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GUEST EDITOR'S INTRODUCTION

The Laboratory's Engineering and Fabrication Branch (TEO) has a long tradition of supplying quality electronic, electromechanical, and mechanical hardware to a broad range of APL programs. From the early days of proximity fuzes and shipboard missiles to today's combat systems, radars, and spacecraft, the skilled engineers, craftsmen, and clerical personnel of TEO have made significant contributions to the design and manufacture of Laboratory systems. The creativity and extensive expertise of our staff (currently more than 250 strong) have been applied to such activities as submarine detection, ocean physics, biomedical instrumentation, shuttle astronomy, photon and particle detection, space physics, satellite navigation, and reconnaissance. The involvement of TEO in Laboratory programs ranges from small fabrication and assembly tasks (a few hours) in support of prototype development programs to major engineering, design, and fabrication efforts (thousands of hours) for fully configured Laboratory programs such as TOPEX (NASA's Topography Experiment) and MSX (the Strategic Defense Initiative's Mid-course Space Experiment).

The Engineering and Fabrication Branch has undergone an extensive revitalization and modernization program aimed at creating laboratories and other facilities to support current and future APL technical activities. Aspects of this modernization were described in a previous *Digest* article published in 1986.[1] Today, we describe the completion of a major milestone of this program with the final occupancy and daily operation of the Steven Muller Center for Advanced Technology.

The first three floors of this laboratory and office complex are occupied essentially by TEO and were designed as integrated design and fabrication laboratories. The third floor houses TEO's design automation activities, with emphasis on computer networks, engineering design applications, and the creation and management of APL's standard electronic component computer design library. Also on the third floor is our packaging design and drafting group, which provides the bulk of the Laboratory's engineering drawings and performs mechanical and thermal engineering analyses. The TEO test and measurement equipment facility is located on the third floor as well. The second floor houses TEO's new printed wiring board fabrication line, which can produce multilayer printed wiring boards that meet or exceed the requirements of MIL-P-55110D.[2] This fully certified board line will be a cornerstone of future electronic fabrication at the Laboratory. The second floor also includes flight and ground system assembly, coordination and inspection operations, and a fully equipped materials analysis activity with scanning electronic microscopy, energy dispersive X-ray, Fourier transform infrared spectrometry, and a complete suite of mechanical test equipment. The first floor is our completely redesigned and equipped microelectronics facility containing extensive clean room laboratories and advanced technological work space and equipment.

The theme articles in this issue provide a snapshot of the progress made and highlight some of the exciting capabilities and facilities now available in TEO as a result of the construction of the Steven Muller Center for Advanced Technology.

The smooth flow of engineering information from design through fabrication, testing, and qualification is paramount to the success of any engineering development program. In today's modern world, all aspects of design, fabrication, and testing must be integrated and carefully coordinated to achieve a quality hardware product while keeping within the constraints of customer budget and schedule. The TEO Branch has actively been working on many aspects of concurrent engineering to improve product flow while maintaining the high-quality hardware standards that have built APL's reputation over the past forty-eight years. The article by Charles describes TEO's integrated design and fabrication approach while illustrating the key dependence on our new facilities.

The Steven Muller Center for Advanced Technology is a state-of-the-art complex for the development and fabrication of electronic hardware and systems. It includes the latest in clean room technology, laboratory design, and environmental monitoring systems, as described in the article by Wagner et al. An interesting feature of the building is the electronic environmental monitoring system that can monitor status (humidity, temperature, particulate count, gas pressures, exhaust operation) on a continuous basis.

A key to future technology at APL is the effective use of computer-aided engineering (CAE) tools, which provide the Laboratory's engineers with powerful methods for design simulation and testing of their electronic circuits and systems. The TEO Branch has made an extensive commitment to the development of design automation activities focused on the delivery of high-quality

CAE services. Our efforts include managing a state-of-the-art engineering design network, structuring and building an electronic parts library system for use throughout the Laboratory, and supporting advanced engineering tools such as analog and digital circuit simulation. Computer-aided engineering tools help designers throughout APL to create and conceptualize their engineering creations. Once the designs are captured in electronic format, computer-aided design (CAD) tools are used to turn them into board layouts, machine tool paths, and materials and test information necessary to fabricate and assemble the resultant product. The article by Crawford and Lee describes TEO's integrated design automation activity, which supports the Steven Muller Center's system of CAE and drafting workstations (more than fifty terminals), and its massive information distribution and collection network (TEONet, with more than 125 terminals). In addition, the Steven Muller Center is the main hub of the Laboratory's CAE network, featuring more than forty-one terminals distributed throughout the Laboratory.

From the design process, the electronic output of the computer engineering and design tools is fed to modern processing machines. Examples of these machines include the laser photoplotter (located on the first floor of the Steven Muller Center) and computer numerically controlled machine tools, such as those in our central machining area (Bldg. 14)[3] and in TEO's printed wiring board fabrication area. The laser photoplotter can scan a 720 mm × 820 mm piece of film in less than six minutes with a resolution greater than 25 μm. Details of the laser photoplotter are planned to be included in a future *Digest* article on the Microelectronics Group.

The fabrication and assembly of modern multilayer printed wiring boards are described in the article by Feldmesser et al. That article traces the basic operations and outlines the necessary process control to ensure board quality and process repeatability. The fabrication and assembly facility and its internal processes were recently certified to MIL-P-55110D[2] for multilayer boards by an independent testing laboratory.

Key to maintaining certification and development of new organic substrates (boards) to meet future Laboratory requirements will be the proper choice of materials and their associated processes. An advanced materials analysis and development laboratory has been established to provide support in chemical analysis, metallurgical engineering, mechanical properties determination, materials engineering, and composite structures development. The establishment of the Steven Muller Center has provided our materials laboratory with expanded quarters and improved facilities to enhance its service to a growing list of Laboratory users, as discussed in the article by Cohen et al. In a companion article by Vest, the role of materials engineering in the development of high-quality, high-reliability materials for space applications is described. The TEO Branch is the focal point for spacecraft materials certification for the MSX program. Much of the analysis and data reduction from the MSX contamination experiment will be handled by new facilities in the Steven Muller Center.

Quality is the cornerstone of all TEO efforts, and concepts of total quality are rapidly being infused into all aspects of our engineering and fabrication activities. The recently formed Quality Assurance and Materials Group is a leader in coordinating activities related to customer service, including instrumentation calibration and certification,[4] fabrication process control, and documentation configuration management. The article by Coleman et al. describes aspects of the activities just mentioned and discusses the direction for, and emphasis on, a flexible inspection process, which eliminates redundancy and focuses attention on the achievement of product quality by worker involvement, process monitoring, and statistical analysis.

The staff of TEO must be recognized as a key element in achieving overall product quality and technical innovation, both today and in the future. The Steven Muller Center has helped in this regard by providing an excellent working environment; carefully controlled and monitored laboratories; and new resources for training, information transfer, and process and office automation. The Center, with its vast array of modern technical facilities, will allow TEO to move into the future with great excitement and enthusiasm, thus continuing and enhancing its reputation as a quality producer of electronic, electromechanical, and mechanical hardware.

REFERENCES

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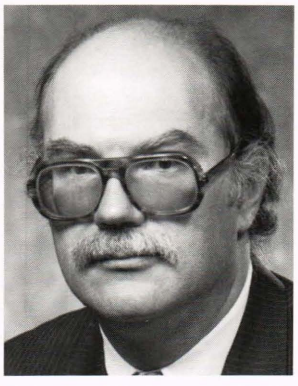

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