21 (Surface Combatant for the 21st Century) program. See, *Navy DDG-1000 and DDG-51 Destroyer Programs: Background, Oversight Issues, and Options for Congress*, CRS Report to Congress RL 32109, pp. 49 – 50.

[xviii] *Science and Technology for the 21st Century Warfighter*, p. 25. This now-five-year-old ONR report was prescient in recognizing the potential the DDG-1000 *Zumwalt*-class destroyer as the lead ship for the Navy-after-Next, noting, "IPS and electric drive will revolutionize surface ship and submarine warfighting capabilities by increasing combat effectiveness and agility while reducing ownership costs, space, requirements, vulnerability, and crew size. Indeed, IPS is critical to the future development of the 'all-electric Navy.'"

[xix] *A Cooperative Strategy for 21st Century Seapower* (Washington, DC, Department of the Navy, October 2007). pp. 6-12.

[xx] *Navy Program Guide 2009* (Washington, D.C., Department of the Navy, 2009). The *Navy Program Guide 2009* provides a comprehensive listing of all Navy aviation, surface, subsurface, expeditionary, and C4ISR programs and is widely-recognized as the most comprehensive compilation of these programs available to the general public.

[xxi] *Zumwalt DDG-1000 Multi-Mission Destroyer: Strategic and Operational Context*, p. 2.

[xxii] *A Cooperative Strategy for 21st Century Seapower*, p.12.