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QUALITY ASSURANCE AND CONFIGURATION CONTROL WITHIN THE STEVEN MULLER CENTER FOR ADVANCED TECHNOLOGY

The Quality Engineering and Materials Group of the Applied Physics Laboratory coordinates customer service-related activities in instrumentation calibration, hardware inspection, project coordination, fabrication process control, and documentation configuration management. A strong effort is under way to promote continuous improvement, broader employee participation, and customer satisfaction into the activities of the group. Areas of focus include working with the APL Engineering Board, supporting the needs of Laboratory-wide calibration, and redirecting inspection activities away from product inspection and toward process monitoring and statistical methods.

INTRODUCTION

The Quality Engineering and Materials Group (TEQ) coordinates customer service-related quality assurance activities in the Steven Muller Center for Advanced Technology (SMCAT). These services include instrumentation calibration, hardware inspection, fabrication process control, project coordination, and documentation configuration management. Steps are being taken to incorporate principles of APL's Total Quality management effort—continuous improvement, increased employee involvement, and customer satisfaction—into the activities of the group. We are committed to greater participation in the technical programs of the Laboratory, including assisting the APL Engineering Board, supporting Laboratory-wide calibration, and focusing inspection activities on process monitoring and statistical methods.

In addition, we are committed to the automation of mechanical systems and to the exchange of data and information via networked computer systems. New electromechanical and computer systems are being studied and installed to facilitate the timely feedback of accurate information to our customers. Calibration, configuration, and workmanship procedures have also been developed to promote consistency in the technical and administrative activities of TEQ.

THE CALIBRATION LABORATORY

The Calibration Laboratory is a central facility for the calibration and repair of APL's test and measurement equipment (T&ME) and maintains the traceability of the Laboratory's reference and transfer standards. It also maintains a data system and the documentation required for measurement traceability, out-of-tolerance notification, and equipment calibration recall. A loan pool of T&ME, personal computer hardware, and peripherals is available to all APL staff members. Calibration personnel also provide assistance in resolving unique measurement problems throughout the Laboratory. (Manuals used as guides for the calibration program and other activities discussed in this article are listed in the bibliography.)

The Calibration Laboratory occupies about 4000 ft^2 in the SMCAT and is divided into the following areas: general calibration, standards, loan pool, technical library, and equipment staging. The Standards Laboratory environment is controlled at 23 ± 1°C and 45 ± 5% relative humidity. The remainder of the Calibration Laboratory is controlled at 23 ± 3°C and 40 ± 15% relative humidity.

The specialties of additional APL technical groups, which reside in other departments, are incorporated into the Calibration Laboratory. This arrangement offers a full range of calibration services and standards in two technical areas.

1. Electrical measurements: voltage, current, resistance, capacitance, impedance, time, frequency, power, attenuation, and waveform. Depending on the measurement, a frequency range of 0 to 40 GHz can be covered, and accuracies up to 2 ppm can be attained.
2. Physical measurements: dimensions, temperature, torque, humidity, mass, vibration, liquid flow, force, pressure, and vacuum. Depending on the measurement, accuracies in the ppm range can be attained.

The Calibration Laboratory has developed a semiautomated meter calibration system that can calibrate analog and digital multimeters at the user's location. We use a laser interferometer to perform on-site verification of machine tools and similar equipment (Fig. 1) and an automatic network analyzer system to calibrate RF and microwave T&ME (Fig. 2). This analyzer also provides National Institute of Standards and Technology (NIST) traceable measurements on devices, components, and systems for various APL groups. The RF and Microwave Section participates in the exchange of measurement data with

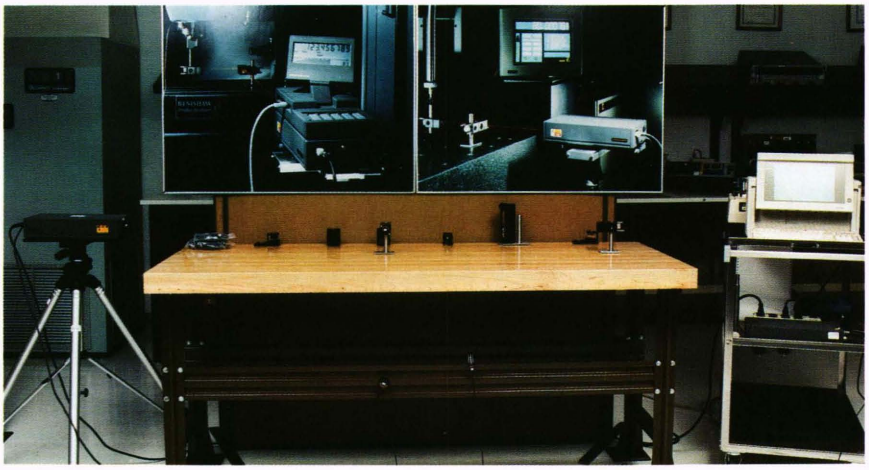

Figure 1. The Renishaw laser interferometer test set-up measures machine tool alignment and calibration.

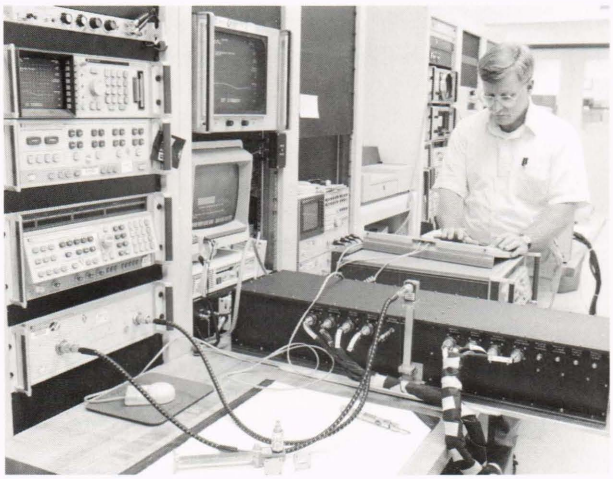

Figure 2. Ku-band microwave transmission unit for the Ocean Topography Experiment program undergoing evaluation.

several companies and NIST to evaluate network analysis abilities.

Statistical methods are used to allow for process control, the determination of overall measurement uncertainty for reference standards, and value predictability. The values of standard cells and resistors are measured to determine drift rates; these ratios are used to predict future values and to compensate for drift between calibrations.

Future plans include the expansion of the Standards Laboratory concurrently with APL program requirements. The Calibration Laboratory continues to monitor the measurement and calibration requirements of the Laboratory and establishes new or expanded services as demands and resources allow. Areas being investigated for possible additions include process control metrology, fiber-optics calibration, laser metrology, and millimeter wave metrology.

We are also developing a local area network to put all automated calibration procedures and results in a single database. This will increase standardization, reduce paper work, and improve data security. In addition, the Calibration Laboratory's Quality Team is actively working on projects to improve the flow of equipment through the calibration process and to inform T&ME owners and users about our measurement capabilities.

PROJECT COORDINATION

The mission of the Project Coordination Section is to provide the technical coordination, staging and assembly of parts kits, and documentation control activities required to support Laboratory hardware programs. Staging activities are associated with the procurement of parts for parts kits, the verification of their traceability, and the collection of associated documentation. Parts kits are a collection of related parts and material assembled during hardware fabrication. These services are offered from inception, through the receipt of released engineering drawings and associated documents, to the point of hardware delivery.

The Project Coordination Section occupies 1500 ft^2 of floor space on the second floor (south wing) of the SMCAT. This location affords ample space for the section office, project coordination activities, parts staging and kitting, documentation coordination activities, and aperture card production functions. (An aperture card is a camera card that contains a photographic negative of an engineering or manufacturing drawing.) In addition, the master tracing and computer-aided design (CAD) tape storage vault is located on the extreme southern end of the second floor. This Class A vault, built to National Fire Protection Association standards, is the only structure of its kind at APL (Fig. 3).

The Project Coordination Section serves as the principal liaison with project design engineers and the various Laboratory fabrication facilities. The coordinator is responsible for releasing the engineering drawing packages and associated documents along with the parts kits required for the fabrication of individual parts and assemblies that comprise the electromechanical hardware built for APL programs. During the fabrication phase of a program, the coordinator assists in technical and administrative problem solving, makes progress reports on request or during regularly scheduled meetings, and keeps abreast of any problems that may occur. The coordinator also helps the customer to follow the published *TSD Hardware Configuration Management Manual*

Figure 3. Technical Services Department/Engineering and Fabrication Branch vault showing the location of magnetic tape and drawing storage.

Figure 4. Staging area depicting parts kitting and assembly.

throughout the course of hardware programs and instructs others in its use.

The parts staging and kitting area receives and procures parts and materials in accordance with the requirements of released engineering drawings and associated documents. These parts and materials are staged (along with any electromechanical details and subassemblies), kitted, and released to the various fabrication areas for assembly (Fig. 4). For example, the parts staging area takes receipt of critical fasteners, distributes them to be inspected and tested, issues them, and maintains records in accordance with APL standards.

Document coordination activities entail the receipt of released engineering drawing packages, the verification of these packages for completeness, and the preparation of drawings for delivery to the project coordinator, who in turn releases them for fabrication. Document coordination personnel receive all documentation to change hardware, verify that revision number sequences have been maintained, and forward copies to the project coordinator, who attaches them to the working drawings in the fabrication cycle. They also maintain and provide filing and retrieval services for the master engineering drawings and CAD tapes stored in the vault, produce aperture cards of the engineering drawings that comprise a completed program, and produce copies of aperture cards on request (Fig. 5). The Project Coordination Section uses various computer programs to produce the task control card (TCC) header entry, TCC opening and closing records, assembly release listings, and the memoranda required as part of the continuous movement of information throughout a hardware program.

Figure 5. Aperture card production. Drawings are photographed and aperture cards are filed for future reference.

Coordination personnel also work closely with other groups within the Engineering and Fabrication Branch (TEO) as new technologies and directions in design and manufacturing are employed. Cross-training in all functions of the section is provided. Members of the section are active in the Quality Teams Program, working on projects that will benefit all groups.

INSPECTION, PROCESS CONTROL, AND CONFIGURATION MANAGEMENT

The primary mission of the Quality Control Section is to ensure that products and services meet customer requirements. This section occupies about 1350 ft^2 in the SMCAT. The area is used for a clean room environment for electronic inspection, documentation configuration con-

Figure 6. Photomicroscope in use at an inspection station.

trol, and section offices. The section allocates its quality control resources between hardware inspection and fabrication process monitoring and auditing.

Electromechanical hardware inspection personnel help the Engineering and Fabrication Branch to verify the reliability of fabricated hardware and fabrication processes. The Quality Control Section has six electronic inspection stations, which are also used by the Space Reliability and Quality Assurance Group of the Space Department and by quality assurance personnel from the Naval Plant Representative Office. All inspection stations are equipped with high- and low-magnification microscopes (Fig. 6). Inspection includes high-magnification video and photographic capabilities (Fig. 7).

Electronic inspection is performed on all fabricated assemblies and subassemblies required by the drawing and other relevant specifications. This may include inspection of stitch weld and wire wrap boards, cables, harnesses, component mounting, conformal coating, bonding, and encapsulation.

Together with several other groups and APL department representatives, the Quality Control Section initiated the development of a comprehensive *Electro-mechanical Hardware Workmanship Standards Manual*. The manual combines quality requirements, specifications, and procedures required during the fabrication of deliverable hardware.

The inspection of fabricated hardware is only one part of a Total Quality Program. With the assistance of the Materials Laboratory and the fabrication groups, a major effort to implement process control is under way to measure, analyze, and report the statistical consistency of fabrication processes.

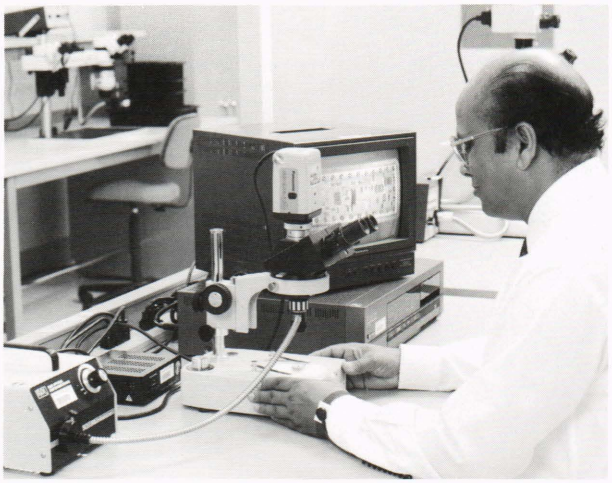

Figure 7. Inspection station with three-dimensional and video inspection capability.

CONCLUSION

The Quality Engineering and Materials Group was reorganized in January 1991 to more effectively address quality assurance issues—issues that are distributed Laboratory-wide and those that are specific to the Technical Services Department. A major effort is under way to build TEQ into a premier quality assurance and materials engineering center for the Laboratory. Personnel from TEQ are instrumental in implementing the Administrative Services Department/Technical Services Department Total Quality Program. Quality assurance in the future will emphasize customer service, continuous improvement, and increased employee involvement.

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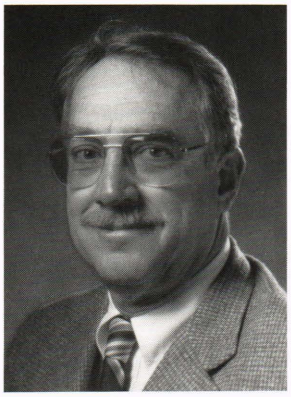
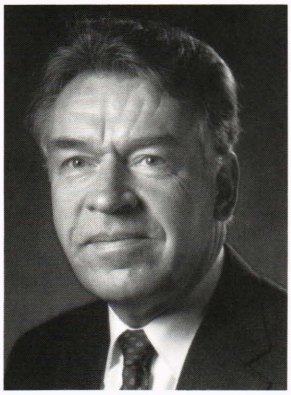
THE AUTHORS



JOHN R. COLEMAN began his career as a metallurgical engineer following graduation from Drexel University in 1962. He served as a Lieutenant in the U.S. Army and worked for Armco Steel Corporation in Baltimore. His career has included assignments to develop melting and processing practices for titanium alloys and stainless steels, quality control, and extensive customer service associated with the application of stainless alloys in the nuclear industry. He obtained his M.S. degree in environmental engineering from The Johns Hopkins University in 1975. Mr. Coleman joined the Quality Assurance and Material Control Group of APL in 1985. In 1986 he was appointed Quality Assurance Group Supervisor.

WILLIAM H. SHAMLEFFER is a member of APL's Professional Staff and Section Supervisor of the TEQ Quality Engineering and Materials Group's Project Coordination Section. He served in the U.S. Navy from 1951 to 1955 and worked at the Glen L. Martin Company (now Martin Marietta) before joining APL in 1968. In 1970, he was asked to organize the Electromechanical Design Section when the original Engineering and Fabrication Branch was formed. He was Section Supervisor for Design Drafting until 1985, when he was appointed Section Supervisor for Project Coordination. He is a member of the Director's Archives Committee, has been active in the Quality Teams Program, and has served as a member of the APL Federal Credit Union Supervisory Committee since 1972.



MARLIN J. JOHNSON received a B.S.E. degree in electrical engineering from Johns Hopkins Evening College in 1975. He joined APL in 1969 and has worked in various capacities for the Technical Services Department's Calibration Laboratory, except for a break between 1980 and 1986 as Metrology Manager of Comsat Laboratories' Calibration Laboratory. He is a member of the Senior Professional Staff and the Project Manager for Metrology and Calibration of the TEQ Calibration Laboratory.

SYED W. ALI received a B.S. degree in quality engineering from the Polytechnic of the South Bank, London, in 1971. Before coming to the United States, he worked for International Computers, Ltd., and Oliver Peel Controls, Ltd., in the United Kingdom. Since 1986, Mr. Ali has been a Senior Professional Staff member of APL's Technical Services Department, where he is supervisor of the TEQ-2 Quality Control Section. Mr. Ali is a quality assurance specialist of manufacturing processes. He has been a member of APL's Quality Teams Steering Committee since 1986. Mr. Ali is a Fellow of the Institute of Quality Assurance, London, Senior Member of the American Society of Quality Control, and a certified quality auditor through the ASQC.

GEORGE L. SKAGGS graduated from the Electronic Technical Institute in Inglewood, California, in 1956. He joined APL in 1971 as a contract employee to establish a dimensional calibration capability for the Calibration Laboratory. He became a staff engineering assistant in 1974, acting Section Supervisor of the Calibration Laboratory in 1980, and Section Supervisor in 1986. He is APL's member delegate to the National Conference of Standards Laboratories and an active member of TSD's Quality Teams Program.