Concept Design and Realization Branch—Part I: Guest Editors’ Introduction

J. Todd Ramsburg and Danielle P. Hilliard

ABSTRACT

The Concept Design and Realization Branch within APL’s Research and Exploratory Development Department provides an array of engineering, design, and fabrication capabilities that broadly support the Laboratory’s mission and sponsored work. It has been more than 20 years since these areas have been reviewed in this publication, and during that time, the Lab’s ability to develop and build complex systems has advanced significantly. Computing power has exponentially advanced the enabling modeling, analyses, machine programming, and novel manufacturing methods—many of which were unimaginable 20 years ago. Electronics, sensing, artificial intelligence, and other technologies have merged and are increasingly embedded to create powerful automated tools. Today, the branch continues to serve the Lab with hardware design, mechanical

engineering, and analysis; (2) electronics fabrication; and (3) mechanical fabrication. The 37,300-square-foot electrical fabrication facility in Building 13 on the Lab's main campus encompasses printed wiring board fabrication, electronics assembly, and microelectronics fabrication. The mechanical fabrication facility in Building 15 on the main campus consists of 40,600 square feet and includes subtractive, additive, and hybrid manufacturing as well as engineered materials (composites, polymer molding, etc.). The design, engineering, and analysis teams are collocated in Building 201 on the South Campus with many of REDD's other technical and research-focused staff members and labs.

THE ARTICLES

The issue opens with "History of the Design and Realization Capabilities at APL," a discussion by Charles and Ramsburg of the long history of this branch, one that in fact is rooted in the earliest days of the Lab and its prototyping and demonstration of its first defining innovation, the VT fuze. While the fuze was novel in its design and ultimately game-changing in its impact on World War II, it was APL's ability to field fully working prototypes of the device that initially showed its effectiveness and convinced national and military leaders to invest in it on a large scale. Since then, the growth of APL's capabilities for prototyping have paralleled the growth of the Lab and the rapidly transforming technological landscape, enabling APL to continue generating countless system developments that have positively impacted the warfighter, the nation's security, and the world's understanding of our universe.

The collection of capabilities, facilities, equipment, and talent within the branch is quite unique among national laboratories and APL's peers, and the tight integration of these manufacturing technologies with the Lab's systems engineering–focused technical sectors is one of APL's greatest strengths. Collectively, they create a distinctive competence in developing products from initial ideas to field-ready systems and hardware. Several articles in this issue discusselo 9nd ht1are. Sev.2 (s g)-7 (e)21.3o6 (y s)13.5]TJ EMC8d7 (h)-14.8 (d)8.2 (ID 91 >>BD learning algorithms enables the detection of flaws in parts in real time, as they are being fabricated. Such qualitative data are critical in predicting how parts will perform in their intended use and provide a basis for the eventual development of live defect healing as parts are fabricated. In particular, this article highlights the powerful intersection of materials science, physics, machine learning, and advanced manufacturing.

Guided by its role as a university-affiliated research center, APL focuses on rapidly developing, prototyping, and demonstrating novel complex systems, and the CDR Branch collaborates with experts across the Lab to support this mission. In "Rapid Prototype Development and Demonstration of a Frequency-Multiplexed Phased-Array Antenna System," Gumas et al. discuss such a project that successfully evolved from an idea to a live airborne system demonstration in less than a year. This team developed a new type of digital beamforming phased-array antenna system that provides greater performance and functionality all while reducing size, weight, and power (SWaP) and overall complexity. In particular, this case study illustrates the breadth of technical skill sets that APL is able to apply to challenges. This multidisciplinary team—including experts in radio frequency (RF) system modeling and validation, RF hardware design prototyping and characterization, firmware development, electronics and mechanical prototyping, system integration, functional verification, and range and flight testing—enabled the agile, rapid, and cost-effective development and demonstration of this novel capability.

Modern engineering and systems development also rely heavily on computational modeling and analysis with the ability to rapidly iterate physical form, materials and composition, system inputs, and the interaction of components or constit (n)9.7 (d c)-3.1 (o)5.7 (m)5.1 (p)-4.1 (o)-7 (1 (o)6 (n2-14.8 (s)7.1 (t).1 (p (, a)-18. n.1 (o)5.7

of the Lab's greatest recent successes, was largely built and executed during the pandemic, a true testament to staff members' mission focus and commitment to both sponsors and their teams. This article also highlights one positive consequence of the pandemic: despite the tremendously challenging and difficult time for the Lab and the entire nation, many of the highly effective tools for remote collaboration and communication adopted during the pandemic continue to be used today to the benefit of this expanding organization.

CONCLUSION

Throughout this issue are accounts and examples of how the work of REDD's CDR Branch benefits APL, its sponsors, and the nation. The advanced tools and facilities are a key contributor, but it is the tremendous and diverse team that ultimately makes these achievements possible. These staff members will continue to build on APL's rich history of fabricating and integrating complex systems and leading ground-breaking research in manufacturing science.

J. Todd Ramsburg, Research and Exploratory Development Department, Johns Hopkins University Applied Physics Laboratory, Laurel, MD

J. Todd Ramsburg (retired) was the supervisor of APL's Concept Design and Realization Branch in the Research and Exploratory Development Department. He has a BS in mechanical engineering from the University of Maryland and an MBA from the University of Dallas. He has more than 35 years of experience executing and leading hardware design, development, and integration in defense, aerospace, and telecommunications. For more than 20 years, Todd oversaw APL's enterprise capabilities for mechanical and electrical engineering, design, and fabrication, including the formation and rapid growth of the Laboratory's Additive Manufacturing Center of Excellence. His email address is todd.ramsburg@jhuapl.edu

Danielle P. Hilliard, Research and Exploratory Development Department, Johns Hopkins University Applied Physics Laboratory, Laurel, MD

Danielle P. Hilliard is the supervisor of the Concept Design and Realization Branch of APL's Research and Exploratory Development Department. She has a BS in aerospace engineering from Tuskegee University, an MS in information and telecommunication systems from Capitol College (now Capitol Technology University), and a PhD in technology man-