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Keeping current in a changing work environment: design issues in repurposing computer-based training for on-the-job training

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Abstract

This paper traces the process of repurposing a sophisticated computer-based training (CBT) program, the System for training aviation regulations (STAR), into an on-the-job training program. The original application was built for students training to be aviation maintenance technicians (AMTs). The new application has been repurposed to function as an on-the-job training aid for aviation safety inspectors (ASIs). Three training issues addressed within the body of this paper are: modifying the training program to fit a variety of training needs and audiences; keeping the training program current; and designing a program that grows with an individual. The first few sections of this paper review the original STAR research program. The latter sections trace the transition of the STAR approach as it is repurposed to meet the needs of a new target group, and the constraints and opportunities of a different training environment. Four conclusions can be drawn from our experience with repurposing the STAR program. First, it is much easier to build a resource that incorporates training than to build a trainer that somehow metamorphoses into a job aid. Second, the system needs to be highly modular. Third, applying a browser approach to interface design increases the options for how the system can be used. Finally, electronic publishing may offer some solutions for training systems that rely on living documents as the basis of their training.

Relevance to industry

As more on-the-job training programs incorporate computer-based training issues in the design of computer-based training to meet new training needs, audiences and work environments will become more important for industry.

Keywords: On-the-job training (OJT); Electronic performance support systems (EPSS); Computer-based training (CBT); Aviation maintenance technicians (AMT); Aviation safety inspectors (ASI)

1. Introduction

In technical fields, the training of an individual does not cease with the acquisition of their credential. The credential is only the beginning. A new recruit often finds himself or herself in an extended journeyman program where he or she is apprenticed to veteran workers. Veterans who are responsible for the new recruit's technical mastery find themselves in a constant battle to stay current with the rapid change in technology. In either case, on-the-job training is a necessary component of most technically based work places.

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Inefficient performance and a lack of competencies have been found among U.S. employees due to a need for apprenticeship-based training that cannot possibly be met in today's large, quickly changing, highly technical, information-rich work environments (Gery, 1991). There are simply not enough expert technicians to cover the continual training demands. Under these conditions, having a computer-based on-the-job training aid that supports the individual as he or she matures into his or her job is very desirable.

Electronic performance support systems (Brown, 1996; Stevens, 1995; Gery, 1991) comprise a new training and job support paradigm of which CBT is one component. Electronic performance support systems or EPSS are electronic technologies that promote optimal performance of the employees as they work. EPSS integrate and coordinate all aspects of a person's electronic work from the word processor he or she uses to the coaching he or she gets while performing a task. EPSS are designed to support the informational, training and operational needs of an employee as the needs arise.

This paper focuses on one aspect of the new EPSS paradigm: on-the-job training aids. The three main issues addressed within this paper are:

- How does one retain sophisticated training techniques in CBT while allowing one to modify the training program to fit a variety of training needs and audiences?
- How does one keep the training program current in technical domains where knowledge evolves rapidly and living documents are the norm?
- Can one design a program that grows with an individual as that individual matures into his or her job?

Specifically, this paper traces the process of repurposing a sophisticated CBT program the system for training aviation regulations (STAR) into an on-the-job training aid. The original application was built for students training to be aviation maintenance technicians (AMTs). The new application has been repurposed to function as an on-the-job training aid for Aviation Safety Inspectors (ASIs).

The first few sections of this paper review the original STAR research program. Included in the summary is a description of the target audience and the theoretical motivation guiding the STAR approach. The latter sections trace the transition of the STAR approach as it is repurposed to meet the needs of a new target group and the constraints and opportunities of a different training environment. A description of each of the learning environments in the new STAR for ASIs is included within these sections. In light of the analysis of this transition, recommendations for handling the three training development issues outlined above are presented at the conclusion of the paper.

2. STAR-AMT

The STAR project began in October of 1994. In the first six months of the project, a needs analysis as conducted and a prototype of STAR built on a Pentium 90 Multimedia PC in Visual Basic. STAR then went through a series of formative evaluations. The first evaluation was conducted in July, 1995, 10 months into the projects start, and focused on usability issues such as navigation, screen design, and perceived conceptual understanding. Evaluation two was conducted four months later in November. The second evaluation was designed to identify what kinds of learning would occur from the STAR-AMT experience. For a thorough discussion of these evaluations, see Chandler (1996). From the result of these formative evaluations, the interface of STAR was modified and its content embellished. In January of 1996, the STAR prototype was published on the Federal Aviation Association Office of Aviation Medicine's (FAA/AAM) Human Factors Issues in Aircraft Maintenance and Inspection 1996 CD-ROM. The CD-ROM is distributed to over 2000 individuals in the aviation industry. This concluded the first phase of the STAR project which formally ended in April of 1996.

2.1. Target audience

The target audience for the initial development of STAR consisted of aviation maintenance

technicians (AMTs) in training. They are students enrolled in a college or high school specializing in this area. Most of these students are new to aviation.

The training program for AMTs includes a course on aviation document research. Learning about the federal aviation regulations (FARs) comprises a substantial portion of the course. Below is a typical paragraph found within the FARs.

> (a) A certificated mechanic may perform or supervise the maintenance, preventive maintenance or alteration of an aircraft or appliance, or a part thereof, for which he is rated (but excluding major repairs to, and major alterations of, propellers, and any repair to, or alteration of, instruments), and may perform additional duties in accordance with § 65.85, 65.87, and 65.95. However, he may not supervise the maintenance, preventive maintenance, or alteration of, or approve and return to service, any aircraft or appliance, or part thereof, for which he is rated unless he has satisfactorily performed the work concerned at an earlier date..... (Summit Aviation, 1996).

Students tend to take this course early in their training program before they have had much general aviation experience. In addition, the material is dry, not intuitively organized, complex in presentation and content, and written in legalese. Students, according to their instructors, tend to take mental naps when they get to this portion of the course. Given their limited experience in aviation, they do not to see the relevance of what they are studying. Students also tend to get bogged down in the details of the FAR passages, missing the big picture. Instructors have few tools to make the material more vibrant and meaningful, relying heavily on reading passages out of the FARs and discussing their content. It is within this instructional environment that STAR was developed.

2.2. Theoretical approach

This section, covering the theoretical approach to STAR, appears in most publications about STAR. It is included here as a convenience to the reader. If you are familiar with other publications about STAR you may skip this section.

2.2.1. Multiple vantage points to complex information

There are two aspects to information complexity that have bearing on the instructional process. One is the relative difficulty of an individual concept. The other is the volume of information. In order to state 'I understand this concept', or to say 'I am an expert in this domain', one needs to be able to integrate components of a concept or domain into a scheme that can be readily demonstrated to others. A key factor to demonstrating conceptual understanding is the ability to identify relevant from non-relevant information. Conceptual schemes help to organize conceptual components and discern the difference between central and peripheral concepts. Taking multiple vantage points to a content area contributes to building conceptual schemes by providing overlapping information where the central themes tend to be repeated (Gordon et al., 1994, Ohlsson, 1986).

STAR-AMT is designed to help students acquire the 'big picture' about what the FARs' role is in aviation. This is done through developing a conceptual scheme about how the FARs impact the daily tasks AMTs must perform, and also what the AMTs' role is with respect to complying with the FARs. This is accomplished, in part, by providing many vantage points to the same body of information. Experiencing complex material, repeatedly, under different circumstances provides multiple opportunities to gain a deep understanding of the subject (Spiro and Feltovich, 1991). Each vantage point not only covers different aspects of the same material, but also reinforces different kinds of study skills. In this way, students are not only provided with multiple ways of viewing the information, but also with multiple opportunities to learn. In addition, information conveyed through one learning environment may best fit one student's style of learning, while the other learning environments fit other peoples learning styles. Thus, more people benefit when multiple approaches to the subject are taken.

STAR-AMT offers several different categories of learning environments: Overviews, Scenarios,

Challenges, and Resources. Each category holds one or more learning modules for students to explore. Overviews show students how FARs are organized, how different parts are related to each other, and who is responsible for what aspects of those regulations. Scenarios are interactive stories that set students into true-to-life situations where the regulations are applied subtly. Challenges require students to exercise certain skills they must develop in order to efficiently search the regulations and understand what they find. Resources are comprehension aids such as a glossary. These aids provide 'as needed information' that can be explored independently or used in conjunction with other, more formal learning environments. Each learning environment could be a stand-alone application. Together they provide multiple vantage points for students to arrive at a deeper understanding of aviation regulations.

2.2.2. Learning in context

Part of the difficulty in teaching the FARs is that students perceive the subject to be very dry. Indeed, some of the tasks expected of the students can be pretty tedious. However, there are many opportunities to convey the complexity and subtlety of the information in interesting ways. Telling 'war stories' by AMTs currently out in the field is one way to make the material more interesting and meaningful to the student. Stories are well suited for capturing tacit instructional knowledge, because story telling is a more natural way for people to convey ill-specified practices (Chandler, 1994).

Another way to make the material more meaningful is to immerse the students in scenarios that confront them with 'real world' decisions related to their jobs. By placing the application of the FARs in context, students have a much better chance of constructing for themselves a schema (Brewer, 1987) for how the FARs operate functionally in aviation. When students are given the opportunity to learn in context, the concepts are acquired more rapidly and durably and are more easily transferred to new situations (Brown et al., 1989). Both 'story telling' and 'situated learning' through scenarios place the information to be learned in contexts that the student can more easily relate to and remember.

2.2.3. Media-rich presentations

Media-rich presentations are a third approach to making the subject of the FARs more interesting. Multimedia has other pedagogical advantages as well. According to Park and Hannafin (1993), multiple, related representations improve both encoding and retrieval. Learning improves as the number of complementary stimuli used to represent learning content increases. For example, when concepts are encoded in both verbal and visual forms, they are retained in memory longer and are more easily accessed, because the two types of information complement each other in the activation, representation and development of related information (Park, 1994). Thus, complimentary information presented through multiple types of media is most favorable for conceptual retention.

2.3. The learning environments

STAR-AMT offers several different categories of learning environments: Overviews, Scenarios, Challenges, and Resources (Fig. 1). Each category holds one or more learning modules for students to explore. Overviews show students how FARs are organized, how different parts are related to each other, and who is responsible for what aspects of those regulations. Scenarios are interactive stories that set students into true-to-life situations where they learn how and why they need to apply the regulations to their daily operations.

STAR-AMT has three scenarios covering the privileges and limitations of AMTs in general aviation. The first scenario is 'new technician'. It asks questions about the privileges and limitations of a new AMT. The new AMT is only holding a temporary certificate. He is asked to inspect an aircraft with a friend, and does not know the friend's credentials. The second scenario is 'special inspections'. This story asks the student to decide what one should do if one is asked to perform work for which one is not qualified. In addition to questions about privileges and limitations, the story covers ethical conduct issues, as well as record keeping procedures. The third scenario (Fig. 2) is 'cartography job'. This story addresses the privileges, limitations and procedures involved in performing a major alteration to an aircraft.

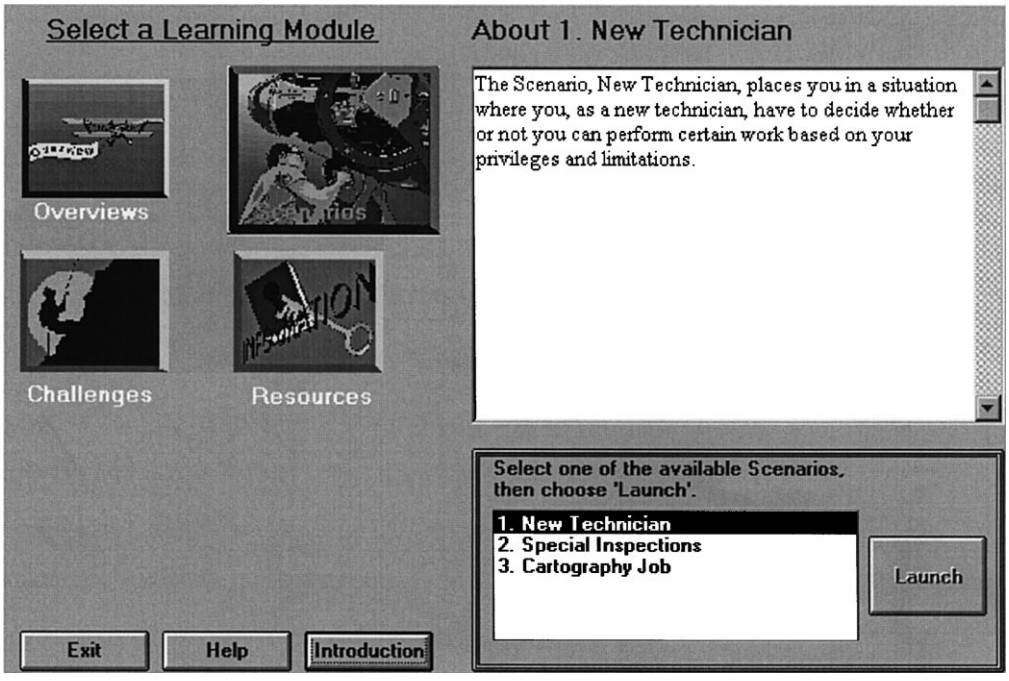

Fig. 1. STAR-AMT directory.

Challenges are designed to provide students with a self-testing mechanism for assessing their knowledge of the material as well as promoting the integration of material covered in the other learning environments. Resources are comprehension aids such as a glossary. These aids provide 'as needed information' that can be explored independently or used in conjunction with other, more formal learning environments. Each learning environment could be a stand-alone application. Together they provide multiple vantage points for students to arrive at a deeper understanding of aviation regulations. A more detailed description of each learning environment is described within this paper in the section titled 'Description of STAR-ASI'.

STAR-AMT represents a more open exploratory approach to training than the more lock step approach commonly seen in the training of procedural knowledge. In an open approach, students are provided with a mechanism for acquiring a global understanding of a domain; there is less control over the specifics of what is learned, however. As an individual builds a conceptual map, that individual will incorporate different details to support that conceptual map. Thus, while each individual will acquire an understanding for the 'big picture', the details that support that global understanding will vary. In complex domains, the curricular goal should not be that everyone knows the same thing, but rather that everyone supports the same general conceptual scheme of the domain with some variation in the details of their common understanding. This approach to knowledge acquisition supports and perpetuates communication within the knowledge community. Common domain themes support the tacit assumptions of the 'truths of the domain' under which everyone is operating, while variation in details promotes ongoing discussion and refinement of the community's collective knowledge. As long as the conceptual scheme is sound and the details incorporated within the scheme are sound, then the variation in the details of knowledge between individuals is actually a strength rather than a weakness within the community.

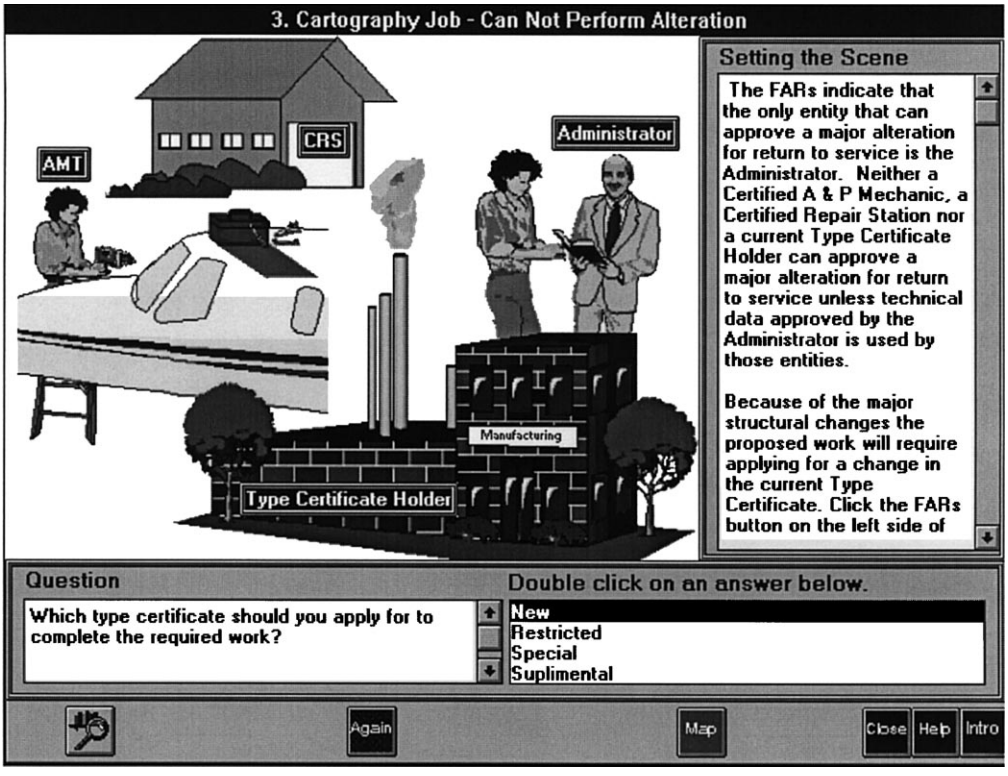

Fig. 2. Scenario – cartography job.

3. Repurposing STAR for on-the-job training

In the beginning of April 1996, the STAR research team began to explore how STAR could be reconfigured to address the on-the-job training needs of Aviation Safety Inspectors (ASIs). The results of this analysis produced a new prototype of STAR called STAR-ASI. STAR-ASI has been published on the FAA/AAM Human Factors Issues in Aircraft Maintenance and Inspection 1997 CD-ROM. No formal evaluation has yet been made of this prototype. The discussion below describes the characteristics of the new target audience and their working environment. After a description of the new STAR application, a comparison between the pure training version of STAR-AMT and the new on-the-job training version of STAR-ASI is made.

3.1. New target audience; new working environment

Aviation safety inspectors (ASI) are a very different target audience in a very different working environment than Aviation maintenance technicians (AMT) in training. ASIs are experienced. Where the AMTs were relatively young naive students new to aviation, ASIs begin their inspection career after ten to fifteen years of experience in the field. They tend to be older. The average age of an ASI is 45. They are specialists in their field and they are also enforcers of the regulations. They must have an intimate understanding of the intent of the regulations and it is assumed that they do.

Another significant difference between ASIs and AMT students is that ASIs are working. Their primary concern is doing their job. Built into the job is an extensive on-the-job training program for both veterans and new recruits. Flight Standards has a well-established mentoring program for all new recruits, and each new recruit must pass an exam for each inspection before she or he can perform that inspection unsupervised. Integral to the general atmosphere of pride among the ASI community is a collective consciousness of how one

should conduct oneself as an ASI. Throughout the halls of a Flight Standards Division Office one is aware of an ongoing discussion about the nuances of the FARs and regulatory procedures. This collective consciousness keeps regulatory conduct in the forefront and is vital to the overall health of the community.

Despite the extensive on-the-job training program, there are problems. ASIs are expected to handle all types of inspections for all types of aircraft, not just their area of expertise. Veterans often feel hard-pressed to keep up with the field. It is easy to become rusty on inspections they do not conduct frequently. New recruits are busy learning through work. Because of extensive travel associated with the job, mentors are often not available to new recruits for consultation.

There are frequent complaints of not being able to keep track of documents and forms. In addition, most of the documents, including FARs, are living documents. They are required to keep legacy data as a historical trail of regulation changes. This history is embedded in the document itself. Orders, for example, specify exactly what an ASI must cover for any given inspection. These documents are what the new recruits are expected to reference when learning the steps of an inspection. Because of the legacy data, following these manuals is cumbersome.

On-the-job training aids for new recruits seem to be developed adhoc. Since each order and on-the-job training manual has been authored by different groups, with no apparent coordination, similar inspections have different emphases depending on the writers. Clearly, a coordinated effort in development of on-the-job training curriculum would benefit the on-the-job training program.

3.2. Description of STAR-ASI

Two inspections were chosen as curricular samples for developing the STAR-ASI prototype: the cabin en route inspection and the A & P inspection. The cabin en route inspection checks aircraft cabin equipment as well as the competency of the flight attendants while performing their duties during a flight. It is a long involved procedure demanding a significant amount of interaction with both the flight crew and the flight attendants. It is also a very public inspection procedure. Passengers can readily observe the inspector's conduct as well as the fight attendants'. The A & P inspection checks the knowledge, training and performance of an AMT. It is a small inspection usually coordinated with other inspections within a fixed based operation or similar facility.

STAR for ASIs is composed of the same general components as the STAR program for AMTs. Three of the learning environments – scenarios, resources and challenges – are similar functionally, with new content simply replacing old content. A new learning environment, Task flow charts, have been implemented in place of the overview learning environment. Below is a description of each of the learning environments.

3.2.1. Inspection task flow charts

Each inspection is considered to be a task (Fig. 3). For their on-the-job training, the airworthiness group has developed task flow charts that show the logical steps for each inspection task, including decision points (e.g., Has a FAR been violated?). By simply implementing these flow charts on the computer, the STAR team has been able to create an interactive version of that representation. Now a new recruit not only has a visual representation of each inspection procedure, but he or she also can investigate each step in the procedure.

Informational media is the most common approach for conveying salient points to the ASI on any given step in an inspection procedure (Fig. 4). The Informational media display provides graphic, video, audio and text capabilities that can be interwoven to highlight important points an ASI should understand while conducting a particular inspection. For example, when an ASI clicks on an inspection procedure step such as 'initiate investigative report', a typical informational media piece may show a sample form, describe under what conditions the form should be used, and how it should be filled out. Within the same informational piece, relevant documents, such as sections of Orders and FARs, are accessible with a press of a button. In another instance, a video may depict appropriate conduct during a delicate point in an inspection; for

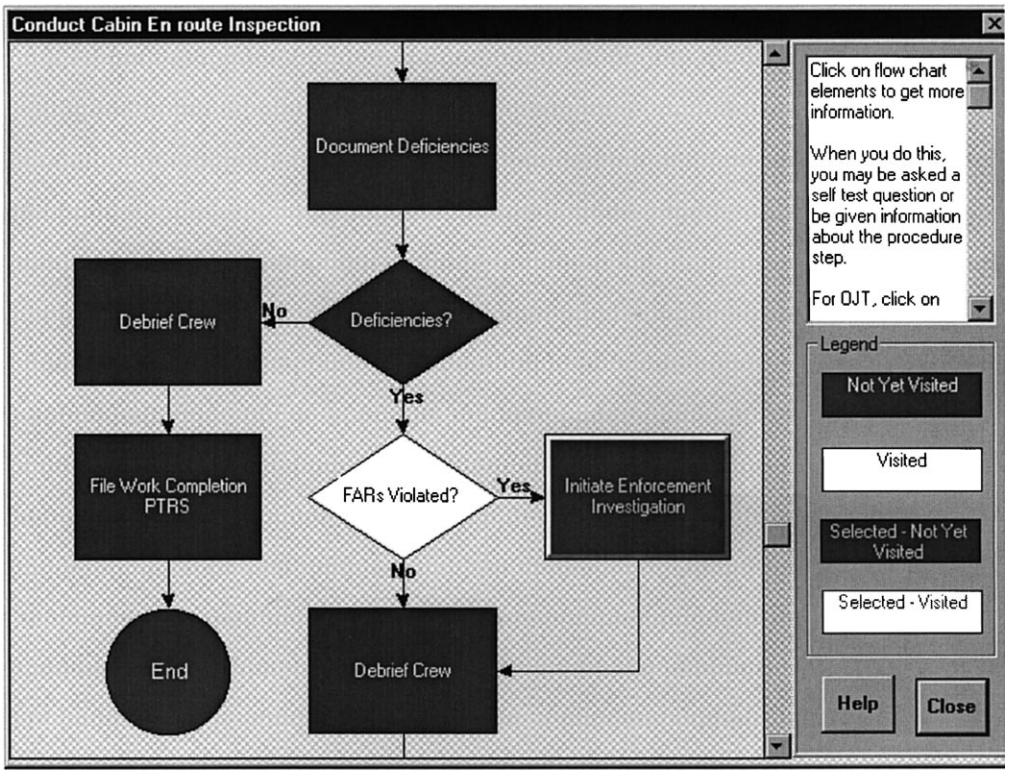

Fig. 3. Task flow chart.

instance, a video might be appropriate to depict how to approach the operator when a violation is discovered.

All other learning environments can be launched from a step in a task flow chart. Depending on the instructional objective, one has the option to ask a quiz question, show what a form looks like, reference a term in the glossary, comment on what an inspector's responsibilities are, or create a mini scenario. Task flow charts give each inspection procedure a structure; the dynamic nature of the computer provides informational depth to that visual structure.

3.2.2. Scenarios

Scenarios are essentially interactive stories (Fig. 5). In the opening scene of each scenario, ASIs are presented an unclear situation where several actions are possible. They are asked a question about what they should do and are presented with several actions that they could take. Each scene is portrayed through a graphic picture or photograph and the new situation is told through text and narration. The graphic picture sets the visual scene and the narration tells the story.

Once an ASI chooses an answer, a new scene in the scenario is presented. The new scene reveals, through commentary and animation, the consequences of the action chosen and the rationale for why the ASI should or should not have made that choice. The ASI is then asked a new question and presented with new options until she or he reaches the end of that story line in the scenario. ASI's may access a map to help them navigate through the scenario. As an ASI moves from one scene to the next, the map updates to reflect the ASIs progress.

One noted difference between the scenarios in STAR and more traditional CBT is the idea that in complex situations there are no definitively right or wrong answers. Understanding why an action may

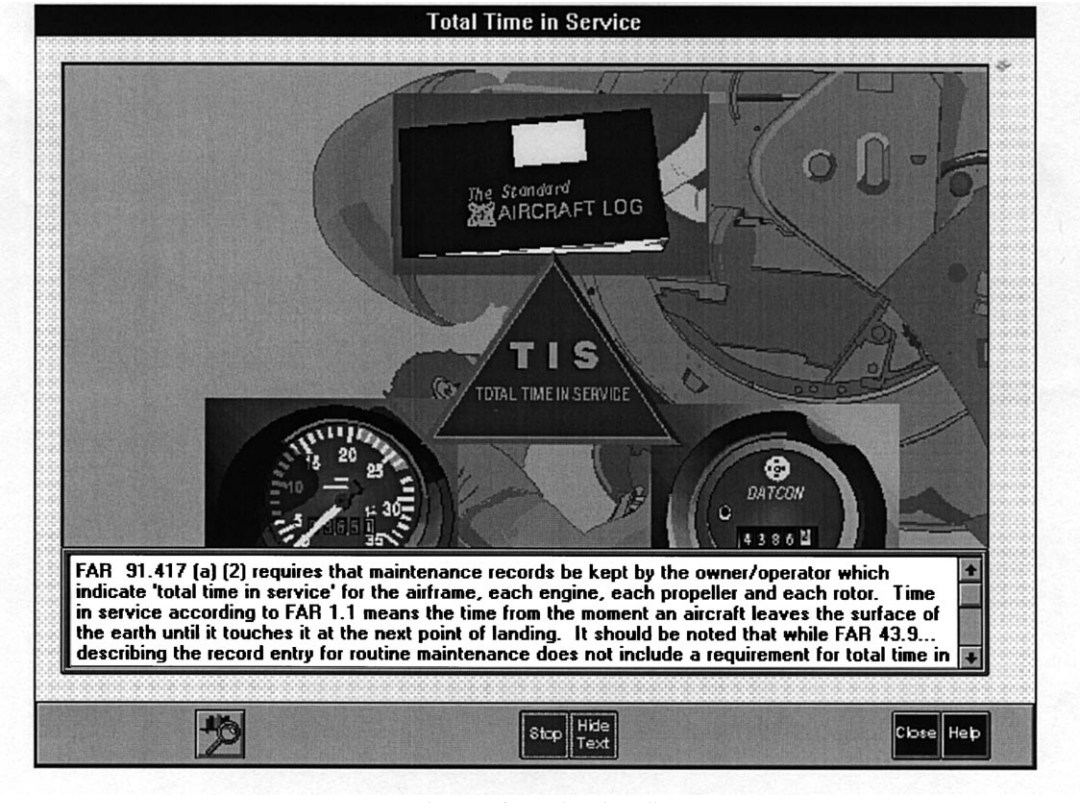

Fig. 4. Informational media.

be wrong is as important as knowing what is right. To get the most out of each scenario, ASIs are encouraged to explore all the story lines (or paths). By exploring all the paths, ASIs acquire a deeper understanding of the situation and of the subtle distinctions they need to make to comprehend fully the intent of the regulations. In this sense, there is no right answer, only deeper understanding.

Scenarios can be stand alone or attached to a step in a task procedure. Stand-alone scenarios are large multi-branching stories providing many salient points to a complex situation. Scenarios embedded within a task step are small – usually making one central point within a specific situation. These mini-scenarios are useful when one needs to place a question within a context. Mini-scenarios are also useful when one needs a rich media format for presenting several different types of information to the user. For example, one may need to display several forms and give several types of background information to the user before that user is able to answer the question presented. The scenario format provides such presentation flexibility.

3.2.3. Resources

Resources are comprehension aids such as a glossary. These aids provide as needed information that can be explored in its own right or used in conjunction with other, more formal learning environments. There are two modules in the resource learning environment. The document browser is designed to provide searching and viewing documents in their entirety. It has full-text searching capabilities both within and among documents.

The glossary (Fig. 6) defines and exemplifies commonly found terms in the FARs. Associated with each term are exemplars of how the term is

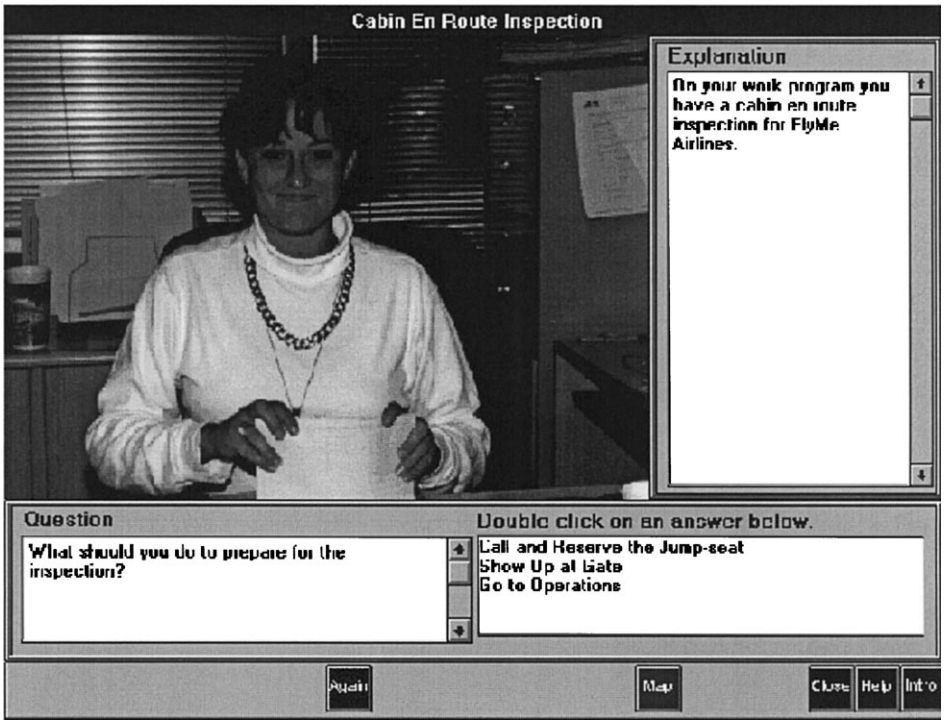

Fig. 5. Scenario – cabin en route inspection.

used in a FAR passage as well as an explanation describing how the term is commonly used in the field. Where appropriate, graphics are provided that enhance the meaning of the term.

3.2.4. Challenges

Challenges are designed to provide ASIs with a self-testing mechanism for assessing their knowledge of the material as well as promoting the integration of material covered in the other learning environments. Challenges can vary in complexity (Fig. 7). They can be of the 'self-test quiz' variety, composed of true/false, matching or multiple choice questions, where ASIs practice quick responses to specific facts; or they can be essay questions – where ASIs are asked to reflect on the intent of the regulations and how they are applied to inspection procedures. Associated with most challenge questions are informational media explaining the rational for the correct answer to each question.

The challenge learning environment is a standalone system that can be accessed from the STAR directory. When accessed through the directory, the ASI answers a series of quiz questions. After the last question, all the true/false, matching, and multiple choice questions are tallied and a score provided to the user. The questions are then reset to try again. At any time the user can leave the challenge learning environment. The user's progress is recorded so a user can return to where he or she last left off.

Individual challenge questions can also be launched from within the task-learning environment. Thus, at any point in a procedure, an ASI may receive a 'pop-quiz' question about a specific procedural step. Associated with each quiz question is commentary explaining the correct answer.

3.3. The emphasis

Interactive task flow charts have become the center piece of STAR for ASIs in place of scenarios. Because inspections are so procedurally oriented, task flow charts best represent what an inspector

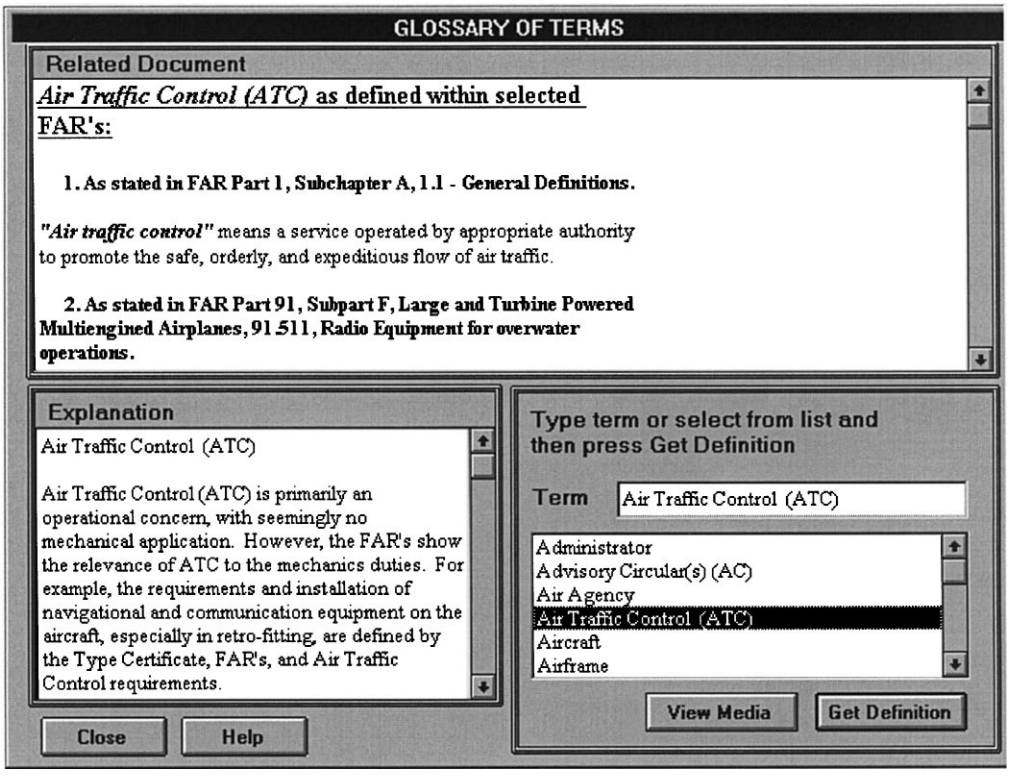

Fig. 6. The glossary.

needs to consider when doing a particular inspection. Interactive task flow charts have certain curricular advantages. They can function as a reference as well as a guide. In the simplest instance, a step may just have commentary or it may have sample forms available to remind ASIs of what the forms look like and for what purpose they are used. Sections of orders and FARs relevant to that step (and only those sections) are attached for the ASI's perusal. Where appropriate, the document is structured and highlighted to reveal its most salient points. Legacy data is removed for clarity. These simple features allow ASIs to review the most salient points and information associated with any given inspection.

Based on task analysis and numerous discussions with ASIs, the research team decided that scenarios are best suited for situations where

- there is a significant amount of interaction between people,
- there are several plausible ways a person can respond to a situation,
- individuals must draw upon a significant amount of their resources or understanding of the situation in order to make the best decision, and
- choosing a wrong answer does not necessarily terminate the story.

The STAR team found that scenarios were much easier to generate for maintenance than inspections. Part of this may have been due to the characteristics of the people who provided the scenarios; part of this had to do with the nature of the two domains. Stories generated for maintenance tended to be about a job that needed to be done and what considerations needed to be made in order to complete the job legally. Many interesting situations could be woven from doing a major repair or conducting a 100 h maintenance inspection. The story tellers being instructors was another advantage.

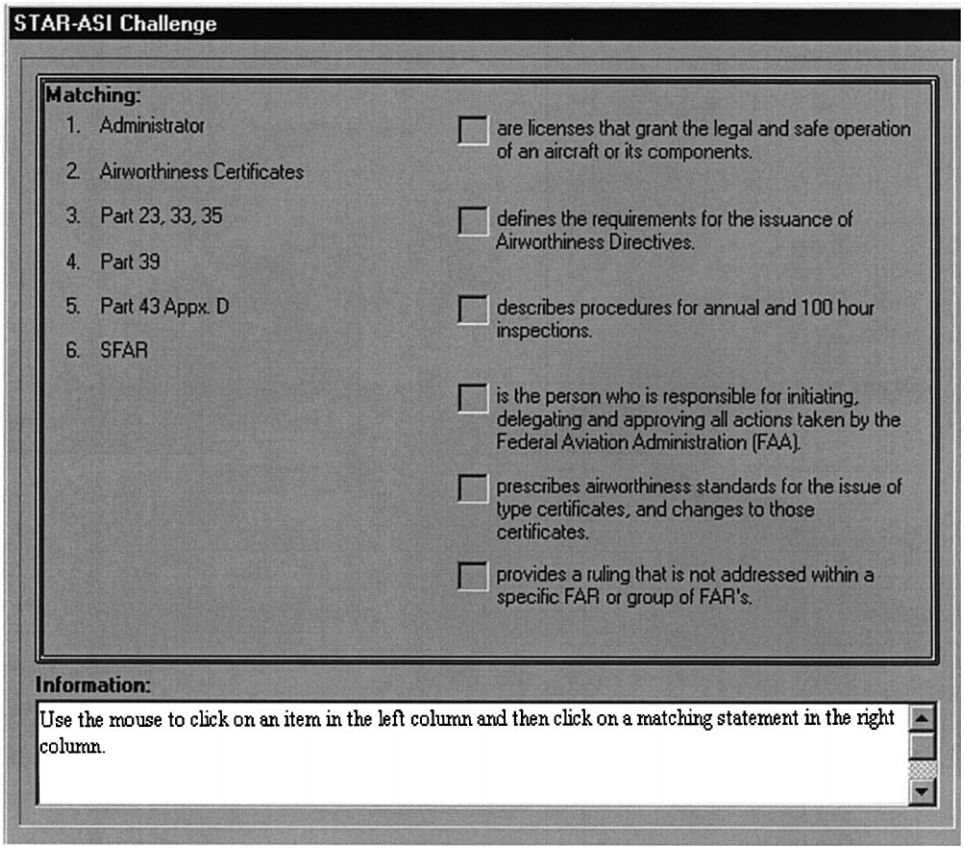

Fig. 7. Challenges.

Part of their job involves weaving stories to make salient points about aviation concepts. Inspectors are more procedurally oriented. They can easily generate 'what if' questions (e.g. What if the captain does not have his medical certificate? What if the first aid kit is not sealed?) but often these questions terminate the story with a violation. The highly procedural and primarily linear nature of inspections makes weaving an interesting and authentic story more difficult.

Some inspections are just not involved enough to warrant writing a 'story' about them. For example, of the two inspections the STAR team used as curricular samples, the cabin en route Inspection had the subtlety and complexity to warrant generating a scenario for it. The A & P inspection, however, did not. A common practice for an ASI is to perform several small inspections together during a site visit. For smaller inspections, scenarios can be handled a couple of ways. They could be broken up into mini scenarios that address a single situation and are launched directly from a step in the task flow chart. Here the ability to present a complex situation in a single scene is retained without the added burden of linking several scenes together into a story line. Another option is to create scenarios about different types of site visits where several inspections are conducted. Each individual inspection may only have one salient point to make, but taken together the scenario is able to reveal the subtlety and complexity of the situation.

3.4. From training aid to job aid

STAR-AMT has been designed to be a training resource to complement instruction rather than to

replace it. Any part of the program could be used within the context of a lecture presentation, or as a reference, or for independent study. Even the scenarios were designed to be explored rather than just stepped through. The structure of STAR is flexible to complement different styles of teaching. While there are many strengths to this approach, there are also some weaknesses. Independent exploration encourages self- directed learning, but at a cost of homogeneity of learning across individuals. While students are exposed to the general body of knowledge from several different vantage points, there is less control over the particular information that an individual acquires. As a job aid, however, this browser-oriented design approach is advantageous.

For STAR-AMT, resources augment and support training; for STAR-ASI, the emphasis is reversed – training augments and supports resources (Duchastel et al., 1995–1996). Even in the context of on-the-job training, the primary activity and concern of each ASI is having the right information at the right time to do his or her job well. Sometimes that may be learning how to conduct oneself during an inspection; other times it may be reminding the ASI which forms are needed for a particular inspection. In either case, STAR is designed to handle both needs. Task flow charts, for example, organize the information into a logical structure. This structure can be used in several ways, depending on the experience of the user and his or her present needs. For a new recruit, the flow chart is a training aid that he or she can step through, see the organization of the inspection, quiz him- or herself, look up terms, or read relevant documentation; he or she can view sample forms and review how and to what purpose they are used. A veteran can review the steps of an inspection not done in a while before venturing out into the field. Or she or he might use it purely as a reference to look up which form she or he is suppose to use or the meaning of that acronym she or he never really learned. Scenarios which target new recruits more than veterans might never be touched by veterans. However, a mentor might employ the scenarios as a vehicle for discussions with new recruits.

4. Keeping current

In the working world where documents are living and policies change, it is vital to create a CBT that supports this environment. Information and training should be designed so that they can be updated and changed easily. This means a more compartmentalized approach. If a step in the flow chart is no longer relevant, only that part should be changed, not the whole structure. In situations where compartmentalization of information is difficult, as is the case of a long involved scenario, the content should not focus on particulars that are likely to change. Rather, themes such as ethical conduct or procedural issues should be addressed. How one debriefs an organization after the completion of an inspection, for example, addresses an important theme about conduct that effects all inspections and whose message is unlikely to change over time.

Living documents, especially if they are expected to retain legacy data, can be difficult to maintain. It is this kind of information that will date a training system. Electronic publishing techniques could help maintain this kind of information. Electronic publishing structures textual information for different views so that the most relevant points are accessible for a particular audience. For example, legacy data can be hidden behind hypertext references. The history of the document is preserved but it does not obstruct the presentation of the most recent version of the document for training or review.

One simple mechanism for disambiguating the tangles of information that an ASI must sort through is to present just the sections of FARs and orders they need for any given step in a procedure. The challenge comes when these references need to be updated. FARs, for instance, are updated every two weeks. Full text search found in electronic publishing may alleviate this problem. A query can be written to access the relevant pieces of information from the total document and display them within the context of the training program. Theoretically, one should be able to update the total document without effecting the query into that document. Of course, the success of this approach is only as good as the query that can be written and

the extent of changes to any given document. Too many or extensive changes could disable the query system.

The last point is to empower the working community to augment its training/job aid. Like living documents, the culture of a work community changes. Training and job aids should be sensitive to this and support it. For example, if STAR-ASI were to be installed on an intranet, the task flow chart learning environment could incorporate a comment box associated for each step in a procedure. If, for instance, a veteran wants to amend an 'official' comment of a particular step, he or she can add his or her comment to the comment box for that step. His or her comment will be available to others in the office. A procedure for changing or updating the official comment could be provided. A mechanism for archiving comments each month is another possibility. The on-the-job training becomes a repository for the collective conscience of the ASI community.

5. Conclusion

Computer based on-the-job training is an integral part of the EPSS paradigm. While computer based on-the-job training is rooted in traditional CBT, unique circumstances to the work environment require additional design and implementation considerations. The main design and development issue addressed in this paper is, 'What design techniques need to be implemented so that the training application may easily be modified to fit both the changing work environment and changing needs of the employee?' From our experience with repurposing the STAR program four conclusions can be drawn with respect to this issue.

First, it is much easier to build a resource that incorporates training than to build a trainer that somehow metamorphoses into a job aid. Traditional training curriculum presents a logical progression of information, concepts and skills. Learners are expected to follow the curriculum in this logical sequence. Resources are also organized logically, but part of that organization accommodates the user's need to answer specific questions quickly. The resource is designed to accommodate fast access to needed information; traditional CBT is not (Brown, 1996; Gery, 1991).

When intended as a job aid, training needs to be thought of as a type of resource. As a type of resource, it needs to be more self-contained – functioning as a coach or advisor to the specific information the user is looking up. Training can still be organized into logical sequences of information, concepts and skills, but it must also accommodate quick answers to specific questions. There are advantages to the 'training as reference' approach. One need not worry about motivating the student. Users are motivated by virtue of the fact that they are asking the question. Because they are actively looking for an answer, their retention should be better as well (Gery, 1991).

Second, the system needs to be highly modular. In STAR, for instance, each learning environment (e.g. resources, scenarios, challenges) is self-contained, as is each learning module (e.g. the glossary, the cabin en route inspection scenario, the A & P task). One can swap out a training module, a learning environment, or a reference guide depending on ones training or job aiding needs.

Third, applying a browser approach to interface design increases the options for how the system can be used. STAR's browser style interface gives the system the flexibility to be a presentation aid, a self-paced tutor or a reference utility. It is not bound to a lock step tutorial approach. Modularity and a browsing style interface give STAR maximum flexibility for accommodating different training and job aiding objectives.

Finally, electronic publishing may offer some solutions for training systems that rely on living documents as the basis of their training, but the ongoing battle to keep training programs current will continue to be a challenge for curriculum developers.

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