



Calhoun: The NPS Institutional Archive
DSpace Repository

NPS Scholarship

Publications

2000

Reinventing the weapons systems of the
future (archived)

Monterey, California, Naval Postgraduate School

<https://hdl.handle.net/10945/39630>

Downloaded from NPS Archive: Calhoun



Calhoun is the Naval Postgraduate School's public access digital repository for research materials and institutional publications created by the NPS community. Calhoun is named for Professor of Mathematics Guy K. Calhoun, NPS's first appointed -- and published -- scholarly author.

Dudley Knox Library / Naval Postgraduate School
411 Dyer Road / 1 University Circle
Monterey, California USA 93943

<http://www.nps.edu/library>



Reinventing the Weapons Systems of the Future

If lucky, a surface ship has ten to twenty seconds to defend itself once a guided missile is launched from a nearby shore, or a sea-skimming missile is detected coming over the horizon. Because reaction times are so short, especially with ships now closer to shore missile batteries due to the Navy's focus on littoral missions, a directed energy weapon travelling at near the speed of light becomes critical for survival, let alone defense.

Future Naval vessels may be able to protect themselves from these and other high-speed threats with powerful Free Electron Lasers (FELs) located deep in the hull, developed by Physics Prof. William Colson and over thirty officer students in the Combat Systems/Physics Program at NPS. These futuristic but real weapons will destroy incoming missiles with an intense electron beam travelling out from a ship at near the speed of light, directed out to the target by a one-meter-diameter mirror on deck. This 100-million-volt energy beam will be powerful enough to cut through over a hundred feet of steel in a fraction of a second. The deck mirror will also act as a telescope to give a clear view of target destruction in real time. (Mirrors made of low-density plasmas may also be used to electronically steer shipboard radar in the next century).

"The Free Electron Laser is in the prototype development stage, and we've already demonstrated it can be used to shoot down missiles," said Professor Colson. "These weapons, which are continuously tunable and whose energy can be delivered in short, clean pulses, could be fielded on ships early in the next century. They will bring about a true revolution in military affairs by making missiles obsolete."

Lt. Douglas Small's research, sponsored by SPAWAR's Navy High Energy Laser Office, focused on how to make FELs small enough to fit on board ship, by increasing the laser spot size on the mirrors which bounce the beam across the ship and into the sky. The larger the spot, the closer the mirrors can be without being evaporated by the beam. After leaving NPS, he was assigned to the "Surface Combatant in the 21st Century" program at the Naval Surface Warfare Center. And for the first time, Lt. Cmdr. Robert Thompson recently tested the effects of FEL pulses on various target materials.

Due to their power, precision and tunability, FELs may also be used as potent offensive weapons - against enemy aircraft, ballistic missiles, subs, ships, land targets, and even satellites. And whether used offensively or defensively, they must operate in a narrow atmospheric absorption window to ensure the beam is propagated to the target without losing its focus. Lt. Cmdr. B. K. Baldauf's thesis on shipboard atmospheric profiling and electromagnetic propagation resulted in recommended changes in the Operational Requirements Document for shipboard data collection in this critical area.

NPS student-faculty teams are also working on Directed Energy Warfare (DEW). Lt. Jeffrey Bennett II proved that shipboard radar directed energy weapons can potentially interfere with anti-ship missiles in dynamic flight tests. His thesis, "High Power Radar Effects on Anti-Ship Missiles," was undertaken in cooperation with the USS Cowpens and USS Mahan, and NAWCWPNCEN China Lake.

DEW also has applications in information operations (IO). Maj. Bill Lang and Capt. Jay Storms, USMC, for instance, researched using directed energy weapons to jam enemy tactical communications. "It's exciting to be one of the first to receive an education so well suited to meeting the challenges facing the military as it approaches the Millennium," Lang said. Free Electron Laser and Directed Energy Weapons work are just two research efforts of direct applicability to the Navy's Theater Missile Defense Project.

The projectile velocity of traditional propellant guns is limited by barrel weight and length, and their chemical explosives take up critical space. Electromagnetic railguns, which use currents instead of explosives and have no moving parts except the projectile, however, have none of these limitations. At NPS, research is also progressing on these cutting edge weapons with a potential for shipboard use.

"Like Captain Kirk and his phaser, the EM railgun lets you 'tune' your voltage, so projectiles can be fired at different

velocities and levels of lethality,” said Lt. Cmdr. Fred Beach, who developed one of the first prototypes. Another student, Lt. Mike Lockwood, recently demonstrated his next generation version of the gun.

“This is really a revolutionary advance in fire flexibility and control,” Lockwood stressed. “When this technology is perfected, we should be able to launch a mass of 100 pounds up to 200 nautical miles with a muzzle velocity of 6,500 feet per second. For that to happen, however, we will have to solve the power problem. It will require a really huge shipboard power source, on the order of two to four million amps.”

In addition to new weapons like the Free Electron Laser and Electromagnetic Railgun, surface ships of the future will continue to rely on guided missiles for both defense and offense. Since the “Father of Cruise Missiles” himself, Rear Adm. Walt Locke (Ret.), graduated from NPS in Electrical Engineering in 1960, student-faculty teams have continued to improve the Tomahawk Land Attack Missile (TLAM), whose program Locke began. This famous NPS graduate later became Director of the overall Joint (Navy/AirForce) Cruise Missile Project.

Today, the Tomahawk missile-to-mission assignment process is still essentially manual, taking up precious time and increasing the likelihood of unnecessary weapons expenditures. When the U.S. struck Iraq in December 1998, an entire battlegroup had to be withdrawn when it ran out of TLAMs, and the replacement ship nearly exhausted her own load by the end of the second day. In response, Operations Research student Lt. Scott Kuykendall developed a robust new computerized tool for optimizing both missile-to-target assignments and firing unit salvo capability for future tasks. Using the program, it takes an individual ship only seconds or a battlegroup only minutes to obtain the optimum tasking order, and also back-up assignments if requested. Kuykendall’s tactical decision aid is currently being considered for shipboard implementation by the Naval Surface Warfare Center.

In the early 1990s, Lt. Charles Swicker’s thesis on how to use Tomahawks to degrade Iraq’s nuclear weapons capabilities, and Lt. Richard Voter’s thesis on the intelligence requirements for tracking mobile missiles, became state-of-the-art for intelligence and targeting planners during DESERT STORM. “I was able to recommend both theses to DESERT STORM planners,” said Vice Adm. R. M. Eytchison, Vice Director of Strategic Target Planning at Offutt Air Force Base. “Such theses rival the best reports we obtain from contractor think tanks, but at a fraction of the cost. More satisfying is that, instead of civilian Ph.D. contractors, the work done as an NPS thesis makes one of our young officers very well informed on an important topic, and that officer has his whole career ahead of him . . . The Naval Postgraduate School should be pleased that its officers are making noteworthy contributions toward solving current problems while also being educated to lead in the 21st Century.”

Professor Donald Brutzman of the Undersea Warfare Academic Group and his students Lts. Martin Whitfield, Chris Hand, Robert Jezek, Jr., and Mark Evans have designed and tested an improved, low-cost torpedo countermeasure using Digital Signal Processor (DSP) technology. The new device, which uses an acoustic modem and all-COTS equipment, will be more effective than current Fleet devices.

[Reinventing Ship Defense](#)