TECHNICAL DOCUMENTATION UPDATING FOR A TRAINER UNDERGOING CHANGE

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Not too many years ago trainers were relatively simple devices requiring minimal documentation support such as a maintenance manual and a few simple schematics. Today, however, trainers have become highly sophisticated systems and subsystems supported by an impressive array of technical documents such as multi-volume maintenance handbooks, design and programming reports, wire and cable lists, provisioning documentation, engineering drawings plus schematic, logic, and block diagrams. As technological advances and improvements are made in Naval weapons and weapon systems, the trainers that simulate the operation and tactical use of these weapons must also be changed. Such changes become necessary not only to in-service trainers, but to trainers underoing development. When we consider that a trainer under development may require hundreds or perhaps thousands of changes, we can begin to appreciate the enormity of the task of keeping all associated technical documents up-to-date.

One cannot over-emphasize the importance of recognizing the problems involved in maintaining up-to-date technical documentation for a modern, sophisticated trainer undergoing change. Let's explore some of the problems that frequently result in outdated documents. Specific attention is given to the following questions: (1) What are the causes of documentation updating? (2) When does a change to a trainer have the greatest impact on documentation updating? (3) Why does a small hardware change cost so much in terms of documentation updating?

WHAT ARE THE CAUSES OF DOCUMENTATION UPDATING?

Let's analyze some of the main causes of what I would like to refer to as a documentation updating cycle. By this I mean maintenance of documentation starting with the establishment of a documentation requirement and concluding with customer acceptance of an updated documentation package. Some of the leading causes of documentation updating cycles include funding limitations, documentation delivery requirements, hardware life cycle planning, hardware changes during trainer development and hardware field modifications. Since it is important to understand the underlying causes of documentation updating cycles, let's investigate each of these causes in somewhat greater detail.

Funding Limitations

It is not at all uncommon for trainer requirements, desired options, and resultant support activities to be incompatible with available funding. Whenever we have this situation, it may result in a reduction in the scope of effort for support items. The scope of the documentation effort can be reduced, thereby lowering documentation costs, by permitting waivers and deviations from the documentation specifications. But this only delays the generation of adequate technical documentation required to support the hardware. Eventually fleet or user requirements for updated documentation reflecting modified hardware will create the need for a documentation updating cycle.

Documentation Delivery Requirements

Frequently documentation delivery requirements constitute a hidden cause of documentation updating cycles. Schedules that require the submission of documents either prior to final design freeze or concurrent with hardware delivery, automatically create the need for documentation updating.

Project teams concentrate on developing and producing the hardware to the required specifications. The objective is to meet all quality and test requirements, and to adhere to a prescribed schedule. Since engineers and technicians on the project team characteristically regard input to the documentation process as being lower in priority to hardware completion, communication between documentators and other members of the project team during hardware development and production is most difficult. To cite one example, a maintenance handbook must be started in time to be submitted in preliminary form at device delivery. To meet this schedule, documentors must start early, gathering inputs from unreleased drawings, preliminary design reports, and conducting interviews with engineers and technicians on the project team. The preliminary reports may not accurately reflect the complete design philosophy of the hardware, since they were prepared before the release of final drawings. In addition, the engineering drawings are in a changing condition. The cognizant engineers and technicians are busy testing the equipment. After hardware shipment, the same engineers and technicians have to be on-site during the final test and checkout phase. Therefore, at a crucial writing stage, the documentor has very limited access to the most knowledgeable members of the project team. The problem, then, is that the schedule requires the submission of documents before the information needed to produce technically accurate and complete documents is readily available. This, in turn, introduces the need for updating documents later on.

Hardware Life Cycle Planning

Since the advent of NTDC Bulletin 40-1, increased emphasis is being placed on integrated logistics support planning. As a result, there is greater awareness today of the need for life-cycle planning for documentation as well as for hardware.

An important point to remember is that although a trainer may be developed as a "one-of-a-kind" device, it may, through its effectiveness, usefulness, and acceptance eventually lead to the procurement of a series of trainers of "near-like" configuration. When this happens, the austere, reduced-scope documents originally developed for the one-of-a-kind trainer require a major overhaul for multi-trainer use. Thus, when a one-of-a-kind type trainer leads to the procurement of an entire series of similar trainers, a documentation updating cycle may again be introduced.

Hardware Changes During Development

The most obvious and accepted changes occur during trainer development. Hardware changes can be the result of many factors such as basic redesign, product improvement, changes in training requirements, deficiencies in maintainability and reliability, test and checkout modifications, and modifications due to operational equipment changes. It is extremely important to recognize that updating documentation on a trainer still undergoing development is just as time-consuming and expensive, and sometimes more so, than updating documentation on an in-service trainer. Hardware changes to either type of trainer mean that technical documentation, either in process or already delivered, must be updated.

Hardware Field Modification

The type of field modification that I am speaking of is the kind that takes place after the hardware has been released to the customer when configuration and document control has passed out of the hands of the contractor. Although the Government may have controls and procedures for ensuring that field changes are documented, many undocumented changes are introduced and result in outdated documentation. The fact that the documentation is outdated may go undetected for some time, but eventually the normal rotation of command and field personnel requires greater reliance on documentation. When this happens, the fact that the documentation is out of date becomes painfully apparent to those who must depend upon it. The result may be a significant number of deficiency or unsatisfactory reports, and this can easily lead to a documentation updating cycle requirement.

The problem then becomes one of updating the existing documentation package. Since the device is now an unknown quantity because of undocumented field changes, the cost of updating the documentation package is exceedingly difficult for a contractor to estimate. In order to determine and verify changes and modifications introduced since development of the original documentation, the contractor may have to send a field team on site to make a wire-to-wire, drawing-to-drawing check of the equipment. Therefore, it is readily apparent that on a complex training device, this type of updating effort could become very expensive.

WHEN DOES A CHANGE TO A TRAINER HAVE THE GREATEST IMPACT ON DOCUMENTATION UPDATING?

Now that we have reviewed some of the major factors that can lead to a documentation updating cycle, our attention must focus on the timing of a change and its impact on the documentation updating process. The extent to which design or hardware changes can affect this process is best shown by dividing the process into four distinct but interrelated phases.

Phase 1 starts when work begins on development of the hardware and continues until design freeze. Most of the documentation activity during Phase 1 is concentrated on preparing preliminary design reports, working outlines for the preliminary maintenance handbooks and the operator's guide and the start of the drawing package and provisioning documentation.

During Phase 1, anywhere from 5 to 15 preliminary design reports, consisting of anywhere from 5 to 15,000 pages, are generated. These reports include General Arrangement, Math Model, Instructor Station, System Simulation, Input-Output, Human Factors, and Special Purpose, to name but a few. A key point to keep in mind is that, although these reports may be technically accurate and up-to-date when submitted, they can become outdated quickly as work progresses on the hardware, and design changes are incorporated.

If the magnitude of a modification during this phase is great, the change may affect all documents in process as well as those submitted. On the other hand, a comparatively minor change may affect the engineering drawings, preliminary provisioning documentation and parts catalog, or perhaps the wire and cable lists. Thus, changes to the trainer during Phase 1 can be significant.

Phase 2 is the time frame between the release of final engineering drawings and hardware delivery. It is during this period most of the remaining design reports, the Preliminary Maintenance Handbook, Operator's Guide, Wire and Cable Lists, and the Training Course Materials are completed and submitted for customer review and approval. Obviously then, Phase 2 is the busiest period from a documentation updating standpoint.

Any changes to the trainer during Phase 2 are almost certain to affect all documents that have not already been submitted, in addition to many that have been submitted. If changes occur when these documents are nearing completion, it may become necessary to revise much of what has already been written. If the affected documents have already been printed, these are outdated even before they are reviewed by the customer. Needless to say, this is the sort of change that has a significant impact on documentation updating costs.

Phase 3 begins with delivery of the hardware, and continues until the end of contractor-augmented support. Shortly after acceptance of the hardware a training course is usually conducted by the contractor. The Preliminary Maintenance Handbook, Operator's Guide, and Programming Reports are used as text books during the course.

Generally, customer reviews of preliminary documents submitted with the hardware last until after completion of the training, at which time customer, instructor, and student comments are incorporated by the contractor during final documentation preparation. These documents, when submitted, contain the lastest information available at the time of their preparation.

Normally, changes to the trainer during Phase 3 have little effect on reports except for the final test report. They may, however, have a significant effect on the final maintenance handbook, engineering drawings, wire and cable lists, parts catalog and provisioning documentation. If the change is major, updating the final documents may develop into a previously unplanned scope of effort. This can result in a significant increase in documentation updating costs.

Phase 4 You are probably wondering what is left to do in Phase 4, since presumably everything was completed during Phase 3. But of course, there are always field changes. As mentioned earlier, once the augmented support period is complete, the contractor who developed the trainer is no longer responsible for configuration or data management and, therefore, changes to the trainer have a new significance. Although minor field changes may contradict existing documentation, individually they may not generate an impetus for a formal documentation updating. However, over a period of time, a series of many small field changes could actually make obsolete much of the existing documentation. When major field changes are undertaken the need for a documentation updating cycle is readily obvious. When this happens, a contractor is needed who has the capability of performing this task. A contract is negotiated, and we are back to Phase 1. This, then, completes our documentation updating cycle.

WHY DOES A SMALL HARDWARE CHANGE COST SO MUCH IN DOCUMENTATION UPDATING?

During contract negotiations, the question often rings loud and clear. "How can such a small hardware change cost so much in terms of documentation?" The Government demands that the contractor answers this question, and contractor management in turn, confronts the documentor who prepared the documentation cost estimate. To help us answer this question, let's check into a hypothetical case involving the replacement of a single component. I like to call this "The Case of a Capricious Capacitor."

Let's assume that in the original hardware design for a typical training device, a 5 millisecond output pulse was required from a one shot multivibrator. However, during equipment checkout, a 10 millisecond output pulse was actually needed. Assume that the capacitor must now be increased in value to increase the pulse width.

To start with, the design engineer would red-line copies of the engineering drawings to reflect the change. An engineering change order (ECO) would be written and processed to authorize revisions to the released drawings.

Copies of the ECO would be distributed to the cognizant departments for updating the affected documents. In a very real sense the ECO is the key tool that triggers the update chain-reaction by communicating the equipment changes to the necessary departments. Let's examine in detail the documents affected by the capacitor change.

Design Reports

Many variables enter the picture when it comes to design reports, since the quantity and types to be submitted vary considerably from one trainer to the next.

In effect, preliminary design reports reflect the as-designed configuration and the final reports reflect the as-built configuration; that is, preliminary design vs final design.

More than likely, some of these reports would have to be changed as a result of the capacitor change. In addition, most of the others would have to be checked to determine if any are affected.

You can see, then, that reports represent an important segment of the complex maze of documentation that must be evaluated when an ECO is generated due to our "Capricious Capacitor."

Maintenance Handbooks

When the ECO is received by the technical writer in charge of the device publications, he must determine which section or sections, of which volume or volumes, of the handbook will be affected by the new capacitor value.

Assuming that our changed capacitor is in a critical timing circuit of a digital sub-system, the writer's analysis of the affected handbook is as follows:

Using the process of elimination, the writer would eliminate those sections that would obviously not be affected by the change. Section 1, Description, normally does not go into detailed descriptions of components and would not require changing. Section 2, Operation, contains operating procedures and control and indicator descriptions and would not be affected by the change. Section 6, Parts Catalog, is generally a reference to the parts catalog supplied under a separate cover.

The remaining sections would, most likely, be affected. Section 3, Theory of Operation, containing circuit descriptions and the schematic or block diagram showing the timing circuitry would need to be changed. Section 4, Alignment, provides detailed step-by-step alignment procedures and would require changes. The new pulse width would be described and the illustrated waveshape would be modified. Section 5, Maintenance, contains trouble-shooting charts and procedures and an assembly layout of printed circuit boards. The timing relationship would change and the new value of the capacitor would change the circuit board. Section 7, Schematics, containing schematic, interconnection, and logic diagrams would also require changes to those areas affected by the new capacitor.

Now, if our changed circuit has introduced output changes which are transmitted to other subsystems of the trainer that have been separately documented in other handbook volumes, the above analysis must be conducted for each volume affected.

Training Course and Materials

Since the training course content and training material are prepared from the same source information as the handbooks, changes which our capacitor introduced in the handbooks must also be reflected in the training material. Again, it's a matter of analyzing our ECO and its effect on training course materials such as lesson plans, information sheets, tests, trainee notebooks, viewgraphs, flip-charts, etc.

Parts Catalog, Provisioning List, Equipment Repair Parts List

Since each one of these documents is generated in the same manner and from the same source data, we can effectively group them together for discussion purposes. Most contractors have a system for producing these documents that is geared to an electronic accounting machine (EAM) or computer print out.

Let us assume a separate file of EAM cards is generated for each of the three lists; that is, a set for the parts catalog, a set for the provisioning list, and still another set for the ERPL. Each list is done in increments by forwarding the released drawings and bills of materials to the tab room for keypunching. The final list is then merely the result of an overall accumulation of punched cards.

By now you can anticipate the problems. If our capacitor change affects any part of any one of these lists after it has been key punched, all three lists must be changed.

So far we have established that changing even a single component in a trainer can have far-reaching effects on technical documentation. We have seen how timing of a change can have a significant impact on the documentation updating cycle. In addition, we have explored

some of the causes which create the need for a documentation updating cycle. We have seen that when hardware changes are extensive, the task of updating all affected documents can be enormous.

Recognition of these factors is important, since they are directly related to life cycle planning for support of a training device as described in NTDC Bulletin 40-1. Many of the problems presented can be relieved by advance documentation life-cycle planning and by allowing for comprehensive control of all technical documentation. Other problems can be resolved by developing and implementing improved methods of storing, retrieving, disseminating, and presenting technical information.

For example, special attention is being given to the application of computer techniques to writing, editing, and the graphic arts as they apply to technical documentation. New training concepts are being studied, such as programmed texts and improved audio and visual aids. In addition, entirely new maintenance philosophies and methods of presenting maintenance information are being seriously considered.

In this presentation, I have tried to create an awareness of the effects of trainer hardware changes on technical documentation updating. What I especially wanted to point out was the need for recognizing, in advance, the multitude of tasks that make up a complete documentation updating cycle. Only by recognizing these tasks and taking them into account at the beginning of the life-cycle planning for a trainer, can significant reductions in documentation updating costs be achieved.