ATE EVOLUTION: HOW WE SLEW THE ATE GIANT

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ABSTRACT

TISTE has been developing Test Program Sets (TPS's) for Shop Replaceable Units (SRU) to be used in our repair depot since the mid seventies. Since that time, the business has evolved from using specialty testers to using large multi-purpose testers to the present use of several small testers. This paper will discuss how and why the small tester concept was implemented and how it has worked in our Section.

INTRODUCTION

Automatic Test Equipment (ATE) has been defined as electronic test equipment that may be programmed through an embedded computer to perform a sequence of actions. This definition encompasses everything from Built in Test (BIT) on a circuit card to a room full of equipment required to evaluate the performance of the weapon system.

In the late 70's and early 80's the prevalent ATE philosophy was "the bigger the better". Consequently we were saddled with test systems which were designed to test limited types of circuit cards and which were not flexible enough to handle cards from other workloads. Some examples of this are:

- The GenRad 179X series tester was developed to test digital circuit cards and installed in 1975.
- The AAI 5565 Tester was developed for testing the analog circuit cards and installed in 1978.
- The KMT (Kelly Microwave Tester) was developed by SA-ALC to test the radio frequency circuit cards and installed in 1978.
- The KPST (Kelly Power Supply Tester) was developed by SA-ALC to test power supplies and their circuit cards and installed in 1978.

This resulted in a large number of specialty testers with unique instruments, operating systems, instrument interfaces, and nonstandard user interfaces. These systems were difficult to learn, maintain, and use.

The Air Force solution to the specialty tester problem was the massive do-everything multipurpose system. These systems combined instruments from the RF, Microwave, Digital and Analog domains in the hope that every possible card from any type of support equipment drawer could be repaired on these systems. Most of the systems were based on the Modular Automatic Test Equipment (MATE) concept.

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All of the MATE ATE at SA-ALC is basically rack and stack analog ATE with varying degrees of digital capability. Examples of these are:

- B-52 MIDATS
- B-1-B IATE
- AN/USM 607
- A10 IATS
- AN/USM 603
- B1-B DATSA

In addition to providing support for all of the above systems, some of them were also utilized for TPS development. It should be noted that we were never fully convinced that using these systems for this purpose was the best alternative.

ATE SUPPORT PROBLEM

SA-ALC/TIST's main mission is ATE support. Our Section's primary goal is to develop organic capability for the different ATE. This is accomplished mainly by developing TPSs for circuit cards out of the supported ATE. In the mid 80's we realized that by developing circuit card level TPSs we did not support the whole system. This lack of system support gave birth to the Integrated Maintenance Process (IMP). The IMP was a process by which we accepted the task of supporting all of the ATE hardware and self-test software, except for the computer and its peripherals. This support required the ATE and its software development station to be provided to us. Expertise was thus developed by hands-on training on the ATE and software development station. As the expertise was accumulated, Tester Replaceable Units (TRUs) or Shop Replaceable Units (SRUs) were repaired using the ATE as a mockup. The IMP task was later further refined to include targeted TPSs for high-failure rate TRUs or SRUs. If a certain TRU or SRU had a high failure rate, this item would have a TPS developed for it. As the IMP process matured, management saw a need for developing a tester dedicated for interim repair of TRUs and eventual TRU TPS development for depot repair efforts. This idea gave origin to the in-house design and development of the TRU Testbench to support the on-going systems support projects. As the IMP evolved, most of the TRU TPS development was now done on the TRU Testbench, while all SRU TPS development was done on the GenRad 2225 testers because of their low cost and availability.

NEED FOR SMALL TESTERS

The first group of GenRad 2225 testers was acquired at a relatively low cost to the Section. These testers were available in our supply system. The GenRad 2225 proved to be an excellent troubleshooting tool. The tester was introduced to the depot repair personnel as a possible circuit card tester. The GenRad 2225 was accepted with great enthusiasm. It could be set up on a work bench and plugged in to a common wall socket. Its execution run time was in minutes and very user friendly.

The next step was to meet with the ATE Program Manager and ask for their input. Of course they were very supportive, especially since the GenRad 2225 was not incurring any costs. The Interface Test Adapters (ITAs) could be built in-house, since no active components would be required. A complete TPS could be produced within six months or less. The small tester was, therefore, accepted and the demand was created.

ESTABLISHMENT OF THE SMALL TESTER GROUP

The IMP created the demand for TPSs to be developed on the GenRad 2225. A couple of TPS programmers were set up in an area to develop TPSs that had been started in the IMP. Then ATE circuit cards, not in the IMP, started to be transferred to this group. As more and more circuit cards...
were transferred to the Small Tester Group (STG) the need to produce TPS's in a more cost effective and efficient manner became apparent. Digital simulators and PC based Genrad 2225 software emulation packages were investigated and selected with this in mind. The incorporation of the new software into the STG increased productivity significantly and had the side effect of increasing the demand upon the STG to produce more TPS's.

GROWTH OF THE SMALL TESTER GROUP

The demand for ATE circuit cards to be transferred to the STG increased because of the low cost per TPS and the fast turn around. This increase in work created some unforeseen problems. One of the problems was our inability to handle circuit cards with microprocessors and other sophisticated circuitry on the GenRad 2225. This problem was solved by the incorporation of the Fluke 9100A Tester to target circuit cards with microprocessors and associated circuitry. The STG then decided to look into the next generation of small testers and decided on the Schlumberger S645 Combinational Test System. The STG was no longer just a GenRad 2225 group.

THE SMALL TESTER GROUP

The acquisition of small test systems has impacted very positively on the way we perform TPS development. By putting together a group of small testers, we have evolved something we now call the Small Tester Group. Making these small test systems attractive are their relatively low cost, reduced long term support cost, decreased training time, and small footprints. All these factors, put together, have minimized the overall tester acquisition costs while maximizing our test capabilities. Some of the small testers challenge even the larger test systems. With specifications such as programmable pattern rates of 20 Mhz, 500,000 uncompromised test vectors in a single test, and +/- 12 volt drive and sense capabilities at all driver sensors, the challenge is met and in some cases surpassed.

Additionally, by incorporating digital simulation, microprocessor emulation, and dynamic mixed-signal testing, the STG now offers low cost functional TPS development with excellent fault diagnostic coverage. This is accomplished by using in-circuit as well as functional testing with guided-probe and fault dictionary diagnostics. The use of small testers, in our experience, has not degraded our test capabilities in the slightest. We have extensive experience with large million-dollar ATE, but we have determined that many of the expensive features found in large ATE, while nice to have in design and production situations, are hardly used in depot environments.

HIGH COST ATE

One of the major faults with the acquisition of high cost ATE in this ALC or other ALC's for that matter, is the fact that upon procuring one, a second system must be procured for the repair shops or machine time has to be shared with production. Now, the acquisition costs doubled or the schedule is lengthened. This is what makes the small systems very attractive and have proved to be the affordable rivals of the million-dollar systems at a fraction of the cost.

IMPACT OF PC-TECHNOLOGY

Recent advances in PC technology now allow low-cost ATE to have as much computing power as their larger
counterparts. Small testers are not by any means a recent phenomenon. As a matter of fact, one of the small testers we use today was first acquired in the late seventies. Although these have been around for a while, they were not generally accepted by programmers because they were rather primitive compared to modern ATE. In our own depot activity, they were mainly used for the repair and troubleshooting of circuit cards. What changed the scenario was the ability to interface these systems with the PC. The tremendous growth of the PC and its related software in the last 10 years has greatly enhanced the capability of the small tester. This has given ATE hardware the capabilities and ease of use which has made the small tester a versatile and effective ATE for most, if not all, our electronic exchangeables workload at this ALC. The significant value the PCs now provide cannot be discounted. Small testers have now become instantly sophisticated enough to rival the performance of bigger systems. The PC, as part of instrument control, and coupled with iconic graphical programming has transformed our jobs from the unstimulating to the exciting. Programs such as LabView from National Instruments, WaveTest from Wavetek, and HP Vee from Hewlett Packard, lets you create visual objects or icons, linking them as in a block diagram to create a program, rather than using traditional high-order languages and their inherent tedious environments. Now, the PC is a major force in data acquisition and instrument control applications, largely because of its versatility and low cost.³

SMALL TESTER ADVANTAGES

A last, but certainly not the least factor of significant importance to consider, is the small footprint small systems present and the value added because of it. Transportability, space requirements and connectivity, and the fact that more engineers and technicians can be productive at any given time for basically the same investment, are some of the significant advantages. To appreciate these benefits added by small testers, you really have to experience the acquisition pains of the million-dollar systems. Then, if you thought the pain would end with the acquisition, think again. Your worries have just begun. Think about finding a large space, think about applying the correct input power, think about long training curves, and the logistics of tester availability and you will most likely end up with a million dollar headache. Admittedly, some of these problems are shared with small testers, but the requisites are a lot less, and so are your headaches. With the low cost ATE acquisition, quick system deployment, short learning curves, and reduced test program development time, we can provide the necessary combination of capabilities to maximize automated testing at a very effective logistical cost.

SMALL TESTER GROUP SYSTEMS

GenRad 2225/35

The GenRad 2225/35 has been our compact table-top digital workhorse. By coupling the GenRad 2225 with PC software like Digital Test Link (DTL), we came up with a powerful digital test system that is easy and almost fun to use. The DTL package is a menu-driven package that provides many software tools for the programmer to use while developing and debugging test programs. DTL also incorporates a high speed full-featured text editor that has proved to be popular.

with our programmers.

**Fluke 9100A Digital Test System**

The Fluke 9100A covers our microprocessor-based and ROM/RAM circuit card requirements. It affords us the capability to test and troubleshoot digital circuitry with support for over 50 microprocessors from 8 to 32 bits. With the additional programming station, we can develop customized functional and troubleshooting TPSs. The TPS design features are highly automated, guiding the programmers through the development process. The heart of the testing approach is a technique used by Fluke called Emulative Testing. It was so named because the tester emulates the microprocessor kernel circuitry on the UUT, therefore testing the boards from the inside out. Additionally, a single-point probe and two types of I/O modules allow the testing of circuitry beyond the kernel. All these capabilities allow us to test microprocessor type circuitry at a much greater level of confidence than ever before.

**S-645 Schlumberger FaultFinder**

The S-645 is an integrated combinational tester selected because of its versatility and compatibility with our existing GenRad 2225 Systems. It has turned out to be a very affordable and adaptable Test System that works well. The 20 MHz functional pattern rates of the S-645 can handle many of today's and tomorrow's technologies. It can test and diagnose most of our difficult and complex boards and devices by using both in-circuit and functional capabilities supplemented by the fault-dictionary and signature-learn features. One of the best liked features is the advanced software user interface that allows the use of simulation data, software translators for the GenRad 2225 and a suite of comprehensive in-circuit troubleshooting and testing tools.

**TRU Testbench**

The TRU Testbench is another member of our small tester group. Essentially, as the name implies, it was developed to handle Tester Replaceable Units. It was designed and built locally by TIST engineers and technicians to support the A-10-IATS, DATSA, USM-607, USM-603 and MIDATS test systems. It incorporates general purpose rack and stack General Purpose Interface Bus (GPIB) capable test equipment which was selected to provide the widest possible capabilities while occupying the smallest possible foot print. All software used in the development of TPSs and testing and repair of UUTs was developed in-house and tailored specifically for use by shop personnel. Eleven systems have been built to date and are actively used in TPS software development and the testing and repair of UUTs. The Testbench, as a whole, provides an integrated test system which was designed with the end user in mind. All software applications are presented to the operator through an easy to use menu system which provides on-line help for each application. These systems have proved to be reliable and very popular with the users. They are low cost and have very short learning curves, which makes them an ideal alternative to large test systems.

**CONCLUSION**

The challenges facing the Air Force have been compounded by tighter budgets, new competitiveness, and hiring restrictions. The Air Force's ability to support the newer weapon systems with less dollars will be put to the ultimate test. How we solve these problems may very well determine the very future of this ALC. Either we perform our jobs more cost-effectively or let our competitors do it for us. This and other considerations will have a direct impact on the
maintenance management, and the effectiveness of meeting our commitments competently and cost effectively. This in essence, will determine which ALC will survive future cutbacks.

Our contribution to the solution might very well be the STG. The STG is a concept that will continue to be an important asset to this ALC. It evolved into prominence because of a need a few years ago and has proven to be a profitable solution to the high cost ATE questions. PC technology has, without a doubt, impacted small testers in such a profound manner that small testers can now be considered for their low-cost, ease of use, small footprints, and versatility. But it is the versatility factor that makes the small testers really stand out. The fact that more technicians and engineers can generate more TPSs at a relatively low cost is what gives the small testers a big advantage over the giant, ultra-expensive, do-everything systems. The "slaying of the ATE giant" through the use of small test systems may have occurred in this ALC at just the right time, in this age of budgetary constraints.