Feature

Featured Overview

The Naval Research Laboratory: 75 Years of Materials Innovation

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A watercolor depiction of the NRL's early buildings on the banks of the Potomac River in Washington, D.C. Shown are the research radar dish and the bust of Thomas Edison. Edison formulated plans for the laboratory with the Naval Consulting Board in 1915.

INTRODUCTION

The course of modern history demonstrates a strong relationship between technological innovation and national security. Earlier in this century, Thomas Edison's belief in this relationship motivated his proposal to establish what became on July 2, 1923, the U.S. Naval Research Laboratory (NRL), the first modern research institution created within the U.S. Navy. For 75 years, the NRL has fulfilled Edison's hopes with a record of technical excellence that has had a profound impact upon national security. The impact of its wartime contributions spans from the development of the first U.S. radar, fielded in time for duty in the critical Pacific naval battles of World War II, to the invention and demonstration of the first satellite prototypes of the NAVSTAR global positioning system, a navigational system that played a critical role in the Gulf War.

The three original divisions established in the 1920s —Radio, Sound, and Metallurgy—pioneered the fields of high-frequency radio, underwater sound propagation, and defect analysis in castings. During the war years, the laboratory grew nearly tenfold with a staff of 4,400 working on more than 900 applied research projects. A number of new devices and systems, such as radar, sonar, various countermeasure systems, and antifouling paints, were designed and developed during this period. A new thermal diffusion process was also developed to separate some of the U-235 isotope used to produce the first atomic bombs.

In the years following the war, the laboratory redirected its focus toward basic research on the U.S. Navy's operational environments: earth, sea, sky, and space. Investigations have ranged widely from monitoring the sun's behavior to analyzing marine atmospheric conditions and measuring parameters of the deep oceans. Detection and communication capabilities have benefited by research that has exploited new portions of the electromagnetic spectrum, extended ranges to outer space, and provided a means of transferring information reliably and securely, even through massive jamming. Submarine habitability, lubricants, shipbuilding materials, fire fighting, and the study of sound in the sea have remained steadfast concerns, to which have been added recent explorations within the fields of virtual reality, superconductivity, magnetism, nanoelectronics, smart and energetic materials, and biomolecular science and engineering. Finally, the laboratory has pioneered naval research into space from atmospheric probes with captured V-2 rockets through direction of the *Vanguard* project—America's first satellite program—to formulating the concepts and inventing the satellite prototypes for the NAVSTAR global positioning system.

Today, the NRL's multidisciplinary R&D program continues to be conducted with an awareness that the challenges posed by international competition and conflict can, in part, be addressed by innovative R&D solutions. On the occasion of the NRL's 75th anniversary, this article surveys a small sampling of NRL's contributions to the field of materials science and technology and how those contributions made an impact upon U.S. seapower and national security. In many cases, those same contributions also made an impact on industrial processes.

RADIOGRAPHY

The development of gamma-ray radiography was an important contribution to the nondestructive testing (NDT) of metal castings and welds. The method, devised by the NRL's R.F. Mehl in the 1920s, entailed the use of gamma-ray radiation as a shadow-graphic technique to detect flaws in cast or welded steels.

This technique was first used to ascertain the extent of suspected flaws in the sternpost castings of the U.S. Navy's new 9,000 tonne heavy cruisers. The integrity of these post castings was vital to the successful operation of the vessels. On examination, the sternpost castings were found to be faulty, and all ten cruisers subsequently had to be repaired to avoid operational failure. During the five-year period before World War II, this NDT technique facilitated the development of improved steel-casting processes. This method of nondestructive examination was used in all stages of the molding, casting, and testing of steels.

Mehl's work on the Navy's cruiser sternpost castings established gamma-ray radiography as an NDT technique. It also contributed to U.S. seapower by improving the production of the high-quality steel for armor, ship frames, and fittings. In 1941, the American Society for Nondestructive Testing originated the biannual Mehl Honor Lecture Series to honor Mehl for his pioneering work in gamma radiography. Mehl and his early