The Modern Maintainer ...Force Multiplier or Achilles Heel?

From "humanitarian aid, to peace support, to operating in a sophisticated warfare environment," the success of today's military operations depends on trained personnel effectively operating modern equipment and systems.

Military planners develop their deployment and engagement strategies assuming that the assigned systems will function properly when used in theatre.

It is taken for granted that the maintenance staff assigned to the operation are fully trained, proficient and have the intimate and detailed knowledge needed to ensure that all systems are available and fully functional when required.

Ensuring that technical staff are proficient and able to quickly and accurately complete preventative and corrective maintenance tasks, requires the establishment of a training and support environment that is available and effective throughout the technician's carreer. The solution must satisfy a work environment that is impacted by the following factors:

- The systems and equipment in-service will be very reliable, maintenance action will be infrequent, and maintainers will require continuous refresher training to counter "cognitive skill fade."
- The number of assigned maintenance staff will decrease, and fewer staff will have proportionally more systems assigned to them.
- Replacement systems will be more fully integrated, have more functionality and be more complex than the systems they replace.
- Maintenance staff will require "system level" knowledge and skills to effect system repairs.
- The complexity of new components will severely limit "component level" in-theatre repair actions.
- System software knowledge will continue to grow in importance and impact.

Modern, technically sophisticated military systems require a fundamental change in the way that maintainers are trained and supported. Training strategies must now accommodate ab initio (initial), regenerative, just-in-time, and regular refresher training. Support strategies must provide the technician with the ability to quickly and accurately access information needed to perform a task while doing it.

The allied governments and agencies that are considered the most advanced in their efforts to properly support their technical personnel are all incorporating and/or experimenting with the combined use of web-based inter-active courseware, Synthetic Maintenance Trainers, and Electronic Performance Support Solutions as the key components of their maintainer training and support environment. The leading "practitioner" nations have formed the International Maintainer Trainer and Performance Support Group and meet bi-annually to share lessons learned, provide insight into new initiatives and to explore the potential of collaborative projects.

The U.S. Naval Personnel Development Command is currently procuring web-based interactive courseware projects that incorporate interacticve courseware, free-play simulations of the target system / equipment and adaptive learning algorithms. This system allows authorized personnel to access the trainer via the web and take a proficiency test by performing an operational and/or diagnostic activity in the simulation. The students' actions are automatically monitored and analysed, and if the student successfully demonstrates proficiency, a message is automatically forwarded to his/her electronic training file, crediting them with this skill. If the student is unsuccessful, the adaptive learning algorithms automatically present an individualized course that is targeted at their demonstrated deficiencies. This environment is expected to reduce training times by 70% to 80%.

Nations such as Canada, the United States, the UK, Japan and Norway now acquire Synthetic Maintenance Trainers in lieu of actual equipment for their training schools. This technology was originally developed in Canada in 1992 and was an off-shoot of the Canadian Patrol Frigate project. These trainers allow technicians to interact with a synthetic model of a system anywhere and any time they have access to a computer. The simulations include representations of the system, a certified Fault Library and models of the tools and test equipment used to diagnose the system. These PC-based free-play graphical representations of systems and equipments have been independently proven to: improve maintainer proficiency by 200%; significantly lower both capital acquisition and through-life support costs; reduce training time by 30-70%; can effectively support both mentored and learner-centric training environements; and, when deployed to the worksite, can sustain a high-level of maintainer proficiency throughout their careers.

Technicians have historically been provided with Technical Manuals – designed as Engineering Reference Manuals – as their primary source of technical and procedural information. These documents are not designed as on-the-job performance aids, are frequently illogically structured to support a maintenance task, and include voluminous information that is not required by a maintainer.

To improve on-job support provided to technicians, countries such as Canada, the United Kingdom, France, Germany, and the U.S. have experimented with the introduction of Electronic Technical Manuals and Interactive Electronic Technical Manuals. This was a positive initiative, however, ineffective navigation

schema usually resulted in condemnation of the product.

Recent efforts have focused on an electronic aid that is specifically designed as an on-job performance support aide for a maintainer. These support tools are referred to as Electronic Performance Support Solutions (EPSS). Based on the results of the early prototype test and trials, the *Joint Strike Fighter* and the UK *Type 45 Destroyer* have specified the delivery of EPSS for their projects. The U.S. Coast Guard Performance Technology Center has reported increases of 300% in technician speed and accuracy for maintainers supported by an effectively designed EPSS.

If maintainers are to remain a "Force Multiplier," they must be provided with a training and support environment that allows them to acquire and practice their skills without depending on access to actual equipment or being provided with frequent and diverse system failures. The solution is to provide access to: an on-line learning environment; free-play models to practice their skills; and EPSS solutions to provide rapid and accurate access to technical information and procedures.

The Military Maintainer and Maintainer Training

Do we still need maintainers in-theatre? The simple answer is "yes!" Military forces deploy away from "friendly" support organizations and need to have organic technical support.

We have witnessed a steady transformation of the military maintainer from a highly skilled craftsman to a system specialist. The training and support infrastructure needed to produce and maintain these individuals also transformed over time to ensure that the maintainer could proficiently and quickly repair the equipment and systems needed by the soldiers, sailors and airmen. Within the last century we have seen the maintainer and their associated training regime transform...

– **from a skilled craftsman who made individual parts and components from raw materials.** They spent years as an apprentice to a master craftsman to learn to produce what was needed. Skill proficiency was maintained through continual work.

– **to a skilled technician who repaired components and replaced parts.** This generation was sent to school to learn the theory of how the parts individually worked and how they interacted when connected together. An electronics technician, for example, learned how to diagnose and replace defective electronic tubes, solder resistors, capacitors, and chokes onto circuit cards, adjust potentiometers, and measure voltages. The training included practical experience in a lab environment and on-job training under supervision. Skill proficiency was maintained by the requirement to complete frequent repairs.

– **to a skilled maintainer who replaced components.** This generation of maintainer spent long periods of time at school to learn the theory of individual equipment operation and maintenance procedures. The technologies in weapon systems had evolved to a point wherein it was beyond the ability of a maintainer to fabricate most of the system components. These maintainers, for example, replaced circuit cards, cables, connectors, pumps, and hydraulic lines; and could complete individual subsystem diagnosis and repair. Training included a limited amount of time practicing maintenance tasks on actual equipment in a lab environment,

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and included on-job training under supervision. Skill proficiency was maintained with difficulty by the requirement to complete only occasional repairs.

– to a current day, skilled system specialist who occasionally replaces components and assemblies. This generation of maintainer spends long periods of time at school to learn the theory of integrated systems operation and maintenance procedures. These system specialists resolve software conflicts, re-boot and re-configure systems, replace circuit cards, fuses and components; and interface with embedded monitoring systems. Skill proficiency can only be maintained with frequent access to off-line training systems and support tools.

Why Historical Training Methodologies will Fail

Achieving and maintaining an acceptable level of proficiency requires the maintainer to practice their cognitive diagnostic skills on a frequent basis. The old adage "use it or lose it" is as applicable today as it was yesterday! Modern weapon systems and platforms are being fielded with very high Mean Time Between Failures.

The historical training model includes: classroom instruction of system theory; a minimal exposure to fault finding on the actual equipment; and then responsibility for operational system maintenance. This model depends on frequent system failures to provide the maintainers with sufficient opportunity to develop their maintenance proficiency.

The Solution to Training and Supporting the Modern Maintainer

What is now required:

1. The Theory of Operation and Maintenance must be taught.
2. Students need to practice their new skills in an environment that allows for immediate feedback from an experienced maintainer (instructor).
3. On-Job-Training / Maintenance Tasks.
4. Regular Refresher Training.
5. Immediate access to technical information and data "as and when needed."

The Proof

Independent tests and trials have shown that the combination of Synthetic Maintenance Trainers and Electronic Performance Support Systems have significantly:

- Reduced course lengths
- Reduced training costs
- Increased student proficiency
- Increased exposure to Fault Scenarios
- Minimized or eliminated post-training skill-fade
- Improved maintainer capability and system operational availability

Maintainers of modern systems need to be trained in Synthetic Environments and supported by effective Electronic Performance Support Systems or they will lose their skills and be rendered ineffective in their jobs. FL

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Maintaining Technical Proficiency

Those responsible for effective system operations frequently make the erroneous assumption that the technical staff are knowledgeable and proficient. This assumption exists because historical experience suggested that, once trained, a technician would only get more proficient and competent with passing time.

That used to be true. Technicians responsible for older, failure-prone technology with frequent opportunities to diagnose and repair their assigned systems, could be trained and – from a training perspective – forgotten about.

However, from 1980 to 1990, a series of changes in our environment were converging and causing a profound impact on the support requirements for the new systems and equipment being acquired. Some of the influence factors included:

- The migration from analogue to digital electronics was dramatically increasing system reliability and reducing the opportunities for technicians to interact with the technology.
- Adoption of quality programs and more attention to design redundancy and reductions in Mean Time to Repair.
- The increasing sophistication in the design of mechanical systems, coupled with the use of advanced metallurgies, caused a migration from component repair to Line Replaceable Unit replacement.
- Budget pressures caused organizations to assign more systems/equipment responsibility to fewer technical staff.
- New technologies were more integrated, software became a more prominent component and system-level knowledge became a requirement.
- The number of procedural steps involved in system operation and maintenance increased substantially.

In the world of technical training and support, the "train and forget" model that had served us well in the last century was now dangerous and out-moded.

It was apparent that technicians that were assigned systems that either did not fail very often or were infrequently in operational use, progressively lost their knowledge and their proficiency. It became evident that major changes to the technician training strategy, and to their on-job support environment, was needed.

Today it is recognized that a modern training strategy must be structured to be available in both mentored and learner-centric environments. It must be suitable in the classroom and effective as an on-site, post-schoolhouse skill refresher. The support environment must be structured to provide the maintainer with enough technical information needed to perform the task of the moment.

Like their operational colleagues, a modern maintainer will learn and practice their skills in a simulated environment and will be supported with electronic on-job performance aids. ■