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INTEGRATED MAINTENANCE INFORMATION SYSTEM: AN IMAGINARY PREVIEW

By

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AIR FORCE SYSTEMS COMMAND
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This paper has been reviewed and is approved for publication.

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This paper describes how a typical maintenance technician in a few years might use a well-integrated maintenance information system. The system is envisioned as having a local (base-level) computer tied to a central computer at an Air Logistics Center. The local computer would provide information for shop (intermediate-level) and flight-line (organizational-level) maintenance. It would drive on-the-job training as well as provide technical data for performance of maintenance tasks and accomplish many record-keeping tasks. An on-board computer also would be used in conjunction with up-to-date information provided by the local and the central computers. Special provisions would be made to assure the acceptability and useability of the system to the technician. If such a system is to materialize, it must be planned now; and, planned as *one* system. If prompt action is not taken, many

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uncoordinated systems may be developed. The envisioned system would not only improve maintenance, but it may be a necessary condition for effective maintenance under combat conditions.

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INTEGRATED MAINTENANCE INFORMATION SYSTEM: AN IMAGINARY PREVIEW

PROLOGUE

The hour just before dawn is dark, with just a promise of the light to come. The flight line, packed with remotely piloted vehicles (RPVs), is slowly coming to life. Small vans are fanning out from the maintenance building. They will transport maintenance technicians to the scheduled aircraft.

Sgt Bayshore is crew chief of RPV #007. She is just preparing to preflight her RPV for a mission. Let's look over her shoulder as she works.

ACTION

Checkout Guided by Cartridge And On-Board Computer

Unfastening a panel on the left side of the fuselage, Sgt Bayshore exposes the control and display panel for the central computer system. She inserts a small cartridge, then turns on the aircraft battery power and punches a button marked "Preflight System Checkout."

Turning, she begins her visual inspection of the airplane. Finding nothing wrong, she returns to the panel where the navigation correctional unit is identified as being in a deteriorated condition.

Computer-Based Maintenance Information/Instruction

By selecting the appropriate button, she quickly receives additional specific information about the deteriorated condition. She agrees with the recommendation of the computer to remove and replace (R&R) the unit, so she requests R&R instructions. She finds that the task is assigned to the crew

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chief, so she identifies and opens the appropriate panel and quickly removes the unit. The panel is now flashing a warning in red that the navigation correctional unit is removed.

Computer-Based Request for Spare

Taking a small wand from a small radio device on her belt, she passes it over the supply information displayed on the screen. Thus, she places the requirement for a spare with the local supply center.

On-Board Records/Plan

While she waits for the part to be delivered, Sgt Bayshore calls up the RPV records on the computer display. An aircraft wash is due in three days; weapon system certification is due in a week. The few items still requiring preventative maintenance are listed and some sheetmetal work is scheduled for tomorrow. The flight schedule indicates a heavy month of flying coming up. She checks the Recent Change List: No major changes in technical order (TO) procedures, monitoring requirements, or performance standards have occurred in the past three days, so she is up on everything.

Daily Update

With everything stored on the cartridge and the cartridge updated at the end of every day, it is not difficult to keep up with changes. The daily cartridge update also dumps the day's collection of historical data, flight information, and condition monitoring data into the central computer system for this RPV module.

The cartridge system works very well, but it is out of date. The cartridge has to be handled every day in this system. Sgt Bayshore surely will be glad when her squadron gets the new system that doesn't have the cartridge.

Direct Tie to Local Maintenance Computer Coming

The new system communicates directly with the local maintenance computer center for update and data dumps. New developments in telemetry technology make the new procedures troublefree and efficient. The new system will make information available to the RPV computer system as it occurs. It will instantaneously update the maintenance and operations information system for planning and scheduling purposes.

The New Navigational Correction Units Arrive--Back to Work

Sgt Bayshore quickly exchanges the old unit for the new one and plugs the new one into the appropriate receptacle. The computer senses the changes, makes its check, then flashes an "all systems go" signal on the display screen.

Just in time -- the Flight Operations van approaches. Sgt Bayshore gives the thumbs up signal to the driver as he passes by. The van stops nearby in a

position to control the movement of all the RPVs as they taxi toward the runway.

Soon, Sgt Bayshore hears her RPV #007 being called on the portable radio on her belt. Time to fire it up and send it off. Quickly, she does so, checking the computer display panel one last time before she steps back and tells the Operations van controller that 007 is cleared for taxi. She watches as the RPVs make their way like robots to the end of the runway, then take off into the early morning light.

Time for a break -- the RPV is in the hands of the pilot in the van for the next two hours. Sgt Bayshore has been on the flight line for less than 30 minutes. Not bad -- that's the forty-second on-time takeoff in a row without an abort. The last abort happened when she disagreed with the computer, thinking that one more flight was possible. Oh, well, she was new then -- she has learned to trust the computer.

Visit to Local Maintenance Computer Room

After drinking her coffee, Sgt Bayshore decides to go to the local maintenance computer room to find out more about this system. On her way to the computer room, she passes the small, one and two person offices containing the maintenance planning, scheduling, and analysis functions. Display terminals tied into the local maintenance computer system have significantly reduced the staffing of the offices, yet everything seems to be in good shape.

With a wave, the computer center operator motions for Sgt Bayshore to come on in. The computer room is small, clean, cool, and quiet. The operator explains the system to Sgt Bayshore in detail.

Local Computer, Many Functions

This small local computer is dedicated to maintenance, and it provides all of the computer support the maintenance organization needs. It runs the maintenance management information system, with terminals in all work centers. This includes scheduling, controlling, analysis, records, training, and mobility, as well as all status and management reporting systems.

Reduced Staff

After all the bugs had been worked out of the system, the staff workload had dropped so much that the excess people had been reassigned to the hands-on maintenance tasks in the various squadrons.

Tie to Computer at Air Logistics Center

Of course, the local computer is also the interface for the weapon system central data computer at the Air Logistics Center (ALC). This interface makes technical data available to the bases, and inputs historical, trend, and operations data to the central data base. All technical order information is

stored in the central computer and transmitted to the local computers for temporary storage and distribution. Distribution is made to the technicians via cartridges for the aircraft, plug-in, portable units for work away from the aircraft, and through direct link with the terminals in the shops.

Stand-Alone Mode for Mobility

Under mobility conditions, the local computer can operate in a stand-alone mode. It will perform all of its normal functions plus providing its own "central data bank" functions. If satellite data links are established at the new operating location, the computer can revert to a local computer tied to the central data bank, or can continue to operate independently. The computer is designed for mobility conditions and requires only minimal attention to a controlled environment and special handling.

Computer-Based Generation/Management of Technical Data

Technical data are virtually untouched by human hands. The prime contractor prepared the data within their own computer system according to the government specifications. Task analysis is managed by the system to insure quality and thoroughness. Updates and changes are made easily and quickly. After validation and verification are complete, the data, including graphics, are input to the central computer data bank for that weapon system at the responsible ALC.

All engineering changes, corrections, etc. are managed by ALC personnel. When a change is required, the Air Force requests the work be done, the contractor completes the work and inputs the change to the central computer at the ALC. The central computer stores, updates, and manages all of the technical data system.

System "Learns" from Experience

The central system has an artificial intelligence capability that permits it to learn from the troubleshooting successes and failures of the built-in system in each RPV. As the successes and failures are combined and analyzed in the central system, the artificial intelligence capability makes necessary adjustments in the troubleshooting strategy and programming. Thus, it provides the most current information to a local computer in an instant.

Cartridge for Each RPV

For each RPV, there is a small cartridge that contains the information that previously was contained in the aircraft records and in the TOs for the aircraft. This cartridge is plugged into the central computer system of the aircraft whenever the aircraft is flying and whenever maintenance is being done.

Automated Update

At the end of each flight and maintenance day, the cartridge is removed and plugged into a receptacle in the local maintenance computer room. This dumps the accumulated flight operations data, historical action taken, aircraft records data, and trend data. This information feeds the maintenance management system, of course. While the cartridge is plugged into the receptacle in the local computer room, the central data bank is queried, and if the cartridge does not contain the latest technical information or performance parameters, the update is made.

Portable Technical Order Device

Sgt Bayshore is very familiar with the portable technical order device. Weighing less than two pounds, the small 7x3-inch device incorporates a radio for communication with her supervisor, an optical character reading wand to order supplies, and the display screen, removable input keyboard, the voice recognition, audio microphone and speaker, power pack, and the data storage.

Self-contained, rugged, small and lightweight, this one device is a technicians's most prized possession. It provides technical information in either video form, audio, or both. It contains graphics that were available only on bulky graphic systems just a few years before and it incorporates a training mode that permits review or on-the-job training (OJT) whenever and wherever the user chooses. The voice recognition capability and the extensive interactive capability allow users to ask technical questions and receive answers as if a very experienced senior technician were personally tutoring them.

Like the cartridge for the aircraft system, this device is plugged into a receptacle in the local computer room for daily update of the TO information and to dump historical data input by the user. It is used for work away from the shop or aircraft, and where it isn't convenient to keep referring to the aircraft panel display. It can be hand-carried, fastened to a belt, or carried on a shoulder strap.

Integrated Maintenance Information System in the Shop

The computer operator explains that the remaining portion of the system is found in the intermediate level shops. The shop device is a combination of automated test equipment (ATE), automated technical order system, and instructional system. The display screen is large, 32" X 32",and provides unbelievable clarity for both text and graphics. An input alpha numeric panel provides total input flexibility, and may be extended to 15' away from the screen. When a component is hooked up to the device, the proper check is run automatically, and the results are displayed instantaneously.

Troubleshooting Information

When appropriate or when requested, additional troubleshooting information is displayed. All information required for any task performed on the component is displayed when requested.

Individualized/Group Instruction

The system also includes a training capability to provide individualized instruction, along with a testing, evaluation, and tracking capability for a great number of students. A built-in projection capability can support a classroom and group maintenance environment.

Able to support several terminals itself, the device thus can be active in any or all of its three modes simultaneously.

Deployability

It is fully deployable to remote locations and requires minimum facilities. Each shop device is linked to the local computer and is updated whenever changes are input to the control system. Thus the ATE, TO, and training materials are always current.

Multiple Options for Technical Data

A few words about the type of technical data are appropriate. The information, both text and the extensive graphics, is stored digitally in the central computer. The user has several formats to choose from, ranging from the most detailed step-by-step procedure to animation-type graphics without text. Several levels of detail are offered, virtually insuring that any given need can be met. Remedial training, quick review, or detailed theory can be provided when requested.

Super Graphics

The graphics are most impressive. In full color, fast, and fully inter-active, they can provide rotational, layering, three-dimensionality, and animation to meet all needs.

Flexible/Effective/Acceptable System

The audio output, voice recognition, tutorial and interactive modes, and the artificial intelligence aspects make the system tremendously flexible and effective. Extremely simple input requirements and complete fulfillment of the informational needs of the technician have insured user acceptance.

Job Enrichment from Portable TO Device

Sgt Bayshore still has nearly 45 minutes before her RPV is due back. She finds a comfortable chair in the crew chief's lounge and turns on her portable

TO device. Reviewing the table of contents, she asks for the theory and operating characteristics of the new terrain-following bomb-navigation system just installed last week. Might as well get caught up on the new technology.

Later, after hearing the return of her RPV announced on her radio, Sgt Bayshore is waiting as 007 returns to its parking spot. Post-flight is a virtual repeat of the preflight with the computer announcing that no failure occurred. Some fuel, check the tires, launch and recover again, and then go home. These 6-hour days aren't bad at all. No wonder there is a waiting list to get on the flight line!

SUMMARY

ONE System, NOT Several

Let me summarize my major points. First, I obviously believe that there should be a system, not several, composed of the following:

- a weapon system computer
- a local maintenance computer
- in-shop terminals
- flight line information device
- information module for each RPV
- RPV display, controls, and computer

Local Computer Tied to Central Weapon System Computer

This system consists of a local computer that is tied into a weapon system specific computer located at the appropriate ALC. This permits the local system to be updated with the most current technical data, and the weapon system computer to be updated with historical and trend data from the base.

Local Computer for Shop, Flight Line and Aircraft

The local computer powers the in-shop terminals, each of which can support satellite terminals for training and evaluation purposes. It also updates the portable device and the RPV module.

The flight-line device is small and performs multiple roles. It contains technical data with graphics, a training mode, a radio, an audio capability, an optical scanning wand, and a voice recognition capability.

The RPV has a plug-in module that contains technical data, operating parameters, checkout and troubleshooting information, a data collection capability and a training mode.

On-Board Computer

RPV display, controls, and computer provide interactive capability through the RPV module while installed on the RPV.

EPILOGUE

Functions Served Effectively/Efficiently

Together these components:

- Store and present the technical data, including checkout, trouble-shooting, and "learning" mode. Updated on a daily basis, the information is always current. Designed with the needs of the user in mind, the data are more accurate and usable than ever before. Inputs are made directly from the contractor's facility, and quality is up and costs are down.

- Provide a training capability, including review, OJT and evaluation.

- Provide inputs to the maintenance management information system via the local computer. Impacted are Job Control, Plans and Scheduling, Records, Material Control and Maintenance Analysis functions.

- Gather historical and trend data via the system. Data are input through the local computer to be stored at the ALC.

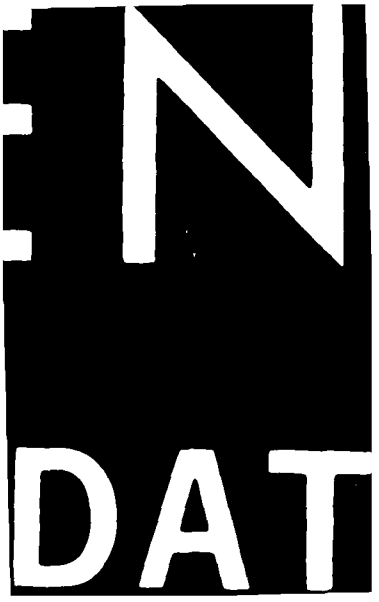
- Provide a radio link to maintenance, supply, and operations.

- Are fully deployable to remote locations, and in the case of the flight-line device, comfortably portable.

ABOUT THE AUTHOR

Mr. Robert C. Johnson is Chief of the Maintenance Performance Section, Logistics Research Branch, Logistics and Technical Training Division, Air Force Human Resources Laboratory. He is responsible for a broad range of studies to improve the capability of Air Force personnel and organizations to perform effective maintenance under combat conditions. He has over 17 years of experience in many aspects of Air Force maintenance. He has worked in maintenance, planned maintenance, supervised maintenance, served on a major industrial team designing advanced maintenance equipment, and conducted and directed R&D to improve Technical Orders and maintenance performance in general.

In 1978, a Division of the American Psychological Association presented Mr. Johnson and three other team-mates with the Military Psychology Award for Scientific Achievement. Mr. Johnson maintains his proficiency in maintenance by serving as a Maintenance Officer in a fighter group of the Ohio Air National Guard.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