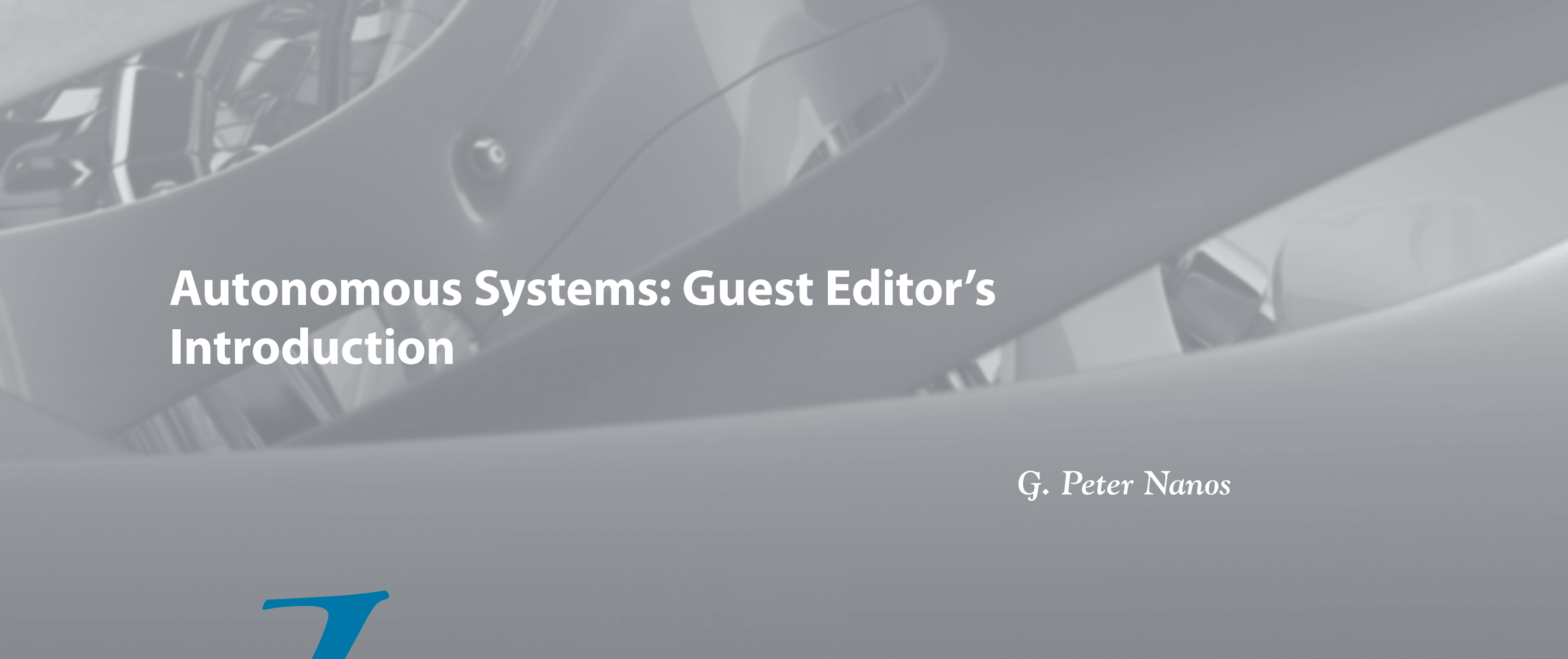

Autonomous Systems: Guest Editor's Introduction

G. Peter Nanos

In the early 20th century, the key elements that determined success in war at sea were the caliber, range, and accuracy of guns; the speed of ships; and the thickness of armor belts. By mid-century, the key elements had become the speed and maneuverability of aircraft, the capacity and number of aircraft carriers, the quality of electronics, and the introduction of nuclear weapons, which, through deterrence, limited the scale of warfare. At the end of the century, the importance of surveillance systems, space systems, precision weapons, and networks had been established. Had the question been asked about land warfare, the progression would have been very similar, with tremendous advances in warfighting capability based on the most modern technologies.

Looking back on the amazing 20th century, it is easy to focus on the details of modern weapons systems, highlighting the microelectronics, lasers, and aerospace technology details and not concentrating enough on the important ideas that are central to our present and future capabilities. It is only by giving these capabilities the credit they deserve that we understand how military need shapes not only the employment of technology but also the prioritization of resources that lead to its development. As pointed out by Jack Keane and Steve Carr in their excellent chronology of the development of unmanned systems, the need for unmanned sensors and weapons was understood very early in the century, when heavily armored dreadnoughts ruled the seas. In fact, the idea of putting machines, rather than people, at risk for highly dangerous missions was so compelling that it resurfaced at periodic intervals whenever new technology gave promise that this fundamental operational dream could finally be realized. Tomahawk and other modern missile systems find their genesis in the first attempts to build and field aerial torpedoes in World War I. Similarly, the recasting of target drones for reconnaissance in the 1950s was the harbinger of the modern Predators that have been employed so successfully over hostile territory for both reconnaissance and strike. These were by no means rapid developments. They spanned 50 to 100 years and were full of false starts, failed programs, and disappointment. It was the compelling nature of the military need that kept the ideas, if not the specific programs, alive until the maturation of technology allowed success.

This issue of the *Johns Hopkins APL Technical Digest* offers a diverse collection of articles that highlight APL contributions to a number of issues being addressed in the modern world of unmanned systems. With the sparse air traffic of the day, few in World War I could have foreseen that ubiquitous use of unmanned systems, coupled with the need to safeguard civil aviation, would require sense and avoid systems as described by Spriesterbach et al. The wars in Iraq and Afghanistan have intensified the development of unmanned ground vehicles for a number of tasks, but none are as urgent as those that bring improved explosive ordnance disposal (EOD) capability to deployed forces. Two papers explore this area: Tunstel et al. discuss their work on improving the ability of human operators to teleoperate robots in remote hazardous locations. Hinton et al. take on the more general topic of system integration by discussing the systems architecture of a family of EOD vehicles.

Of a more exploratory nature are papers dealing with unique modes of locomotion: Grande et al. discuss their work on mapping and control algorithms for a Buckybot. Kutzer et al. explore a mechanism that allows an insect-like vehicle to climb, and then the authors evaluate the vehicle's stability. Finally, there are two papers that deal with unmanned systems with the addition of autonomy: McGee et al. report on the successful result of 8 years of effort to develop and test an autonomous lander for exploration of airless bodies such as the moon or asteroids. Bamberger et al. explore the geolocation of RF emitters using small autonomous air platforms.

It is hard not to be impressed by the breadth and depth of these articles and what they say about the complexity of the field of unmanned systems. It takes a laboratory of the breadth and depth of APL to make meaningful contributions either to the underlying technology or to the fielding of these systems. Judging by these articles, APL is doing both.

As a final note, APL has a burgeoning group of staff members that have become interested in the contributions that autonomy can make to military systems, and they are making important contributions to the field. It should be noted that autonomous systems are on the list of technology priorities for DoD. It is also hard to believe that autonomy, with its promise of cost savings and enhanced capability, will not stay near the top of DoD's list of research and development priorities for a long time. Being able to operate platforms without trained pilots and with simple interfaces to allow intuitive tasking by the operational user provides huge advances in utility but, more importantly, huge reductions in cost by obviating the need for a large number of pilots and other trained operators. That many at APL are stepping up to the critical challenges in this field says a lot about the Laboratory's ability to go where needed. It also positions APL to take a leadership role in what can become the next important idea that drives technology development.

The Author

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