CHAPTER 22

Human Systems Integration and Training for New Systems

JOHN KLESCH and WILLIAM STEMBLER

22.1 INTRODUCTION

Program managers face a great dilemma in deciding how to incorporate training into new systems. They are aware of training's importance and do not wish to neglect it, but it is viewed as a high-cost element that can be deferred most easily without sacrificing overall program objectives, so there is a strong incentive to neglect it. There are three overriding reasons for this dilemma. First is a management misperception in the relative value of training compared to other system requirements. On the one hand, training is one of the critical elements in any new hardware or software system. Training is needed not only by operators and maintainers but also by leaders, supervisors, and managers involved in any new system. As a critical element, it is expected that training would play an equal role with all other critical elements of the system to maximize the gain on capital investment for the system as a whole. On the other hand, training is seen as a convenient means to reduce rising costs in the overall development program or to avoid schedule slippages that may threaten the program. This reason stems from poor management practices and can only be resolved by smart business decisions that will not allow training or any other critical element to be the bill payer for program funding and scheduling problems.

The second reason for the program manager's dilemma is the perceived high initial costs of human systems integration (HSI) requirements. Although many program managers of new systems recognize the importance of HSI, they tend to trade off HSI considerations in their investment strategy and assume more risk because of upfront costs. This invariably leads to less than optimum performance of the system initially and, in the long run, may lead to a serious loss of return or even failure of the entire investment. This reason is more legitimate than the first but should be resolved in favor of HSI so long as the costs are justified in terms of total system performance and affordability trade-offs.

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The third reason for the dilemma is meeting the total requirement for training personnel to operate, maintain, and manage new systems. This reason is the soundest reason for the program manager's dilemma and will be dealt with extensively in this chapter. An introduction to the personnel training requirements that any new systems must meet to assure both initial training and sustainment training is provided below. This will be followed by an introduction to the problems facing the program manager when utilizing training technology to help meet these requirements.

22.1.1 Personnel Training Requirements

There are three major requirements for personnel training on new systems:

1. *Personnel Must Be Trained Effectively* The training for operators and maintainers of new systems must first and foremost be relevant. Students must be able to acquire the skills needed to perform all of the tasks necessary to meet the mission or goals and objectives of the system. They must reach a degree of proficiency as quickly as possible so they can initiate operations with the new systems. Since there will be very few others to turn to for assistance on this brand-new system, they must get as close to mastery as possible. They must also have some means to sustain that proficiency once it is achieved. Errors on new systems are frequently critical because that which becomes obvious over time became obvious because the errors led to serious failures. For example, placing a simple but critical filter incorrectly into an army tank has led to repeated engine failures that continued until training was refined.
2. *Personnel Must Be Trained Immediately* New equipment training must be done for all organizations as soon as they receive the equipment. Preferably, personnel are trained before the systems arrive so they can be immediately productive. Any delay means downtime of the system or risk of damage if operated or maintained by unqualified personnel.
3. *Personnel Must Be Trained Efficiently* Most program managers are faced with rising costs, potential cost overruns, and a tight budget that focuses on hardware. In order to train efficiently, they must develop the training as cheaply and quickly as possible and devise means to also deliver training inexpensively to keep the cost per student in line with the budget allocated.

Nowhere is the difficulty of meeting personnel training requirements better illustrated than in the Department of Defense (DoD) where dozens of systems are fielded each year that generate a like number of new system training requirements. Program managers, who are to acquire these systems, are carefully screened and educated in university-level programs. These university programs and curricula are painstakingly designed to ensure program managers are equipped to do a good job. The managers are taught to carefully consider the requirement; study the various alternatives to meet this requirement; perhaps engage in some prototype testing using mockups, simulators, and breadboard models; and, finally, obtain independent field testing and evaluation of the hardware. They understand the need for operators and maintainers to perform with some degree of proficiency if the system is to approach its design capability. Nevertheless, training is seldom developed or tested with the same rigor and priority that the hardware receives. Consequently, the goal of proficient performance is seldom achieved, and as a result, the training burden continues to grow as the systems mature.

In the civilian sector, the computer industry and electronic equipment industry provide prime examples of the mismatch between training requirements and new system operations. Extremely powerful software systems are seldom used to anywhere near their potential. Meanwhile, help desks are required to maintain a 24-hour, 7-day-a-week (24/7) service for users who frequently do not know how to operate the basic features because they have not been trained adequately, if at all. Nearly everyone, at some time or another, is expected to sit down and start using a computer system regardless of his or her experience with the system. It is left up to the employee to learn, usually haphazardly, on the job how the actual application program operates. While there is no accurate way to measure the loss of productivity each time this occurs, the fact that it is nearly a universal experience, even among experts, tells us the loss is significant, if only on the basis of a very expensive item of equipment and software not being used to capacity. Retail companies invest huge amounts in automation of sales, linking it inextricably with inventory and accounting. But, they fail to train their clerks to use the equipment and programs properly and efficiently (Compton, 1999; Stapp, 2001).[1] The net result (especially during holidays and sales days) is long lines and lost sales as sales personnel wait for a supervisor and customers finally leave in frustration. Amazingly, the retailer may later invest in expensive programs to determine why customer loyalty is waning and still more expensive programs to attempt to win them back. Did they save money by shortcutting training?

22.1.2 Training Compromises

To paraphrase a common saying among experienced trainers and managers of new systems, "Personnel must be trained effectively, immediately, and efficiently: Pick any two!" Faced with the problem of considering quality, time, and cost simultaneously, program managers almost always are forced to trade off at least one of the three. Because of the tight requirements to meet performance standards, the trade-off is usually between cost and time. Typically the program managers resort to traditional training methods that appear to allow them to meet time requirements for the first units, minimally meet performance standards, and stay within the initial budget. The subsequent system owner, who is responsible for life-cycle costs, however, may sooner or later be confronted with a huge sustainment bill to pay, so this initial balance of *effectiveness, immediacy, and efficiency* can be very short term in duration.

Instructional developers sometimes must minimize development time by covering only basic information formally, expecting the instructor to fill in the gaps as they are revealed during training. Time on actual equipment also may be minimized and available photographs or drawings used in their place. If necessary, managers may raise the instructor-to-student ratio or simply cut down on the amount of time spent in training. The latter is done by reducing the amount of time spent on a task or by eliminating entire tasks from the curriculum.

Follow-on units subsequently face long periods of expensive train-up time as shortcomings are revealed and replacement personnel attempt to learn the system. Revised, "beefed-up" training programs are later produced, duplicating much of the original effort. While new personnel will receive the improved training, those already in the field will still require updated training. However, to be efficient, this training is tailored to their needs to avoid training in what they already know. In essence, this requires yet another expensive training program to be generated. In addition to these high costs of training, there is the immediate cost of downtime that can be experienced with any failures of the new system when first fielded, which in manufacturing can bring about a crisis and in the case of a military unit disaster.

The above paragraphs describe typical methods that allow the manager to keep a program moving but almost always introduce numerous delays and higher costs to correct deficiencies later. This raises the question of whether the three requirements could be better met with improved training technology.

22.1.3 Training Technology Limitations

Technology and, in particular, information technology improvements are systematically being applied to new systems, yet the training for new systems has not received the same treatment. While many training techniques and approaches have been developed, tested, and refined, they all fall short in one way or another when applied to new systems. For example, one of the more promising training technologies, interactive multimedia instruction (IMI), which is now being routinely and successfully applied to other training needs, is not being applied to new systems.

The primary difficulties in applying IMI to new systems in the past have been the following:

1. It is very expensive to develop IMI and becomes too expensive when many changes are required, which is always the case in the development of new systems.
2. It is very time consuming in the development stage.
3. It has not shown sufficient flexibility to meet the fielding schedules of new systems.
4. Metrics do not exist for assessing training impact over the system life cycle so managers and decision makers have not been able to justify additional expense over traditional, conventional training techniques.

In the sections that follow, we will examine the strengths and weaknesses of IMI for new systems and explore ways that a new system can utilize the strengths of this technology while retaining some of the advantages of more conventional training methods.

22.1.4 Chapter Overview

The chapter has three primary objectives:

- to examine how technology has been applied in the past to solve training problems;
- to evaluate the advantages and disadvantages of IMI for improving training effectiveness, immediacy, and efficiency; and
- to describe an HSI process that combines IMI and conventional training techniques into a cost-effective process to meet new system training requirements.

22.2. HSI TRAINING TECHNOLOGY APPLICATIONS

Over the last decade great strides have been made in addressing training needs through the use of computers and communication systems. Computers have provided a number of advantages over traditional systems for training. They can store vast quantities of information; provide graphics of various types, ranging from line-drawn diagrams to photographs, video motion, and animation; and include interaction capability. Communications have likewise had a dramatic effect on training. Video teletraining (VTT) has made it possible to bring live training to multiple remote sites. Telephone lines have made long-distance audio presentations and interactions available anywhere in the world. The Internet with its websites has made possible the sending and retrieval of information and, when harnessed in support of computer training, has made interaction of students with vast amounts and types of information an everyday reality. So how has technology specifically improved training in effectiveness, immediacy, and efficiency for new systems?

22.2.1 Technology and Training Effectiveness

The overriding question with training effectiveness has to do with how well students can perform tasks when they have completed training. Students' skills to perform critical tasks never before encountered can be developed and sustained by technology in a number of ways. First, the stimuli presented in the actual task can be reproduced and enhanced for careful study and examination. Being able to see objects clearly and as often as necessary will make the task easier to understand and thereby to perform. For example, removal of complex or delicate parts of equipment, such as an aircraft radar antenna or a computer display unit in a tank, can now be illustrated on a monitor that shows task details in a linear sequence. Graphics, rather than sketches or very cluttered photographs, can show the removal steps in three dimensions, showing components as they are removed and focus on critical elements by blinking, highlighting, or other graphic techniques. Figure 22.1, for example, shows how graphic cues can be used to highlight the location of a control box on an item of equipment and at the same time magnify the control for observation.

These capabilities provide numerous opportunities for the developer to make training more effective. The opportunity to inject various whole/part learning paradigms is quickly evident. With computer technology each student can be shown a whole procedure step by step, then brought back to focus on part tasks of that procedure that can be learned independently. Within the part tasks the students can be required to interact by answering questions and demonstrating that they can pick out relevant cues. Finally, each student can

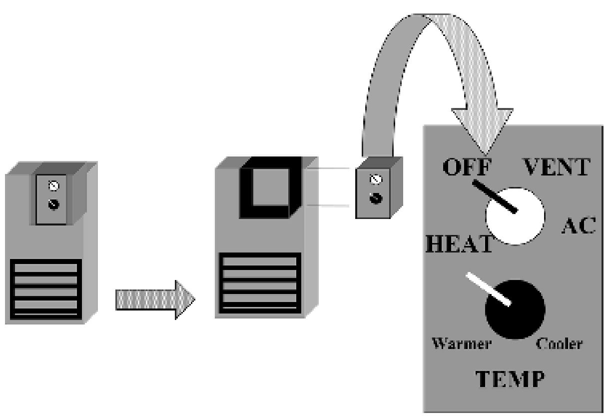


Figure 22.1 Graphic cues used to highlight an item.

be asked to step through the entire sequence with the student in control to demonstrate that he or she understands the entire procedure. In the case of tasks where the real-world task is also done on the computer, the instructor can have immediate evidence of training effectiveness and transfer. When external or mechanical work is required, there is the opportunity to learn the part tasks first in simulation. There will be far less uncertainty in performance when the students work on real equipment. Students will also be likely to perform with fewer errors and require far less time to reach mastery. Supervisors can use the same training program to learn the new system and later monitor the less experienced trainees' progress (Kulik, 1994; Metzko et al., 1996; Howard, 1997; Parchman et al., 2000).

As a specific example, consider that the critical task of learning to identify friendly or enemy combat systems has always been done using two-dimensional "flashcards." With technology we can now teach students to identify and distinguish between combat systems by presenting images at different distances, in different attitudes, and different environments. Now the soldiers can learn at what range they can identify friend or foe with certainty by having the computer-driven graphics present images that simulate known distances. Students also can view comparisons that highlight silhouettes and distinctive characteristics. Next, they can see the differences when the cues are gradually faded or completely removed. See Figure 22.2 for an example of fading cues as darkness approaches. The stimuli can also be degraded to simulate dust, twilight, camouflage, or other real-world conditions.

Moreover, these same combat systems can be immediately shown in a total desert environment with appropriate camouflage or mountainous, snowy terrain as background with another type of camouflage. Still further, students can now learn what the systems look like while they are moving, as in the case of a mobile system. Students can see how the appearance of the system will change as it draws closer or moves farther away either directly or at an oblique angle. Computer graphics can also now be used to aid the soldier in learning to identify thermal heat signatures of friendly and enemy systems again using accurate simulations. These skills can be absolutely critical in conducting night operations

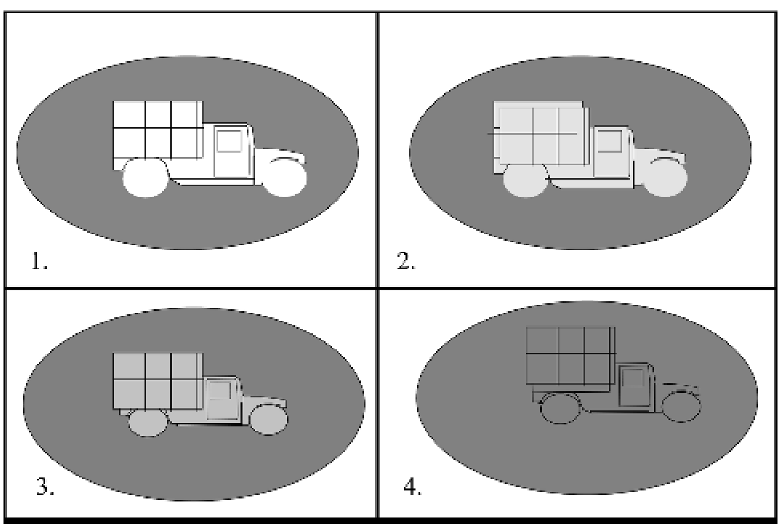


Figure 22.2 Graphics used to diminish cues.

(and avoiding false targets such as animals, trees, and outhouses!). These are a few examples of many ways improvements can be made in training effectiveness with technology to support new systems. Electronic performance support systems (EPSSs) are under development that will be embedded in many new systems that will use similar techniques to aid actual operation. A training support system that replicates that EPSS can be used anywhere outside the system to enable both less expensive initial skill acquisition as well as sustainment when students are in a school or otherwise distant environment from the actual new system hardware.

22.2.2 Technology and Training Immediacy

The most important question for training immediacy has to do with how quickly we can get the training to all the students who require training. Technology is now used to improve training immediacy in several ways. Instructors videotape the live training sessions and can offer the tape to students who were absent when the new system training was presented. This can be repeated for as many additional sessions as required. Where properly equipped facilities exist it is possible to do live VTT via long lines or satellite to long-distance multiple locations, although some scheduling problems can arise. Placing the training session on a CD-ROM or on a website makes training accessible and available most anywhere in the world. Moreover, changes or safety alerts can be supplied via the Internet in a matter of minutes, if required, as opposed to hours, days, weeks, or even months.

22.2.3 Technology and Training Efficiency

The primary question for training efficiency has to do with how we can lower the costs of production, reproduction, and delivery. Technology has been applied in numerous ways to reduce both time and cost of lesson production. For example, computer word programs permit the developer to make corrections quite easily to plans of instruction, lesson materials, and other handouts. Application of templates to maintain a standardized “look and feel” is done by simple electronic command. Vugraphs can be quickly built and modified by accessing easy-to-use programs. Graphics and photographs can now be electronically imported for easy insertion into the vugraphs or handouts. Vugraphs can be stored and projected electronically and hence are easily updated. A demonstration on actual equipment can be more quickly captured on videotape than was done previously with film. Immediate editing and updating with video technology also serve to lower costs of development. Modern copy machines make reproduction of even color diagrams and photos within reasonable costs.

For delivery, accommodating more students via VTT can reduce the cost per student trained. Using VTT to bring the training to widely dispersed students will also greatly reduce travel expenses and time spent in traveling. Using websites on the Internet or using CD-ROMs to provide timely updates everywhere at once can lower distribution costs. Mailing a CD is much cheaper than mailing heavy boxes of printed materials.

22.3 TRAINING REQUIREMENTS AND IMI

In the previous section, we presented several technologies that can aid the developer and the customer. In this section, we now look at IMI, which has incorporated many of the technologies listed above, to determine how training can be made more effective, immediate, and efficient. Being a combination of useful technologies, one might expect it to be the best of the best. If it can be the best, why is it not used more often? Before one can judge the merits of employing a new technology, it is important to examine more closely that which it is to replace. What are the specific areas where improvement can be made? What are the expected goals for the new technology? How does one determine if the goals are achieved with the new technology? Is it really better, faster, and cheaper? And if not, why not, and can anything be done to improve it? By answering these questions, one can systematically design an improvement process using the new technology.

22.3.1 Training Effectiveness

The advantages and disadvantages of traditional standup instruction compared to IMI for training effectiveness are considered below.

Traditional Standup Instruction and Training Effectiveness Traditional standup instruction remains the methodology of choice for new systems simply because the systems are so prone to last-minute design changes that expending any effort to create IMI has not been viable. Even use of video technology is not considered favorably because it must be carefully scripted, then filmed under close-to-ideal conditions that are rarely available in the laboratory or production lines. Moreover, traditional standup instruction is a proven technique. Since the time of Socrates, the teacher-and-pupil, one-on-one pedagogical approach has been known for its effectiveness. Given a subject matter expert with a modicum of teaching skills, a set of vugraphs, possibly the actual equipment, and a plan of instruction, one can expect to obtain some success. The instructor can respond to the student on the spot. He or she can detect which student is struggling and offer more help. More importantly, growth in skill and knowledge can occur when a student explores ideas and concepts with a receptive, experienced trainer. In the military, for example, the instructors are trained to respond in just this manner. Conveying leadership skills as well as technical "tricks of the trade" are two examples where live instruction excels.

The reality for new systems, however, is that the session is more than likely to become just a lecture with possible questions and answers. The forgetting curve is steep under these circumstances, and unless the developer or instructor has the time or inclination to make detailed handouts, the students must rely on a good memory or the class leader who took good personal notes. The resulting problems impacting effectiveness on the job are well known and tough to completely overcome. Serious errors can be committed or new personnel may be restricted to an observer/helper role for a substantial period of time. Parts may be replaced that do not need to be replaced and secondary malfunctions induced. The reasons are sometimes very evident. With new equipment the actual hardware is not likely to be initially available for any kind of hands-on training. The instructor may demonstrate procedures, but the usual problems of being able to see the procedure or see it more than once leave the student far removed from the desired recognition of cues, stimuli, and opportunity to practice responses. Consistency in the instructor's responses or among different instructors sometimes poses a problem for effectiveness. Video taping of critical procedures can be used, but quality shooting, scripting, and narration are rarely available in the time allocated for new system training. When time is available, the cost for professional production would equal the entire training development budget. While even poor-quality taping done in-house to save dollars will have instructional value, the point is simply that the instruction is far from optimized for effectiveness. The most important drawback is that traditional standup instructional classes are not optimized to elicit responses from students, especially all the students. Even if a good instructor asks frequent questions, each student does not have to answer each time. Thus, learning is not being reinforced and the effects, if not later sustained, will diminish significantly.

Advantages of IMI to Training Effectiveness The power of IMI begins with its ability to (a) provide a useful demonstration of the task and (b) allow students to view the demonstration as many times as necessary until they are comfortable with the sequence. To do this, IMI may incorporate a variety of graphics and graphic techniques that aid the student in visualization of the task. For new equipment this becomes crucial if the student must begin training on equipment that may not have reached the production line or the location where he or she is to work. There are many graphic alternatives that IMI can use, usually in combination. Still photographs of actual equipment can be used to provide initial cues and context. Figure 22.3, for example, shows the engine and then provides focus on the distributor. Graphic information may also be provided using line drawings, video clips, or animations depending on the complexity of the task.

In addition to graphics, text can also be presented in a variety of ways to keep student interest in the content and allow focus on critical material or objects that the instructor wishes to call to the attention of the student. In Figure 22.4 the example on the left uses numbered paragraphs to help the student logically group the electrical and mechanical components. The example on the right uses the same idea but with a bullet structure to reduce the number of words and to provide additional emphasis on the key items by singling them out.

The verbal content and the graphics can be supplemented and enhanced by the addition of audio that can provide additional or reinforcing verbal information via narrative and

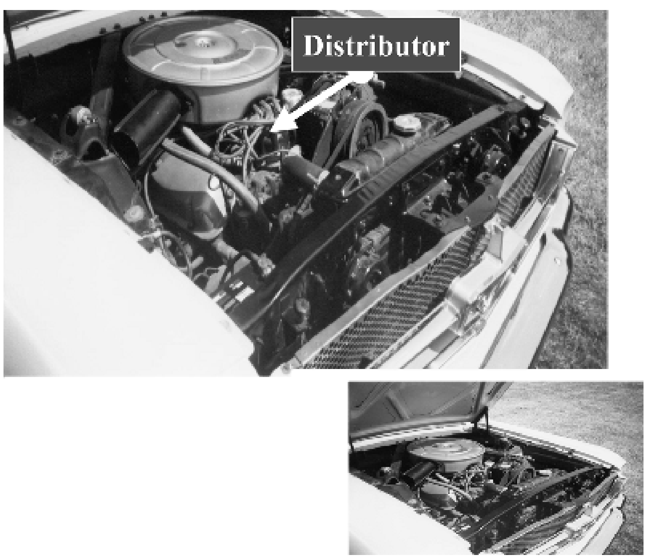


Figure 22.3 Example of still photos.

1. Mechanical and electrical controls are used to regulate the heating and air conditioning system.

2. Mechanical controls such as grilles and louvers can direct air flow and regulate the amount of air coming into the unit or being discharged from the unit.

3. Electrical controls allow the user to select the type of air conditioning desired such as cooling , ventilation or heating and the temperature of the area .

Mechanical systems regulate the HVAC system air flow:

- •Louvers direct air flow
- •Grilles regulate the amount of air entering or leaving the unit

Electrical systems allow selection of mode and temperature to be maintained:

- • Mode selector switch- allows heating , cooling, ventilation, or Off modes
- •Temperature control thermostat allows selection of desired temperature

Figure 22.4 Examples of text presentation.

aural cues (e.g., sounds of the equipment under normal and failing conditions) to aid depiction of the task and the opportunity to practice discriminating among aural cues when the task requires it.

What follows next is even more powerful because IMI can then use the same procedures to allow (or require) the student to perform the task (now *you* do it). Often this hands-on practice is not possible with traditional instruction because of time, expense, availability of equipment, danger, and/or the availability of an instructor to monitor performance as it occurs. In contrast to traditional methods, each student can be required to respond to each element of the task. The lesson can be designed so that the student cannot advance until all elements are covered. If the student does not respond correctly, he or she can be guided or sent into a remediation sequence. As illustrated in Figure 22.5, the students may be told, based on their responses, that they have identified part of the answer but that they still must acquire additional information. They are directed by the screen and the highlighted navigation arrow to return to the previous information presented. Further, IMI can allow students to practice as much as they like until they are comfortable with their performance.

Interactive multimedia instruction can be designed to show and use a variety of feedback mechanisms and schedules to achieve optimum student performance. Novice personnel can be given early and frequent feedback by eliciting small chunks of information that they have just been exposed to in the lesson. As the lesson and student progress, fewer single-item feedback questions can be posed and summative questions requiring them to link several sequences of information can then be introduced. Figure 22.6 illustrates a test of the student's knowledge of both the sequence in which a task is to be performed and the location of the items addressed in the task. When desirable, scoring can be used as progress or diagnostic indicators and also for recordkeeping purposes. (Have you done it correctly? Do you need to review again? Have you met all the criteria?)

Disadvantages of IMI to Training Effectiveness Authoring systems are frequently complex to use and maintain and are sometimes proprietary, making it difficult

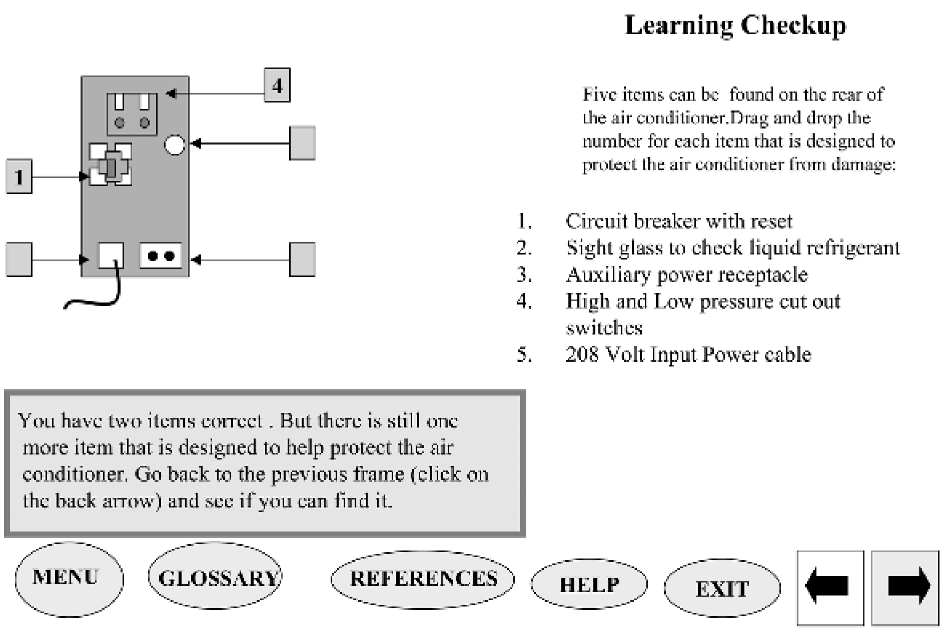


Figure 22.5 Example of remediation direction.

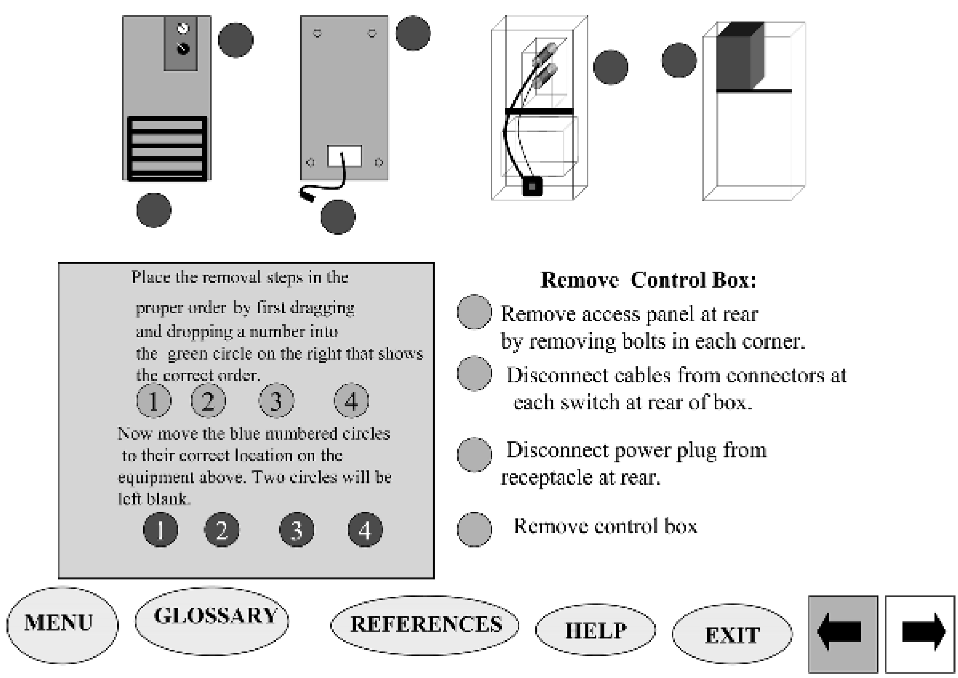


Figure 22.6 Linking sequences.

to disperse without purchasing site licenses for all recipients. Animations, photographs, video clips, and other high-density graphics quickly generate problems for Web-based IMI over the Internet because of the size of the files created. In order to produce really effective IMI, the course developer must prepare storyboards, create appropriate graphics, and create appropriate and useful audio. Then he or she must decide on the right mix. If the right mix among the three media is not found, the effort may only confound the student. The "look and feel" between developers' lessons can vary widely, but if an IMI course is to be prepared quickly to meet a deadline, the production manager must use multiple developers. The developer could therefore wind up with lessons that are different enough that the students are distracted or, in worse cases, completely frustrated because the requirements and presentations differ so much within the same course or perhaps within the same lesson. Listings of some common problems that arise in the design of IMI are provided in Table 22.1. Some of the problems can be fixed by establishing standards (indicated by "S" in the table) and ensuring that the designers all adhere to them. For example, establishing conventions for navigation through a program or consistent placement of text can solve some problems. For other items, judgment (coded as "J" in the table) must be used that comes from experience based on comments or observations from trials with the lessons.

22.3.2 Training Immediacy

When customers buy a new item, they want the training for the new item immediately upon receipt or preferably even before receipt if that were possible. That way new systems are placed in immediate use with personnel who are immediately productive. There are two major difficulties facing the training manager in meeting these customer preferences. First, organizations that are spread over vast geographic areas pose challenging logistics problems because to be cost effective, the objectives are to train everyone at once and minimize the period during which two separate systems (old and new) must be maintained. Second, since engineering or other system deficiencies are likely to induce changes in the system until the last possible moment before fielding, the data for training materials are always out of date. This requires the training manager to begin training development early with the best available data but at the same time have a flexible system that can accommodate last-minute changes.

Traditional Standup Instruction and Training Immediacy Traditional standup instruction provides training immediacy very well. This is accomplished by training an instructor or instructor team, devising a plan of instruction or syllabus that relies on reproducible handouts for the students, and providing some vugraphs and possible training aids for the instructor. Vugraphs and handouts usually can be changed rapidly, so the only waste is in the outdated materials that are replaced by updates. The problems begin to arise when either the students or the instructors must travel in order to receive training. In addition to adjustment of personnel schedules, the airlines, hotels, adequate training sites, local transportation, reservations, and eating arrangements all must be quickly scheduled at each place. The more students, the more systems, or the more geographically separated students are from the instructors, the more likely the chances are for major disruptions. The situation only worsens when weather changes, labor strikes occur, unexpected illness or other emergencies occur, or simple mistakes occur. The result is personnel miss training and do not acquire the immediate skill capability required.

TABLE 22.1 IMI Media Problems

IMI Problems	Media	Category
Media competes with rather than complements other media.	Narration may be distracting if not tied tightly to text or graphic. Multimedia animation may provide only "entertainment" and lessens the educational value.	J
Too busy, therefore stimuli are distracting.	Text can be in too many formats or a poor format for providing focus on key information. Graphics can be too complicated to quickly grasp relevant cues.	J, S
Too much information is presented in a single frame.	Typically a problem with text but can occur with graphics and even narration if too lengthy.	J
Information is too large for the screen or too small to be seen for required detail.	Usual problems with graphics. Can be a serious problem if video only is used for fine detail work without adequate lighting, angles, and lenses.	**S**, J
Sounds used are distracting.	Audio sounds may be irrelevant and become annoying after a while instead of adding to the learning environment.	J
File is too large for Web delivery.	Delay in downloading may inhibit learning process or be unusable.	**S**, J
Frames are very complicated and expensive to produce.	Animations, details, and colors may not be required for conveying the skills required. May impact budget and cost effectiveness of media.	J
Student finds it difficult to follow from one frame to another.	Frames may not be consistent in layout and navigational tools may not be present or adequate.	S
Student gets confused from one lesson to another.	No common guidelines between designers and writers.	S

Note: Fix categorized as J = judgment and S = standards (bold indicates it is more important).

Advantages of IMI to Training Immediacy Interactive multimedia instruction can get in-depth asynchronous training to everybody, everywhere quickly by using CD-ROMs to store and deliver the training. With CD-ROMs there is a great opportunity to include substantial amounts of video and other graphics. The speed of distributing the courseware can even be made greater if the courseware is designed for use over the Internet. Being able to reach all of the students at the same time almost regardless of location is an extremely powerful advantage over other methods that are constrained by the availability of students, facilities, and instructors.

Disadvantages of IMI to Training Immediacy At the present time, IMI cannot be used practically for Web-based training if the files are too large (because of the graphics containing long video sequences, bitmap photos, or heavily graphic animation). If last-minute changes are required, it can cause a significant delay in the release of the courseware while updates are being made. If CD-ROMs are used, new CDs may have to be cut. If not done well, IMI will still need to provide a substantial period for students to contact instructors, retake the course, or seek other assistance such as peer help. Longitudinal studies are needed to determine if the absence of a human will have a significant impact on long-term retention of material compared to live instruction. Investigations show that certain students will not be comfortable in an unstructured environment where an instructor is not present (Abell, 2000; George et al., 2001; Lee et al., 1996).

22.3.3 Training Efficiency

To adequately address efficiency of the training methods, it is important to examine the strengths and weaknesses of both development and delivery. Costs must be addressed considering both monies expended (what does it cost to develop an hour lesson of instruction) and performance efficiency. To accomplish the latter, a measure of efficiency (MOE) is needed that compares student and instructor time spent against expected student performance. This allows the training manager to assess the potential value added by each student for the amount of investment.

Costs Associated with Development In this category we consider the costs associated with the development of the product to where it is ready to be used by either an instructor or a student. Actual costs will vary depending on location of the work and the workforce, the nature of the topic under development, the requirement for subject matter technical expertise, and the technical approach used to prepare the courseware. The first two factors are self-evident while the latter factor refers to the method in which training development personnel are assigned tasks and how they function.

Costs of Traditional Standup Instruction Standup Instruction can be prepared quickly because it is typically prepared by experienced staff that work from a previous plan of instruction (POI) built for similar systems. They may likely get access to early draft materials from the system developer such as draft technical manuals (TMs). Following an outline they can easily prepare sufficient vugraphs to conduct a class. Under conscientious management, the developers will be given access to engineers and other subject matter experts (SMEs) to develop the initial materials. They may be able to photograph the equipment or mockups in the shop. The costs associated with this development can be as low as 40 hours development time for 1 hour of instruction.

Vugraphs prepared to support this type of training typically contain entirely too much text to be effective as a visual media. So the reliance and success of the technique is on the dynamics of the instructor. On the audio side, the narrative is presented simultaneously with what appears on the screen. If the narrative and screen cues are totally unrelated, you now have inefficient media, because they are competing for the student's attention. If the instructor is dynamic, he or she will first call attention to a major teaching point on the screen and then proceed to support, enlarge, and reinforce the teaching point with examples, anecdotes, and questions to stimulate the students' responses. However, the keyword is *if*. To make instructors consistent, you must take time to develop a script or detailed outline in your plan of instruction. This takes time and additional funds and is not always effective. We have all witnessed the instructor who, not wishing to miss any major points, stands behind a podium and reads a script verbatim. The students' time is now not being used efficiently; some may be snoozing or daydreaming.

If vugraphs are used with good graphics, they take time to develop, and the cost goes up. If videotaping is used to avert the need for drawings, it takes time to prepare and shoot a proper script. If nonprofessionals do the videotaping, it will usually be less than perfect in terms of camera angles, jumpiness, shadows, and general composition. If professionals are used, it is expensive, especially if you need the work done quickly as you would for a new system. It also can no longer be readily updated so the speed advantage is taken away.

Costs Associated with Development of IMI The major drawback for using IMI is the initial cost of development. Good, highly interactive IMI has been known to require 300 hours of development time per hour of instruction, which can mean costs ranging from $20,000 to $40,000. The more animation and interaction that are inserted, the higher the cost. Interactive multimedia instruction is usually referred to in terms of levels of interactivity supported by the IMI from simple page-turner (level 1) to exceptionally complex interactivity based on an intelligent learning model that adjusts to each student (level 4).

Another major reason IMI is not used more often to support new systems is the total length of time that can be required to prepare it for delivery and use. A single course of 130 instructional hours can take up to two years from the time of task analysis to final delivery of a useful product. A painstaking sequential process is generally pursued following task analysis to first develop outline storyboards, decide on the right mix of media, develop the media, go through the editing and review process, add narration and other audio, and assemble each lesson. Then the lessons are staffed allowing a certain number of weeks for review. After all comments are received, the entire development process is repeated to accommodate the changes. If hardware changes occur at the last moment, it is very difficult, if not impossible, to recover. When the lessons are totally prepared they are loaded on the server if they are to be part of a Web-based course. Validation is then accomplished with target audience students using the materials directly from the Web.

Costs and Savings Associated with Time Spent in Training Given that two courses using different media have been validated as teaching the required skills and knowledge, time spent in training can be used as an MOE of each media to deliver training to an individual (e.g., the time it takes the average student to get through the course). The efficiency of each medium can also be determined in terms of meeting the needs of all students collectively (e.g., the time it takes to get all students up to standard). Finally, the time required for each media to sustain the acquired skills can be compared.

Costs and Savings Associated with Traditional Standup Instruction Instructor-led live instruction can save costs because it can be easily changed in place to accommodate a specific target audience. This can reduce the amount of time spent in training if the majority of students indicate by either pretest or in-class discussion that they already know certain materials. The instructor can reduce the amount of instruction required or even bypass certain lessons or parts of lessons. Because this method is live, it is also flexible, and the instructor can improve on the course as he or she goes from group to group and discovers deficiencies or ways to improve the instruction.

Traditional live instruction can incur significant costs, however, since it may require that a great deal of time be spent traveling to each site for instructors or to a training site for the students. Travel may consume an entire day and, if delays are encountered, can result in fatigue before training has even started. Frequently, equipment must be carried along, which at a minimum is expensive and inconvenient to transport. The equipment may also get damaged and may not work upon arriving at the site. These indirect costs can be significant and must be covered in any study of cost–benefit analysis. Experience has shown that another significant cost to traditional standup instruction is that if instructors visit a work site they will have to repeat that visit periodically because of turnover of personnel. The alternative is to develop a train-the-trainer package, which adds to the cost of the program and represents another set of documentation that must be kept current. Traditional training is also "lockstep" in mode. This means that, on the average, unless the student population is unusually homogeneous, the brightest students will be spending hours in the classroom unproductively while attention or time is given to the slower students. The temptation will usually be to leave the slower students behind to catch up later as best possible. This latter group will, therefore, not spend as many productive hours in the classroom as needed to meet the standards of training. These students must be retrained, and the costs must be added to the program.

If traditional instructional methods are used, especially in connection with VTT, to squeeze more students into each class to drive down the cost per student, this must be approached very cautiously. There are limits to the number of students that can be attended to simultaneously to give each the opportunity and requirement to respond. This has been found to be about 8 to16 students per site, especially for technical subjects, and with VTT no more than three or four sites, even if only 8 students are located at each site. With any higher number of students or sites, efficiency quickly turns to inefficiency because the unattended students fail to learn to mastery. They will need to be retrained or learn on the job and risk inadequate performance and remain unproductive while learning. These costs too must be entered into any cost–benefit analysis.

Costs and Savings Associated with IMI If properly executed, IMI can be very cost effective. Cost savings have been validated in many different areas. For example, many studies have shown that the time required for training a task to a measured standard can often be reduced by 20 to 30 percent over a traditional means of instruction. As a hypothetical example, consider that 100 employees earning $100 a day are being trained together in a course requiring five days or 40 hours. If the same performance can be achieved in 20 percent less time, that would equal 8 hours or one day. In pay that amounts to $100 per student and a total of $10,000 for the group.

Another type of savings validated is travel time. In our hypothetical example, if the students were delivered IMI at their company location or their home, they could save on average $1000 per person in total travel costs (e.g., transportation, food, and lodging). That would amount to a total of $100,000 in savings for that cost. If you consider that they are sometimes paid for traveling on travel days, that could amount to another $100 to $200 per student and an additional $10,000 to $20,000 for the total group. The bottom line is that if you trained four or five such groups annually, you would recoup your investment within the first year and get all of your personnel trained effectively. Moreover, they could use the same courseware to sustain their skills over time.

A third type of savings documented, though not as universally studied as the above factors, is the time and cost of training equipment and materials saved when students are learning to operate or repair an item of equipment. This is for the hands-on phase after completing the knowledge phase of training. In studies of marksmanship, trainees require fewer rounds of live ammunition to qualify. In studies of both operation and maintenance, IMI-trained students make fewer mistakes, thus reducing wear and tear on the end item (Ross and Yoder, 1999; Throne and Lickteig, 1997).

Note that these are cost savings associated only with training. Because more students can be brought to greater competency quickly, the cost savings due to improved performance on the job can be well above that expected with more conventional training. Moreover, students will be able to access the training for refresher training at any time and therefore sustain their proficiency, whereas conventionally trained personnel can be expected to have a steeper decline in retention, particularly for tasks infrequently performed. These are perceived advantages that have not been adequately tested. Metrics do not exist for assessing training impact over the life cycle of a system. While strong rational arguments can be made for the efficacy of IMI, the fact remains that we do not know the long-term impact of the technique. It can legitimately be questioned as to whether IMI alone can ever provide a satisfactory solution. Long-term studies are clearly required. The few that have been done comparing any types of media and techniques typically show no significant difference over time. Many other factors such as motivation account for long-term performance. It has been suggested that the question can be partially answered by channeled metrics that can be used to attribute performance to a particular method. Examples of such metrics would be the need for refresher training looked at in terms of elapsed time (how soon is it required based on performance tests and work records), frequency (how often is it needed), and length (how long of a training period is needed).

In summary, there is mounting evidence that traditional instruction may not be as effective, immediate, or efficient as needed by new systems when compared with the possibilities offered by new IMI technology. Although there are clear, short-term cost-effectiveness advantages, some real issues remain to be clarified in terms of long-term training and cost effectiveness.

22.4 HSI APPLIED TO TRAINING DEVELOPMENT PROCESS

As powerful as IMI appears to be, equally powerful are some of the drawbacks that prevent it from being applied to new systems. The challenge is to reengineer the training development process such that a large IMI project can be completed on time, within a reasonable budget, and still be able to reap the outstanding benefits of IMI that have been listed above. In this concluding section we present a new paradigm for the production of IMI. The procedures described below are based on a commercial program called The Courseware Factory.[2] It is in essence a marriage of the old concepts of mass production and efficiency studies with new concepts of information management made possible by powerful computers, servers, database technology, software such as Hyper Text Markup Language (HTML), and the Internet. UTOPIA[3] is a unique tool for authoring and data management that has made execution of this paradigm particularly reliable and cost effective. The specific examples shown here are based on UTOPIA; however, the principles illustrated can be applied using other similar tools to achieve the same general benefits.

The principles used by UTOPIA are illustrated with the following topics:

- mass production,
- analysis of the bottlenecks,
- reengineering the design and development process,
- new tools for the designers and developers of IMI, and
- additional tools and methods.

22.4.1 Mass Production

One of the tenets of Henry Ford's mass production process is use of an assembly line that is laid out in logical, usually linear order that supports continuous production. Specialized activities are carried out at each of the workstations, and the number and type of workstations are determined by the classic and proven instructional systems design (ISD) model. Typically, a training developer is assigned to perform each of the ISD functions shown in Figure 22.7 for the assigned lesson. Functions would be performed linearly with the cycle beginning again following student or customer feedback.

The training production process for an IMI production facility would begin with a similar streamlined approach adding technology specialists to the process. Figure 22.8 shows the role of each of the specialists in the production sequence. Interactive multimedia instruction requires specially trained graphic artists who prepare new types of graphics such as animation made feasible by computer software. If the IMI is to be Web based, personnel are required who have training in that specialized area. Audio specialists and narrators are other special skills required for comprehensive IMI.

22.4.2 Analysis of the Bottlenecks

F. B. Gilbreth's principle of breaking a task down to its most basic activities to study how it can be done more efficiently is applied to the above classic model. There are at least two

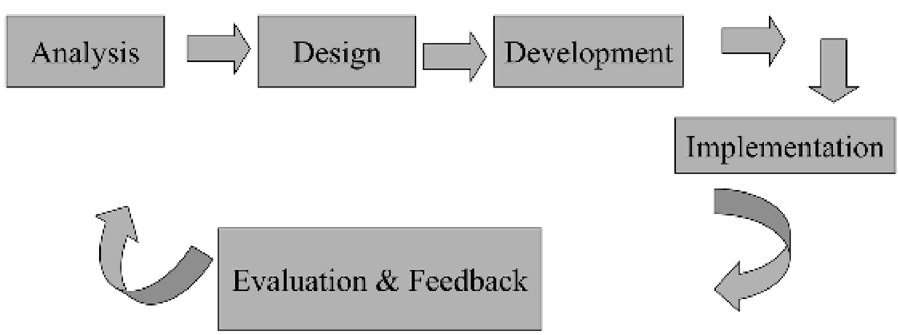


Figure 22.7 Instructional systems design model.

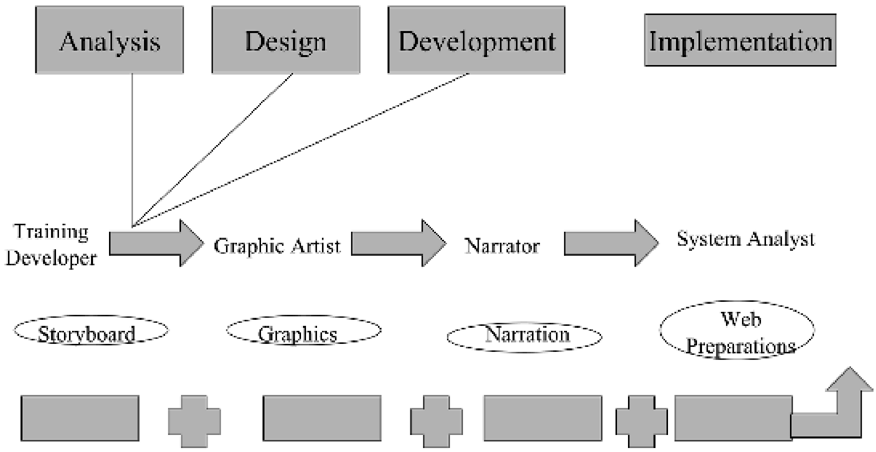


Figure 22.8 ISD model applied to IMI production.

major bottlenecks that can occur in the production of IMI of any scale when the linear model is followed: (1) the process itself and (2) evaluation of the product.

Linearity of the Development Process The process itself can be a major bottleneck because, as noted earlier, it has been developed linearly, which generates queues. Instructional designers must generate storyboards, usually starting with the output of a task analysis that lists the task, the condition, the standard that must be achieved, and then the task elements or details. The graphics specialists, narrators, and system analysts usually wait until this process is done to take their turn to act on the product. Figure 22.9 shows the linear flow of data as modified by each specialist.

When the courseware designer has completed a few draft storyboards, he or she will discuss the required visuals item by item with the graphics designer. When the graphics are completed, the screens would be produced and would have to be checked by the designer. Next, the narration would be prepared and added. When the lesson designer has written the narration, the narrator can then proceed. Note that if the narration is to be synchronized

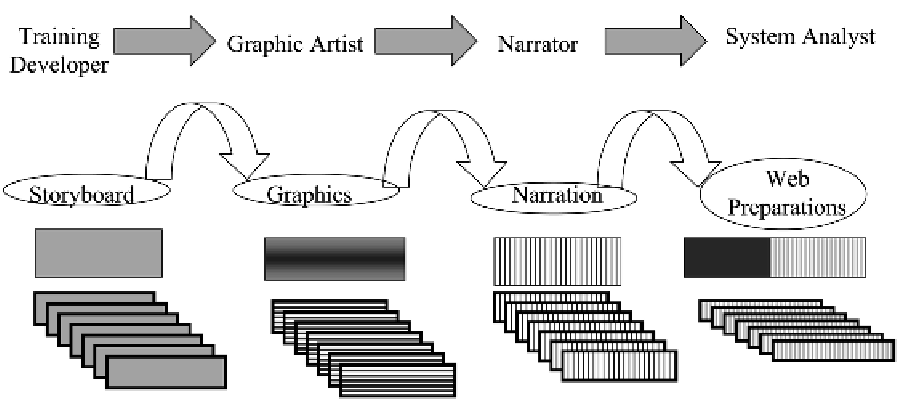


Figure 22.9 Linear development model—production stage.

with the action in the text and graphics, the designer must carefully script the cues and work with the narrator and audio engineer. If the narrator is in a far removed studio when recording the narration and discovers apparent glitches in the script, there must be either a temporary halt or a scheduled update to the session; this increases the bottleneck. When the narration is done and added to the screens, the designer must again check the product. Finally, the product is turned over to a systems analyst who applies appropriate coding and adds other details so the product is ready for testing for transmission from the website. If the analyst uncovers problems such as size of files being too large to move over the Internet, graphics not fitting properly on the screen, text being too small or runs off the screen and cannot be seen, the product must be returned to the designers, graphic artists, or others for an appropriate fix.

Application of Quality Control Functions The second major bottleneck is evaluation of the product. Figure 22.10 shows that there are at least two major layers of quality control review that enter the production queue. These reviews, if performed, can create serious bottlenecks for the manager.

The supervisor may at any time wish to (and should) either spot check or perform a complete review of each lesson. Serious additional bottlenecks arise if you expect the designer and developer to continue work on new tasks and attend at the same time to the supervisor's review. If designers or supervisors have all the materials in their possession to do the evaluation, it means that others do not have access, and the bottlenecks continue. Multiple copies or a shared drive can be used but must be carefully orchestrated and controlled by the designer to ensure all inputs are correlated and entered into a master copy. This process consumes a great deal of time if done correctly, and meanwhile the designer is not able to move forward on new material development. Still

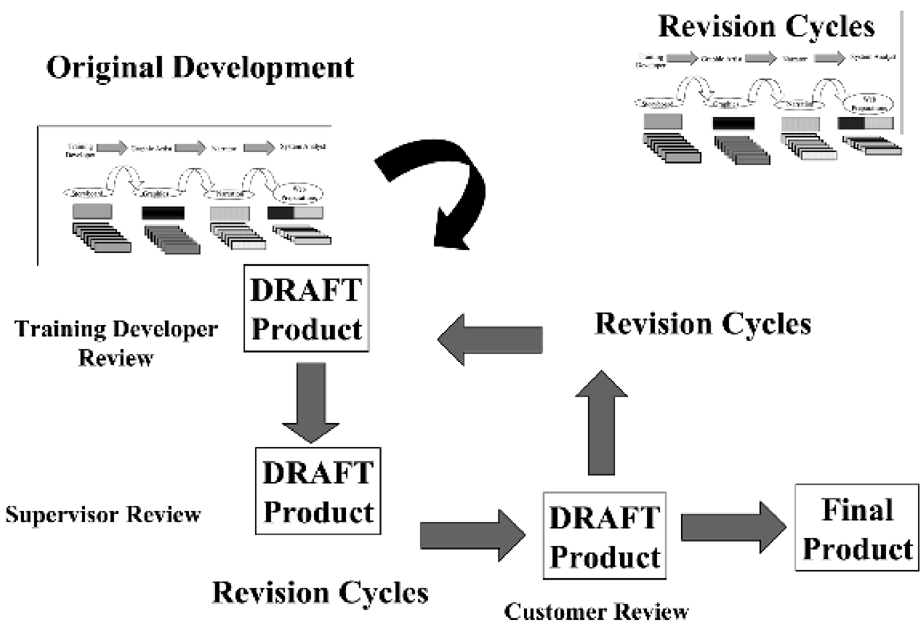


Figure 22.10 Linear development model quality control stage.

other serious bottlenecks arise if the supervisor evaluates the lessons of several designers and developers who are all working on lessons that belong to the same course and discovers that the styles are too different to be used in the same course. If some of the designers must reformat their lessons to resemble the other lessons, the bottlenecks continue.

At various points along the way the users or customers of the product also expect to review the product. When they do review the product, they again initiate their own internal queue going from department to department and evaluators and supervisor. When they return the product, they expect to see the changes that they made and have an accounting of the disposition of their comments and whether or not they were resolved. The product or answers must then be prepared by the development staff and returned to the customer. It can readily be seen why IMI production is a very time-consuming process and why to attempt to do it on a massive scale has run into serious difficulties.

To overcome these problems, HSI engineering principles can be applied to all stages of the process. First, the design and development process can be reengineered. Second, tools and methods can be developed to assist in the production and control of products that can lead to standardization and high quality. These methods must still be coupled with training and job performance support materials for all employees and supervisors to ensure proper execution.

22.4.3 Reengineering the Design and Development Process

Methods to overcome the bottlenecks are based on certain principles that, while traditional and time honored, lend themselves well to solving the new problems of development of technology-based training. These are small-team concept versus individual effort, synchronization of multiple teams working in parallel, and continuous quality control.

Small Team versus Individuals The workstations are broken down to provide individual teams consisting of a training designer to develop or author the lesson and a graphic artist who is also assigned other application responsibilities, such as loading the storyboards, graphics, and narration into the database. Together they have the responsibility to generate the first stage of the lessons.

Synchronization of Multiple Teams Placed with these personnel are other teams who also produce lessons for the same course. Assigned to the entire group of teams are Web designers who load the material and test it for suitability for transmission over the Internet with major browsers to ensure usability as Web-based instruction. In order to standardize the output across lessons, one lesson author and one graphics specialist are designated as leads in their respective specialties. The entire group is assigned a chief who can work directly with the customer to determine both product and schedule. This organization could be nested and replicated as necessary to accommodate large production efforts. Figure 22.11 depicts such an organization sharing a networked database. This organization allows for efficient use of specialized skills as well as a free flow of information in the production of IMI.

Principles of Quality Control Quality control must be done as a major, multilevel, continuous process and not as an end-state process when it is too late, a “lip service” check that is worse than no checks, or an after-the-fact check after poor products are

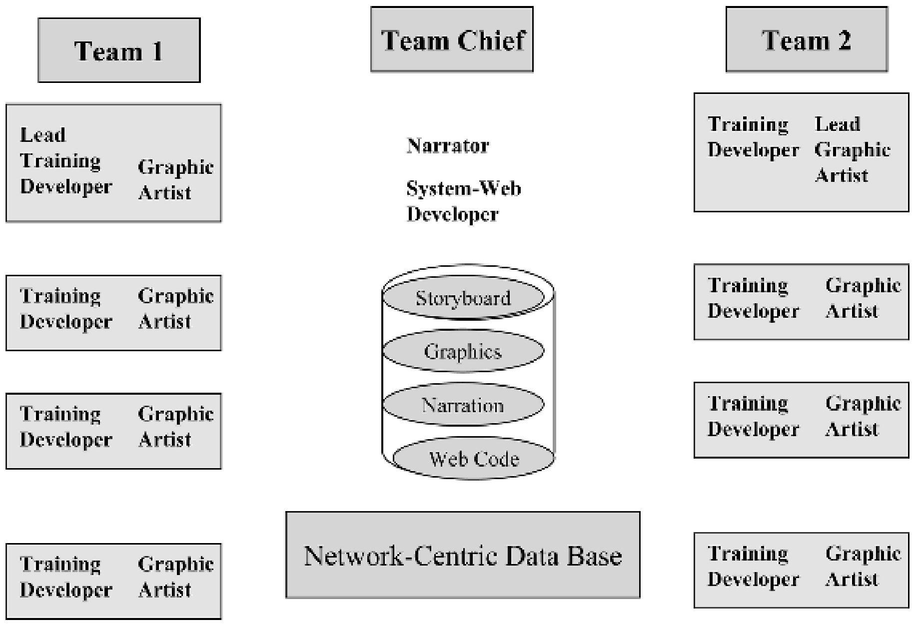


Figure 22.11 A model production assembly.

delivered. Beginning at the very top, there must be a production manager who watches both quality of products and schedules across the entire assembly. For each lesson and course there are two additional levels of checks that can be done to assure standardization and quality: the lead designers (content and graphics) and the group chief who oversees all lessons going into a course. In addition, the system developer could serve as a further quality control check if items do not load on the server properly or cannot be retrieved properly through the website.

To continue the analogy to a mass production factory, the requirement is to create a process to produce a series of lessons that all meet certain standards (effective in conveying the skills and knowledge to the criteria required) that have the same “look and feel” across all lessons to relieve the student from having to learn new navigational skills or encountering confusing formats because the lessons were designed by different authors. These same lessons must be usable on the Internet (efficient). Each course must be custom designed to meet a particular customer’s needs and delivered on time as requested (immediate).

22.4.4 New Tools and Processes

New tools are being continuously developed that have been made possible as a result of the information revolution, including use of authoring systems that use a network-centric common database, automate the generation of products, provide on-line access, and leverage the use of templates.

Common-Use Database Figure 22.12 illustrates how a database should be designed to allow multiple authorized users simultaneous access to the database. With simultaneous access to a central database, the lesson designer can be working on one storyboard while

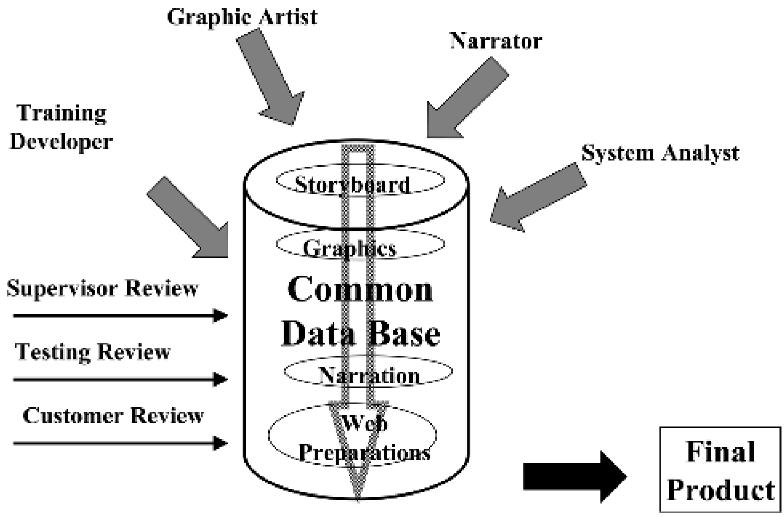


Figure 22.12 Network-centric nonlinear development model.

the graphics designer is accessing another storyboard to see what graphic has been requested. The lead designers can call up still other storyboards to check on progress and quality. At the same time the designer is preparing storyboards he or she can also be preparing instructions for the graphic artist describing what is needed by way of graphics. This is done on the same document accessed on the database. Thus, the supervisor and other reviewers can simultaneously use the same data.

Use of Templates To generate a consistent product efficiently, there are tools to assist team members to perform their roles. The tools consist of an authoring tool featuring automated protocols and templates making data entry and retrieval into and out of a database very efficient. The database should contain templates for a variety of types of frames and graphics that will serve as a job aid, serve to generate a consistent product, and allow for speed in application, as will be illustrated later. With a single click the lesson designer or graphic artist or supervisor can cause the storyboard to be formatted for a preview or with another single click the entire lesson (in whatever status it may be in at the time—text only, text and graphic, text, graphic, and audio) can be generated and viewed as if a student were taking the lesson. It should be able to be refreshed at anytime. This will make the process ideally suited to handle last-minute changes that arise with new systems. Additional features and functions of these recommended tools are described below in the context of the roles they support.

Using object-oriented programming, lead designers and chiefs can select certain templates based on customer input and target audience descriptions, which are then required for use by everyone working on individual lessons. This enables the design team to quickly generate a consistent product. One way to be consistent is to require graphics to be generally placed into a certain quadrant of the screen for all lessons. For example, all or most graphics may be on top or bottom of the screen or left half or right half, so the student always knows where to expect the graphic and likewise the text to occur. Figure 22.13 illustrates two frames that have the graphic in the same location (in this case, the upper two-thirds of each frame is reserved for the graphic).

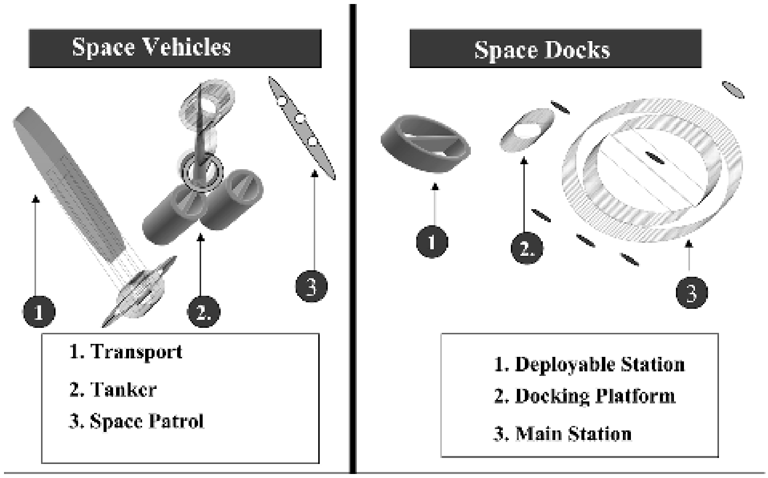


Figure 22.13 Examples of "upper$\frac{2}{3}$" graphic layouts.

A useful template here would allow the author/designer to display text he or she is generating for a screen to see if the text will fit the remaining space, given that space is reserved for the graphic. Note that the actual graphic does not need to be created in order to do this; only a template need be used. An example is provided below where this particular authoring tool automatically generates a screen so the designer can see how the layout will appear to the student. The designer can immediately make changes to ensure that the text fits properly and is displayed properly. In Figure 22.14 the illustration depicts a

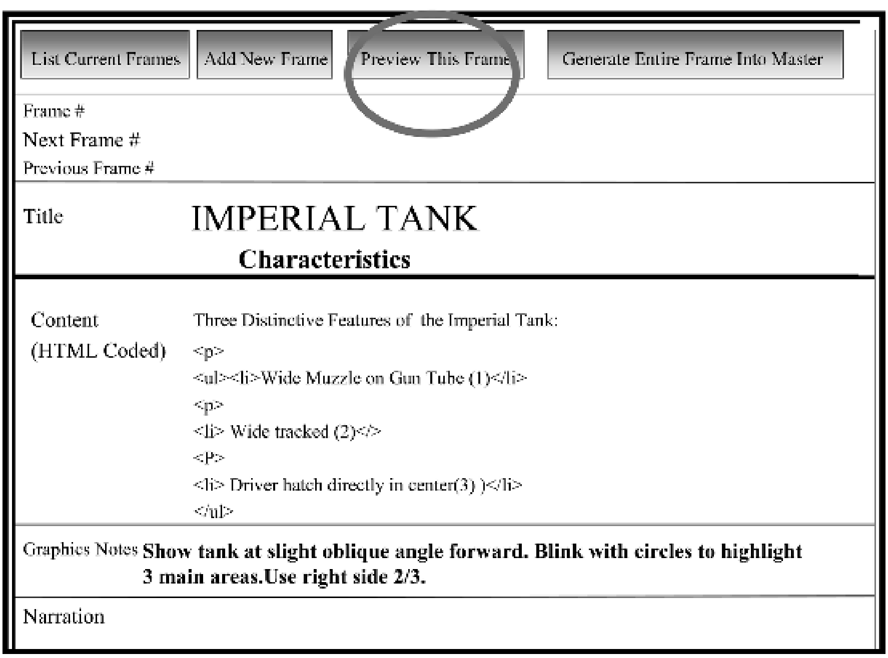


Figure 22.14 Net-centric authoring screen layout.

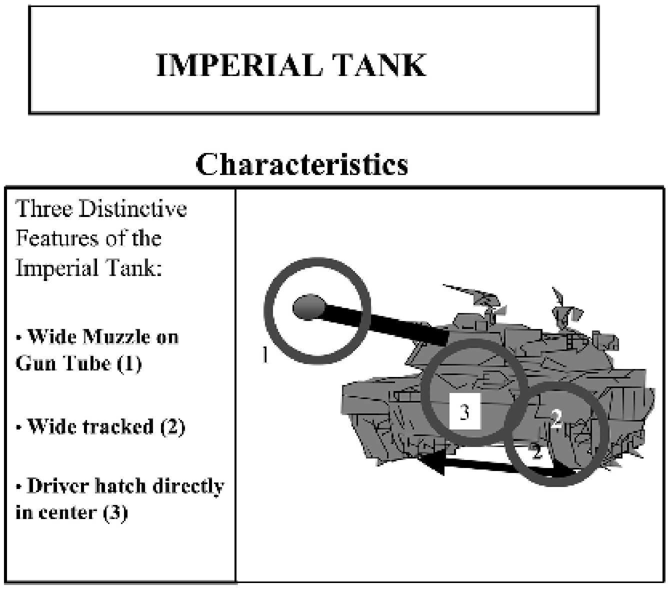


Figure 22.15 Composed screen with graphic added.

comprehensive storyboard that is Web based. The designer can type in the content with code. Then with a click a preview of the screen can be called up to determine if both text and graphic will fit properly (see Fig. 22.15).

This process alone saves countless hours when graphics are being prepared because it saves both designer time and artist time and shortstops false starts that may have to be changed later when either the graphics or text prove to be too large or not usable for the screen. Likewise, at the same time the designer also enters the draft narrative on the same document that will supplement and enhance the graphic and text. Figure 22.16 depicts the same storyboard as above but with narrative added.

This is ideal because the developer is focused on the learning strategy and can immediately capture the narrative while still thinking through the process. This again saves time so that the developer does not have to refocus his or her thoughts later and try to create the narrative at a later time. The same tool allows the designer to assign numerical codes to each storyboard so that sequencing can be done, interaction can be supported, and navigation can be supported. Once the numerical tags are assigned, the tool takes over. The tool generates the text screens, the new screen with addition of the graphics, and a narration report that becomes the actual script to be read by the narrator.

Tools for Graphic Designer The graphic artists could draw a variety of catalogued graphics from a library and also prepare new graphics using contract-furnished illustrations. When required, graphic artists and developers can digitally photograph the items required at customer sites. These photographs and line drawings can then be changed and enhanced with software to other forms such as vector graphics to enhance the graphic and use it for animation. In this way animation sequences can be devised that use less file space than photographs and make highly interactive Web-based IMI practical. Figure 22.17 shows stages of a simple line drawing being enhanced to more closely depict real

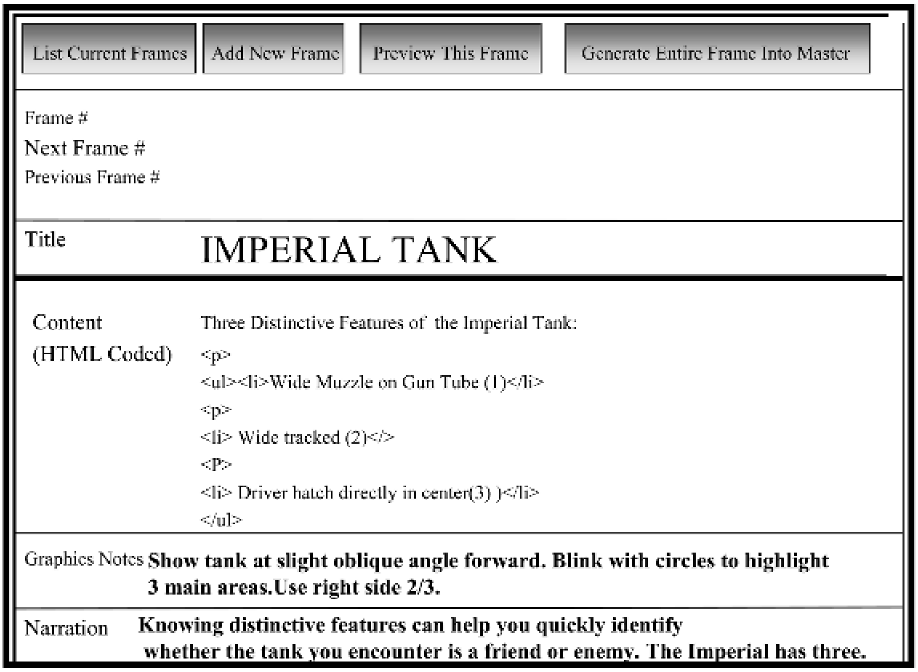


Figure 22.16 Authoring screen layout with narrative.

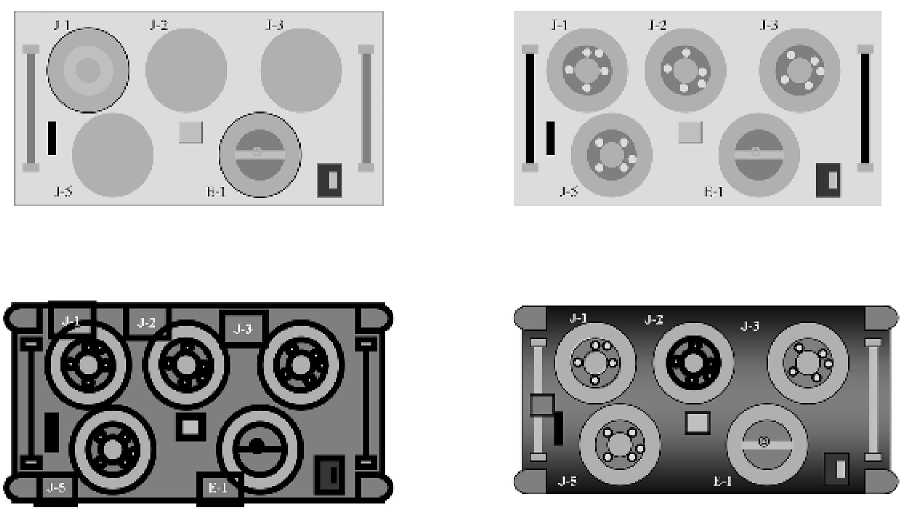


Figure 22.17 Example of enhanced graphics.

equipment without having a large file size required for the illustration. This is currently critical in Web-based training that must reach users with a wide range of receiving capabilities.

Tools for Narrators and Audio Engineers Being in-house, the narrator, audio engineer, and lesson designer can quickly meet to go over any problem areas whenever they arise and are able to fix them on the spot. The audio engineer may also wish to maintain a library of copyright–free music as well as sound effects that could be used to enhance a lesson where required. He or she can advise the designer of both the availability and suitability of audio cues and stimuli beyond narration. In-house personnel can be used as the narrators for the draft lesson as well as the audio recording and editing tasks. This method allows them to aid the audio engineer as to the intent of the narrative and allows them to serve as an immediate quality control for the designer.

The draft lesson with narration is made accessible to the customer to ensure their preferences are met. When the audio is sufficiently ironed out, a professional narrator is brought in to complete the narration. The lesson designer is usually present in the event of any questions. Because the system is stylized and standardized, there are rarely major problem areas that are required to be fixed.

Software Application/System Developer/Web Developer The system developer loads the draft narration so the lesson designer can actually audit the lesson storyboard by storyboard to determine if any changes were required before the same script is turned over to the customer for review. Later, the developer reloads the narrative when the professional narrator has completed the lesson.

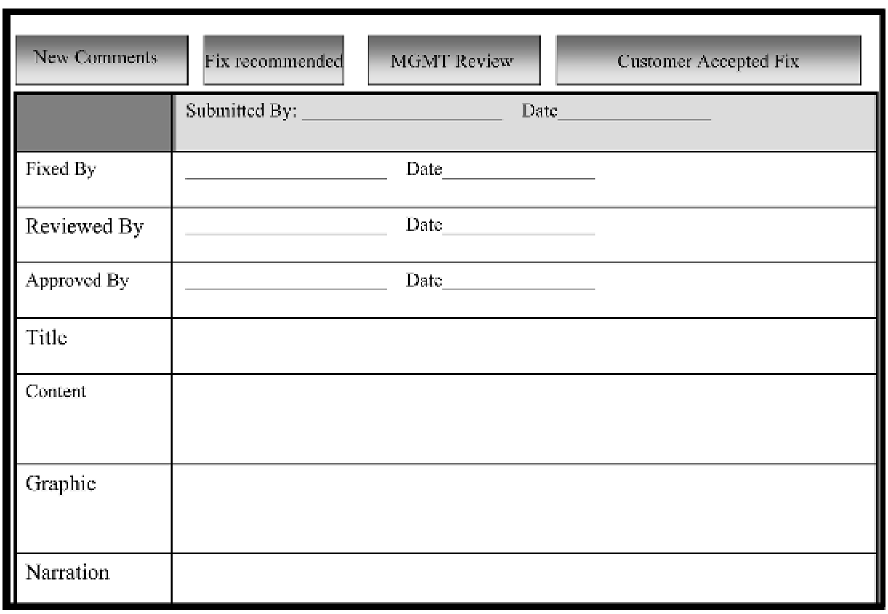
The system developer will next load the entire lesson outside the internal firewall and determine if any problems are encountered when two major browsers are used to access the lesson. When the developer is satisfied that the lesson can be delivered, it is ready for release to the customer who can review the product.

Role of User When feasible, the user should be involved throughout the development period. Representatives of the target audience can provide required insights as to skills already attained, aspects of the work environment that may influence how a skill is conveyed or practiced, and how the developing formats meet their needs and expectations. Still other user representatives may provide the subject matter expertise that ensure the lessons are technically correct before they get to the field for testing. When it is not feasible to have the users available, the developer should seek surrogates from within his or her own staff and ensure that the development process gets back to the users frequently.

In-House Evaluators/Independent Testers In addition to the group leader doing spot checks to ensure the look and feel are following the customers' preferences and are consistent, the production manager, subject matter experts, and formally assigned editors review the lesson. Clarifications to text, graphics, audio, or inherent training strategy may be requested. This may be done with only a sample or, if spot checks show the product as high quality, essentially an alpha version of the entire lesson. In this latter instance the product may simultaneously be released to the customer in order to speed the review process.

Streamlining the Review and Follow-up Process The same database that allowed the lesson to be built can now be used to support the review process. The special tool supports free play review by multiple authorized (password-protected) reviewers simultaneously worldwide. They can review the entire lesson frame by frame and with a single click be able to submit a comment, correction, or suggested change that is automatically cataloged by frame number and identifies not only the comment but also the comment owner and the date of the comment. The tool generates a special report on-demand available again to authorized users who can view all the comments. The comments can be reported and sorted by date, user, or subcategories of the course or lesson. The lesson designer, or if deferred to the supervisor for sensitive comments, can then generate the deficiency report (DR) and respond to each item right on the same report. He or she can correct the database and report what action was taken in the report. Typical items to include in a DR file for both management and archival purposes are shown in Figure 22.18.

A quality control person (evaluator/tester) will then verify that the correction was made and that the response was appropriate to the comment. Thus, a customer or supervisor or any reviewer can determine the status of their comments as to whether or not the problem was understood, who made the correction, and whether or not the correction was validated and when. There is, of course, opportunity to simply comment in reply with no further action when a satisfactory answer or rationale can be given as to why something was presented in a certain way. Sometimes the comment is simply laudatory in nature, which helps designers to know they are meeting their goal. At any rate, the lesson will not be released until all such comments have been satisfied and validated. The speed, precision, and simplicity of this process again make it ideal to support new systems that continue to be refined.



New Comments | Fix recommended | MGMT Review | Customer Accepted Fix

	Submitted By: ____________ Date____________
Fixed By	____________ Date____________
Reviewed By	____________ Date____________
Approved By	____________ Date____________
Title	
Content	
Graphic	
Narration	

Figure 22.18 Deficiency reports of resolution.

Test Questions and Exercises To ensure training effectiveness, a large pool of test items are prepared for the customers' approval based on the task analysis and target audience assessment. In-house personnel and later target audience personnel are administered selected test items as a pretest that cover all critical tasks. Given that the students are expected to not know the majority of questions, a pool of items in the same category including some identical questions are administered as a posttest to validate that the lesson has conveyed certain knowledge required to perform certain tasks. Treatment of training effectiveness is beyond the scope of this chapter. It is important to note, however, that such testing of relevant skills and knowledge is an absolute requirement to ensure training effectiveness.

Throughout the lessons about every fourth frame seeks to elicit a response from the student to ensure they have acquired the knowledge of those immediate frames. The tests and exercises given at the end of the lesson topic are also used as a means of reinforcing that knowledge. Figure 22.19 shows an example of an end of a section within a lesson on the setup of an item of equipment. The task requires that the correct cables and connectors be mated and that the ground wire be attached first to prevent a hazardous condition. The student would be required to know each of the cables and connectors in order to be able to pass the test. The student's ability to complete the procedure without error would indicate mastery of the knowledge required to perform the task completely and safely.

22.5 SUMMARY AND CONCLUSIONS

An HSI approach to new systems training can provide a process whereby personnel can be trained effectively, immediately, and cost effectively. The new technology provided by IMI is essential to this new process, provided the strengths are utilized and the weaknesses

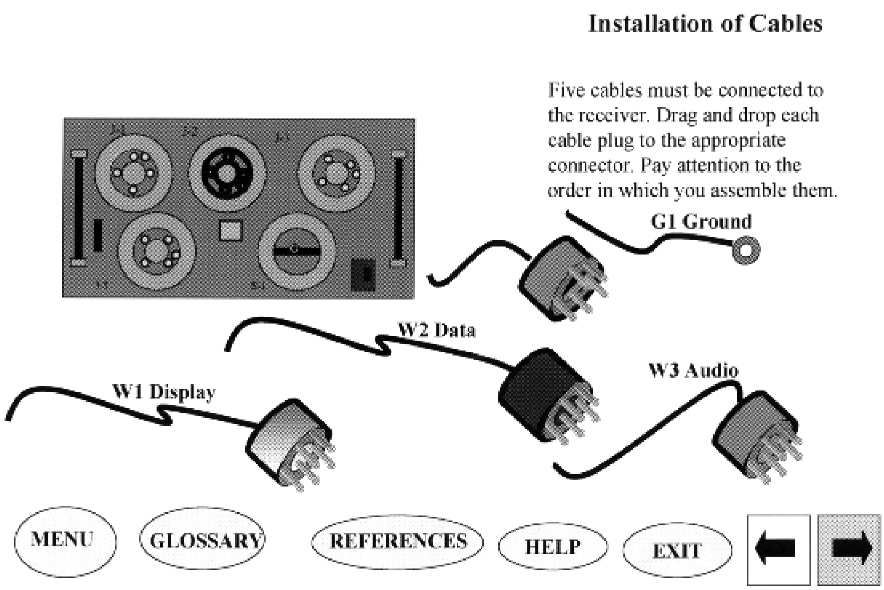


Figure 22.19 Example of end of section test.

controlled. The chapter discusses the major process changes and concepts that can make IMI a viable candidate to support new systems training. These changes and concepts are summarized under the three critical requirements for personnel training on new systems:

1. Personnel must be trained effectively. This requires an IMI production process having the following:

- continuous and timely quality control with production supervisor oversight and incremental testing and review;
- IMI designed to use the proper mix of audio, text, and a full range of graphics;
- IMI designed from the student's perspective, including, as a minimum, a) a useful demonstration of the task understandable by the student, (b) capability for the student to perform the task, (c) capability for student practice, and (d) feedback of student performance; and
- experienced personnel leading the project, staff adherence to a common look and feel, and building competency among all production staff.

2. Personnel must be trained immediately. This means training development must be completed on time with the fielding of the new equipment despite last-minute changes. This is feasible for the following resons:

- It is now possible to simultaneously work and review draft training materials using the same database.
- Team and multiple team concepts can be applied.
- The DR process provides for rapid simultaneous worldwide reviews and fixes.
- The acceptance process can be streamlined, allowing the customer to see the changes requested and the supervisors to have complete oversight of the progress.
- Internal testing of the first draft greatly reduces need for subsequent changes.
- The product can be placed quickly outside the internal company network and be made available, with password protection, over the Internet for customer review. This will allow customers to review the product at their leisure, home site, or even their home. Access to the Internet and one of the two major browsers is all that is required.

3. Personnel must be trained efficiently (i.e., at least cost). The IMI production and delivery process can be cost effective by introducing actions like those that follow:

- Documenting the process with audit trails to show the customer the basis for any designs as well as provide a strict accounting for time and effort spent in development.
- Using procedures that provide ability to work concurrently, rather than linearly. This includes use of templates, reuse of data including graphics, and having free access to a common database.
- Training and sustaining acquired skills for many personnel simultaneously worldwide via CD ROM or Web-based training.

In conclusion, we have found that by determining and analyzing the bottlenecks of the training development and delivery process for new systems, it is possible to define a new set of efficient training requirements. These new requirements can be fully met through reengineering of the development process and by providing new tools and methods that are now cost effective because of improving information technology. Using these methods and tools as part of an HSI approach to new systems training, it is now possible to develop and deliver effective training materials on time and at reasonable, competitive costs.

NOTES

1. Stapp (2001) was a major source for the background literature in this chapter. Compton (1999), cited in Stapp (2001) annotated bibliography, states that historically over half of all sales and field force automation projects have failed.
2. *The Courseware Factory*™ process was devised by the coauthor, William A. Stembler, in 1996.
3. UTOPIA is a proprietary tool developed for Computer Sciences Corporation by Dave MacLuskie.

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