EVOLUTION OF AN ENVIRONMENTAL TEST LABORATORY

PREFACE

"RESULTS OF ONE TEST ARE WORTH MORE THAN 1,000 OPINIONS"

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INTRODUCTION

Environmental testing is defined as the subjection of a physical object or device to external forces, both natural and manmade, to determine operational malfunction or failure of the test specimen.

Natural forces include temperature, humidity, altitude and combinations of these three: rain, sand and dust, salt spray; and others that are unique to a specific geographical location.

Man-induced forces are: mechanical shock and vibration, electromagnetic interference (EMI), electromagnetic pulse (EMP), nuclear radiation, and others associated with handling, installation and maintenance.

The laboratory's ultimate objective was to have the capability to generate, induce, and measure these parameters over a wide range of parts, assemblies and end items.

THE BEGINNING

As far as the authors are concerned, the lab start was in 1954. Vacuum tubes and discrete components were the building blocks of data processing. Products ranged from bore-hole cameras and ore-car weighing devices to large power-hungry processors such as the 1102, 1103, UNIVAC II, FILE COMPUTER and their associated peripherals. The laboratory was located in the original Engineering Research Associates (ERA) building [later designated as Plant 2] on Minnehaha Ave. between Prior and Fairview Avenues. The facility originally manufactured domestic hot water radiators; then during WWII, the plant built gliders used in the invasion of Europe. We were specifically located in

the center rear area of the main building. Rooms were divided by 4-5-foot high wooden partitions with "chicken wire fencing" above. Two 8-foot wide floor-to-ceiling doors opened to the back loading area. Air conditioning was yet to come, so when the doors opened in the summer there entered a blast of heat! Conversely, in the winter cold and snow followed the same pattern. It was not uncommon to arrive at work on Monday morning to find your desk covered with up to half inch of dirt, snow or a combination of both!

Test equipment was rudimentary: high temperature was a small domestic cooking oven, low temperature was a wooden box and dry ice. Temperature cycling was nonexistent. A 500 force-pound sinusoidal vibration exciter [shaker] was housed in a rear annex [chicken house.] Measuring equipment consisted a few multimeters, an oscilloscope and some self-designed apparatus.

The company was under contract with Sperry Systems to manufacture gyroscopes. The plant was located on St. Peter Street in St. Paul. They had a high/low temperature, humidity and altitude chamber manufactured by Bowser Corp. Sperry indicated we could use the unit when not in use for gyro testing. Harold was guardian of the chamber; we would bring test specimens to Harold and he handled the details.

In 1956 the laboratory moved to Plant 3. Plant 3 was a warehouse building located near the southwest corner of University and Prior Avenues. It was winter when we moved in and almost no heat in our area. Sacks of sugar and other commodities lined the office and lab areas since the former tenants were just moving out as we were moving in! Just as we got settled in we had to move out. The entire plant was destined to be a manufacturing facility.

MEETING REQUIREMENTS

We moved into office and climatic lab areas in the west end of Plant 2. This gave the needed room for environmental chambers. We initially occupied the east section where we housed the shock and vibration test units. The vacuum tube era was coming to a close; semiconductors were the name of the game for data processing. ATHENA, the USAF missile guidance system, and the AN/USQ-17 Navy shipboard operational control units, were being built. Environmental test requirements were specified by USAF's MIL-E-5272A and the Navy's MIL-E-16400. Other specific requirements, referenced by these documents, could be imposed depending on unique environmental conditions that the hardware may encounter. These documents were the main drivers to get a certified test facility on line.

Over a period of a couple years a high-low temperature humidity walk-in chamber and several smaller high-low temperature chambers were procured. Also, a 5,000 force-pound shaker and a Navy medium weight mechanical vibration system came on board. Later we built a sand-drop shock system and acquired a Navy light weight shock machine. Some environments which were not considered feasible, because of test equipment cost, were performed at Environ Laboratories, Northern Ordnance, and American Petrochemical.

Missile guidance systems required other types of shock and vibration tests. These necessitated wide band input levels. To meet these different stress levels, we acquired a hydraulic shock system and a random vibration exciter. Also, with advent of the Soviet Union cold war the need arose for measurements of system level radio frequency emissions. There was a distinct potential of strategic information recording by the enemy. Enter FED-STD-222 as the primary directive for reduction/elimination of this information. A test chamber completely enclosed with metal plates and necessary measurement apparatus was procured. We were now in the counter-espionage business!

FULL CAPABILITY

Although testing of parts and subassemblies continued, the principal action was at the main assembly and system level.

Qualification testing of the NTDS equipment family was oftentimes stressful. High temperature-humidity tests of the CP-642A and CP-642B computers, the Keyset Central, the Keyset Universal and the Paper Tape Unit required that the test operator enter the chamber at regular intervals at +50 degrees C with 95% relative humidity to run operational tests. Limited testing was done on the CP-667 computer before the Navy decided to not issue a production contract. Two other computers, developed for Navy applications, were also qualified - the 1218 and 1219.

We were active in qualification testing for a series of airborne automatic antenna couplers. Testing was performed on couplers for the Boeing 707 jetliner, KC-135 USAF jet tanker, and the VC-137 cargo aircraft. We also performed environmental qualification testing of couplers for the P-3C surveillance prop-jet and the Hughes Aircraft (HACON) "B-58 hustler" supersonic bomber. High impact shock, random vibration, and high altitude were performed in addition to the other natural environment tests.

The Marine Corps MTDS heli-huts, transported by helicopter under battlefield conditions, housed a CP-808 computer, a 1532 Paper Tape, and a 1540 Magnetic Tape drive. Since the huts were lifted, dropped and transported over rugged terrain, important tests included shock and vibration. Huts were tested at St. Paul, Craig Systems, the hut manufacturer, and Aberdeen Proving Grounds. Tests included "railroad humping" and the infamous "Munson Road" test which entailed mounting the hut on a 2.5 ton military truck and driving at prescribed speeds over irregularly spaced "Belgian Blocks." The MTDS system passed this test, although the truck transporting the hut sustained major damage!

During the 1990 to 1995 period, Defense Systems Division's name went from Unisys to Paramax, back to Unisys, next to Loral, and finally to Lockheed Martin. The lab was moved from Plant 2 to the sub-basement of the Eagan building [Plant 8]. Since floor space was limited, not all of the test equipment was retained. Vibration exciters,

mechanical shock, temperature/humidity, altitude, and RFI/EMI capabilities were installed in Plant 8.

Design of products to meet customer requirements changed from a "start to finish" mode to making necessary changes to "commercial off-the-shelf' (COTS) units to meet environmental conditions. Qualification testing of COTS proceeded virtually unchanged, since use environments remained intact. Evaluation testing is more quantified as project design engineers require more detailed data needed to redesign for specific deficiencies.

Since neither of the authors has been associated directly with the laboratory for several years we believe that current operation is, in general, as previously described.

EXTRACURRICULAR ACTIVITIES!

Some occasions arose where we tackled jobs that weren't purely in the environmental testing realm. Because of certain employee qualifications and unique physical apparatus we took on several special engineering activities. Two of these come to mind.

1) In the '70s we were working closely with the Sperry Long Island group that used UYK-7s in a sonar development project. Two medical doctors [friends of individuals in the Sperry group] had financed development of a special diathermy device. The machines, when put in use, produced spurious radio interference well in excess of FCC specifications. Sperry requested that we review the design with the objective of reducing the radiation to an acceptable level. Other than human muscle treatment, we heard the doctors had thoughts of using the device for aging wine and aiding in circumcision surgery. Some circuit redesign, shielding and filtering improvement were accomplished with a reduction in radiation. In spite of our best efforts, we failed to meet FCC specifications. We felt that a major redesign was needed and should be performed by RF design specialists.

2) On July 6, 1972, a fire occurred aboard the Navy carrier USS Forrestal while the ship was docked at the Naval Operating Base at Norfolk, Virginia. The fire occurred in the Admiral's quarters, which was in close proximity to the computer bay. Navy fire crews were brought in to fight the fire. Salt water was used on the fire without regard to the quantity or its effect on equipment in areas not directly affected by the fire. Investigation revealed that the computer bay hardware was seriously degraded by fire, smoke, heat, and salt water. Equipments were standing in approximately two feet of salt water for two days. Removal of system elements was performed by naval personnel with little regard for handling sophisticated electronic hardware. Main frames, chassis, modules and cabling were unloaded and piled in random dockside locations. This modus operandi inflicted secondary damage to that of the fire.

Cmdr. Eric Swenson, an initial member of the Navy NTDS development team, was assigned to review the overall situation. After examination of the damaged equipments he decided here was an opportunity to see if this ruggedized hardware could be refurbished to full operational condition. The logical choice for the job was Univac. Engineering and Manufacturing were contacted, but neither showed any interest in taking on the challenge. After a short meeting with the Commander, the Test Lab took on the challenge!

The damaged computers and associated peripherals were shipped to St. Paul and housed in the mechanical test area of Plant 2. Detailed examination of all modules, assembles and main cabinets was performed and disposition determined. We determined that nine of the ten major items could be refurbished. Eleven minor items (teletypes, tape readers, keysets, etc.) were severely damaged and scrapped. Major items were disassembled to the lowest module level. Modules and subassemblies were washed in water with a non-corrosive detergent to remove smoke and salt residues. Main frames were sprayed with the same detergent, rinsed with distilled water and dried in a walk-in temperature chamber. Modules, chassis, cables and main frames were functionally tested prior to total assembly. Reassembled units were powered up, diagnostic and operational software programs were run with any malfunctions noted and corrected. Units were then operated for approximately 40 hours to shake out any remaining discrepancies. Design and Field Engineering personnel aided in bringing these units up to their full operating condition. PX-10630 is a detailed report of this refurbishment operation.

Successful completion of this major refurbishment contract led to the establishment of a central department, located in Plant 2, to perform refurbishment of early and current NTDS hardware.

ACKOWLEDGEMENT

From a four-man staff and manual facilities to a fully functional environmental operation, the Lab's engineering, technical and support individuals were the key to making the Laboratory a professional entity. Noted below are some of the men and women who contributed to making our testing department successful over 40+ years of operation.

Brown, Bob
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ENHANCEMENTS TO CAPABILITY, 2000 - PRESENT:

We expanded laboratory floor space by adding 5400 sq. ft. The Electro-Magnetic Interference shield room also houses 10 ft x 20 ft reverberation chamber for high level susceptibility testing. In addition to the capabilities mentioned above, the Environmental Test Laboratory has the capability to test Ships Motion and Attitude, Drip, Airborne and Structureborne Noise, and has also added the capability to replicate shock responses generated during Mil-S-901 heavyweight barge shock testing on payloads up to 300 lbs including the fixture. In the near term a larger machine is expected to be installed that will shock test payloads up to 2,000 lbs including test fixture. Thanks to Paul Carlton for this paragraph and acknowledgement of recent support staff.

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FINAL NOTE

The authors hope that this document provides the reader with some insight into the development of a facility that was instrumental in making UNIVAC known as a leader in supplying its customers with very reliable state of the art products. The Laboratory continues to operate under Lockheed-Martin's direction with the same objectives and confidence to fulfill customer needs and requirements.

Paul 15 APRIL 2008 *Bob*

AUTHORS

Paul Welshinger graduated from the University of Minnesota in 1950 with a BEE degree. Upon graduation, he worked for a small hearing aid company in Minneapolis and later for federal Cartridge Corp. He joined Engineering Research Associates Division of Remington Rand Corp. in August 1954, badge # 2408. During his tenure he held positions as Manager of: Design Support Operations, Quality Assurance [vendor Surveillance], and Integrated Logistic Support. Paul retired in 1986 after 32 years of employment.

Bob Keenan graduated from the University of Minnesota in 1956. Following two years in the military service he joined the environmental test lab at Remington Rand Univac in 1958. He continued in the same department through eight name changes of the company, retiring from Lockheed Martin in 2001.