materially reduce the usability of the item, and Minor defects are departures from specifications or standards which have little on the item's usability. MIL-STD-105D also defines a "defective" as an item containing one or more defects. Therefore, the error classifications of this Spec. are applied to engineering drawings as follows:

First: A drawing sheet is considered as a "defective" since it can contain one or more defects. From this:

1. A Critical defective is defined as a drawing, list, or sheet thereof, which is omitted by the contractor from the drawing package. We will know it is missing because it is listed or referenced on some other drawing or list, or is required due to the intended use of the hardware and drawing package as detailed in MIL-D-1000.
2. A Major defective is a drawing or list which does not agree at the time of the test, with the actual hardware configuration it is graphically representing, or the data items it is tabulating.
3. A Minor defective is a drawing or list whose title box or drafting format is not in accordance with the drawing specification requirements under the contract.

As our last consideration, how does the Center's choice of MIL-STD-105 also help the Contractor? Well, he can now more accurately evaluate and supervise his Drawing and Configuration Control Systems by quantitative self-checks of the system during the hardware development phases. Quality and Reliability Assurance Handbooks H-107 and H-109 are available and are intended to supplement MIL-STD-105 for in-plant, in-process sampling checks to highlight problem areas as they start to develop.

In summary, gentlemen, we apparently have a mutual problem which requires efforts from both sides of the contract to correct it. The Government has found how to improve its shortcomings and it is hoped that by the application of statistical sampling techniques in accordance with MIL-STD-105D, NAVTRADEVCEN will investigate its contractors to review and reappraise their drawing and configuration control systems and improve them, as required, to attain that high degree of technical accuracy between the finally configured hardware and its associated drawings, which NAVTRADEVCEN will be quantitatively specifying and field verifying in future training device procurements.

THE COMMUNICATION OF TRAINING EQUIPMENT DESIGN INFORMATION

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At Westinghouse during a recent concept study, a new technique was developed to assure that training and teaching requirements would make the necessary impact on training device design development. It worked so well for us, that we present it to you for your consideration. It is especially appropriate since an article in the August 1968 issue of Electro-Technology addressed itself to a similar subject indicating that there exists a problem of some significance which was aptly described, in the editor's encapsulation of the article, as follows, "Despite the evidence that human engineering can prevent system failure, equipment designers continue to reject the remedies offered by human-factors specialists. The specialists share the blame - often the engineer can't read the prescription." In that article, entitled "Human Factors: Engineering's Blind Spot," the authors, David Meister and D. J. Sullivan, point out that the human engineer has a problem in that he must be an after-the-fact critic or a Monday morning quarterback. He cannot specify in advance but rather must wait until the designer creates something before he can evaluate it from a human factors point of view. When this evaluation indicates a design change is desirable, the designer erects a wall of resentment from behind which he protects his device from the human engineer. The result, of course, is that too often human factors considerations do not have adequate impact on design. The article also points out the human factors specialist" . . . could make a more meaningful contribution to design if the communications problem were resolved."

At Westinghouse Coral Springs we have attacked both of these problems by assigning an engineer the task of defining training requirements. The person selected should have a varied background for it is important that he not be identified with any of the human factors or design disciplines. In the case in point, the person was trained as an engineer, but his experience was mainly management oriented in the areas of operations, administration, configuration and data. We called him a Training Liaison Engineer (TLE) and one of his major functions was to act as an intermediary between designers and human factors and training specialists. To accomplish his assigned task, the following approach was developed:

1. Collect information concerning operational equipment, tactical procedures, and existing and projected training techniques.
2. Define the total training problem including limits.
3. Determine the role of the training device under study as a part of the total training problem solution.
4. Define gross requirements and features of the training device based upon its role. This includes suggestions on cutting costs; for example, instances where simulation need not be 100% faithful to operating conditions.
5. Communicate these requirements in meaningful terms to all project personnel.
6. Follow up to assure that the training requirements are being included in the concept formulation.
7. Participate in brainstorming sessions to develop approaches.
8. Participate in trade-off studies to assure the training problem and human factors considerations are adequately considered.

All of these steps have one thing in common - The Art of Communication.

Let us consider the art of communication by viewing three of its important facets:

1. Status of the Communicator. (The TLE)
2. Content of Communications.
3. Timeliness of Information.

FACET 1 - STATUS OF THE COMMUNICATOR

The initial move to establish the status of the communicator should be made as early as possible, preferably at the proposal stage. The methods used may vary. But whatever means are employed, they must accomplish two things. First, they must convince the designers that management considers the human engineering discipline a valid input to design. Second, they must apprise the TLE of his area of responsibility, and, perhaps more important, they must impress him with the need for initiative and decision making. In companies where the program manager concept is practiced, as it is at Westinghouse, the Program Manager must also participate in establishing the TLE's status. In the instant situation, the Program Manager took a simple but highly effective approach. He placed the TLE in the organization on the same level as the lead design engineers and the system engineer, not in a staff or consulting capacity but in the line organization where he was expected to be an initiator of ideas rather than a responder to line personnel's requests. He was given an active rather than a passive role. He could interface with the other line engineering disciplines on an equivalent level, had the same direct vertical access to the project engineer and, through him, to the program manager. In addition, he had direct access to the human factors specialists, the psychologists, and the training specialists. This visible support of the human factors discipline by both plant management and program management is absolutely essential. It is the foundation upon which the TLE builds his case.

FACET 2 - CONTENT OF COMMUNICATIONS

Obviously, the content of the TLE's communications are entirely his responsibility. He has to assure that he expresses the training requirements in terms that are meaningful to the user - the design engineer. He must devise an approach which is palatable, and act in a manner which will maintain the status afforded him by management. For the purposes of this paper let us define content of communication as everything the recipient of the message can see or hear in a particular message. This means that content, in this context, includes format, addressee, distribution, signature, language, and approach as well as the substance of the message. Appropriate blending of all of these ingredients can aid significantly in getting the point across and in influencing the recipient's actions. If the communicator is participating properly in the program and keeping his eyes and ears open, he can tell when he's making his point. This revelation may come in various forms. It may be heard in casual conversations. It may be demonstrated by the Program Manager supporting the TLE's ideas in conference. It may be hinted in the ease with which fact finding trips are approved. It may be divulged by other program personnel seeking out the TLE to discuss program problems in general. At this time, it would be well to point out that if some of these indications of success, (some "go's" in the "operational feedback") are not evident fairly early in the program, investigation is in order to find out why.

Now let us look at the aforementioned ingredients of communications content briefly to see how they may be used to stimulate the sought after "criterion performance."

First a standard format should be selected to present all training or human factors information in order to establish some formality to the messages. It may be similar to that used in specification preparation; and while it need not follow M-200 to the letter, it should present the information by employing major headings, sub-headings, standard paragraph numbering, tables, and matrices - a format the user doesn't have to fight. While discussing format we should also mention addressee, distribution and signature as these truly are a part of the format. In all instances the communication should be distributed by means of a short covering memorandum which explains what the attachment is and its purpose. These memoranda should be addressed to the Project Engineer, distributed to all project personnel plus the Engineering Department Manager, and signed by the TLE. The significance of these details will be better appreciated if you will reflect on how many times have you picked up a piece of paper from your "IN" basket or the middle of your desk and asked "What am I getting this for? What is this? Who sent me this? or Who put this out?" The memo eliminates these questions. Furthermore, by being addressed to the Project Engineer, it tends to emphasize the importance of the message and by being routed to Program Manager and the Engineering Department Manager, it lets all recipients know (since the distribution is shown on the memo) that management is aware of the TLE's activity.

Next, consider language. It would be easy to brush this consideration aside with a truism such as, "language should be clear and concise." However, this isn't sufficient, for what is clear and concise to the human factors specialist is not necessarily clear and concise to the designer. The task of the TLE, then, is to try to express himself in some kind of inter-discipline language. This must lean more heavily toward the designer's usage, since he is the one to be influenced. At times it must be reduced to the common denominator of expressing examples in terms of everyday experiences such as might occur while driving an automobile.

Now let us consider approach. Use of examples, as mentioned above, is one approach the TLE can employ to emphasize a point in the written or oral communications.

It might be well at this point, to inject that oral communication is as important as written. In addition to the interchanges at scheduled meetings, the TLE must utilize informal contacts at the desk, conversations during lunch, and the other informal discussions which occur during the course of a day at work. These oral exchanges may be used as a sounding board to test the effectiveness of the TLE's campaign, to try out suggestions, to clarify a point missed in a meeting or a memo, to emphasize training requirements previously published or to solicit support for a controversial concept which is important from a training point of view.

Approach methodology should also include the use of logic. Not only is this good general practice, but in the instant situation, it was especially important since the engineer prides himself on having a logical mind and it is the engineer who must be influenced. Of course, the logic has to extend beyond the sequence of presentation. It has to show logical back up for conclusions drawn and recommendations made. It has to state the "why" as well as the "what." In short it has to be attractive to the logical mind; for if it is not, it probably will be rejected regardless of how valid its message is.

Another bit of approach technique which can be employed is to discuss a forthcoming communication or the need for a communication on a particular phase of the program with the Project Engineer prior to preparing it. This is done for two reasons: (1) it helps to assure that the communication includes things that are important to the program from the Project Engineer's point of view, and (2) it gives the TLE license to introduce the message with such phrases as "Pursuant to our discussion, . . ." or "In response to your request, . . ." This device can help to enhance the stature of the message and thereby increase its impact on the recipients.

Thus far, under content of communication we have considered only those techniques which can be incorporated to help the message do its job. Now let me suggest some things which might be mentioned in the communications - the real substance of the message.

- An abbreviated treatise on how to determine what should be included in a training device.
- A definition of the training problem.
- Suggestions for design criteria.
- Suggested characteristics of the training device.

The last subject tends to infringe on the design and systems engineer's prerogatives; however, it is felt that by offering some alternate ideas for consideration, the designers' horizons might be widened early in the program so that "tunnel-vision" can be averted. Furthermore, by addressing himself to the designer's problem the TLE is able to demonstrate an appreciation for the total problem which helps establish a rapport with the other engineering personnel as well as the Program Manager.

Another appropriate subject of the TLE's memoranda is Human Factors Orientation. This was the purpose of some of the communications released by the Westinghouse TLE. By way of example, W. W. Prophet's paper "The Importance of Training Requirements Information in the Design and Use of Aviation Training Devices," and "Human Factors: Engineering's Blind Spot" by David Meister and D. J. Sullivan were circulated to all Program Personnel as a means of attuning them to the need for serious consideration of the human factors input to the concept formulation not only as a requirement to meet but also as a means for cutting costs. So much for content of communications.

FACET 3 - TIMELINESS OF INFORMATION

Timeliness of information is essential and a preliminary definition of training requirements should be published as early in the program as possible even if some conclusions are premature. This of course requires updating as information is gathered and analyzed during the course of the program. However, the TLE must attempt to influence the design concept as it develops rather than to correct it, a feat which would be impossible if he waits until all information is collected and digested. By that time, many of the design concepts will be cast in concrete.

We now will discuss how the above approach may be utilized during the follow-on prototype and production phases of this type of program.

Before going any further let us state one precept: "Communication is just as much an art and as serious a problem during the prototype and production phases as it is in the conceptual phase of a program." With this in mind, our task resolves itself into the definition of the following:

1. What are the Program interfaces within which the transfer of necessary training equipment design information is a critical problem and what are the communication vehicles that can be used to resolve the problem.
2. How are those vehicles controlled so that proper communication content and timeliness may be realized.

We would define the program interfaces in the following sequence:

First, the transition from system to hardware design. At this point the system designer must convey to the hardware designers his design requirements and objectives. But this is seldom, if ever, sufficient; he must also convey to the hardware designer elements of system philosophy; e.g., why a particular tolerance is so "tight" and what the possible effects on the equipment's overall performance are if the tolerance is not met. What are some of the vehicles the system engineer has at his disposal to accomplish this communication task? Certainly such documents as System Requirements Specifications, Interface Control Specifications, and Design Criteria Specifications, to name a few, may be used to convey the more succinct requirements and objectives. But how does the system designer express the more nebulous elements of his philosophy? How many times have we experienced the frustration of initiating a rather costly design change in the late stages of the prototype program or, even worse, in the middle of production because a design engineer had chosen a component or "black box" design that met the detail design criteria, but was not completely suitable in its particular application?

Many more times than not the trouble can be traced to the fact that the designer did not have all the available "system philosophy" information at his disposal. We will postpone our discussion of the way to combat this problem until later.

The second interface is between hardware design and manufacturing and test, wherein the design engineer must concisely state or depict the configuration of the equipment to be manufactured and tested. He also must specify the test requirements of the end product. Documents such as engineering drawings, wire running lists, materials and process specifications, and test specifications are among the communications vehicles used to accomplish this. At this time it is well to emphasize that, unlike the transition from system to hardware design, the design information transferred from the design engineer to the manufacturing and test departments cannot have a nebulous quality but must be clean, concise, and, hopefully, exact. In other words, the equipment's configuration must be completely defined.

The third interface is between the contractor and the equipment user. The critical problem here is the transfer of both design and support information. Typical communication vehicles used are: spares provisioning data, planned maintenance reports, maintenance engineering analysis records (MEAR), training program requirements, and technical publications such as operational and maintenance handbooks. It is impossible for us to overemphasize this interface, for it is here that the contractor must provide for the transfer of configuration, test, operational, maintenance (both preventive and corrective), and training information, not only to the customer representative or project office, but to the ultimate user of the device. If this is not accomplished the utility of the equipment will be seriously compromised.

The control of all of the required documentation across the indicated program interfaces seems quite a formidable task, but one that must be accomplished. We heretofore have defined some of the problems associated with the communication of equipment design information. Now we will discuss the Westinghouse approach to controlling the communication of Training Equipment Design information during the prototype and production phases of the program. As was previously mentioned, a Training Liaison Engineer (TLE) was appointed at the outset of the concept phase of the program. This man is certainly a key element in the prototype and production phases also. However, since the communication of design information becomes not only more critical but more formal as the program progresses, it is the practice of Westinghouse to assign a Configuration and Data Management specialist at the outset of the prototype program. What is the desired backgound and status of this individual? He should be trained as an engineer, since he will be constantly communicating with them and must, after all, understand the jargon. But it also is important that he have an understanding of manufacturing, test, and product reliability operations. Too, it is certainly desirable that he have some understanding of the user's desires and potential problem areas. In addition to all of this he must be well trained in his field of specialization. The Configuration and Data Manager (CDM) is considered a member of the program management staff; therefore, he functionally reports to the Program Manager and is generally shown on his organization chart.

The duties and responsibilities of the CDM include being Secretary and Deputy Chairman of the Configuration Control Board (CCB), of which the Program Manager is the chairman. In addition, he has the authority to prescribe the format and schedule for contractual data items to be produced by the functional organizations, and is responsible for delivering the contract-specified items on time, in the correct format, with usable contents, and at a reasonable cost. Since communication of data at Westinghouse is treated as a management instrument as well as a contractual requirement, planning includes both internal and contractual data requirements.

The CDM assures that each item of data to be produced has been assigned to the proper functional organization for preparation and that sufficient means have been provided for checking quality and adequacy. He accomplishes this by establishing a detailed schedule with milestones for preparation, checking, approval, and reproduction of each item of data. He monitors the development status of each item of data against the schedule and reports on schedule performance to the program manager and to the manager of the responsible functional organization.

As each formal document; e.g., System Requirements, Design Criteria, and Test Specification, Engineering Drawing, Parts List, is released, its configuration is established and controlled from that time forward, in the same manner that the actual training device's configuration is controlled. All revisions to the training device's design data package, from the System Requirements Specification through delivery of the last configured contractually required data item, must be approved by the CCB, which is organized by the Program Manager at the beginning of the Prototype Program. It is here at the CCB, where all proposed revisions to the training device and its data package are to be evaluated for approval, that the TLE, as a member of the CCB, performs one of his most vital functions.

Since the TLE was instrumental in laying out the system design requirements as well as the overall system philosophy of the training device, it is most important that he contribute to the program's continuing development. This is accomplished by requiring that all proposed changes be reviewed and evaluated by the TLE for their prospective impact on the training requirements to be satisfied by the device. It is through this method of utilizing the special talents of the CDM and the TLE, together, that the art of communicating training equipment design information within the applicable program interfaces, we feel, moves nearer the practice of a science.

PROCUREMENT PERSPECTIVE

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PROCUREMENT PERSPECTIVE

In keeping with the theme of this Third Annual NTDC/Industry Conference -- "Innovations in Training Device Technology" -- the speakers this morning will discuss some of the contracting innovations in procurement management that are being applied to training device acquisitions.

I will briefly -- very briefly -- discuss "procurement perspective" with perspective being defined as the "capacity to view things in their true relations or relative importance."

Although there have been many innovations in procurement management during the past few years, -- in fact, there are those who will contend that it has been a revolutionary rather than an evolutionary process -- the purpose of these procurement innovations or techniques is to assist in the achievement of basic objectives that are unchanged. These objectives being the acquisition of a quality product, delivered on time, at the lowest over-all cost.