ADVANCES IN AUTOMATED AUTHORING: LINKING TECHNICAL DATA WITH COMPUTER-BASED TRAINING COURSEWARE

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ABSTRACT

This paper describes the concept of linking automated authoring tools such as the eXperimental Advanced Instructional Design Advisor (XAIDA) with electronic technical data. The ultimate goal of the research is to significantly reduce, as much as possible, the need for human intervention in the creation of computer-based training courseware. Weapon system developers are required to provide DOD agencies with technical information about systems they develop. System developers routinely conduct costly analyses which result in voluminous data such as task analyses, technical manuals, graphics art, and other documentation that could be used for training. Recently, DOD specified that data be delivered in electronic format sometimes called Interactive Electronic Technical Manuals (IETMs). Later in a system's life-cycle when training courseware is developed, paper documents derived from the IETMs are frequently used as a basis for creating computer-based training courseware -- also in electronic format. By utilizing the IETM data originally created by the weapon system developer several benefits can accrue to DOD. They can: 1) achieve true concurrency in training by establishing a dynamic link between weapon system documentation and the training that supports it; 2) reduce or eliminate the need for paper-based documentation of the training development process as specified by ISD; 3) simplify the long logistics trail following the acquisition of weapon systems; 4) streamline the ISD process; and 5) save costs as a result of the decreased amount of time and manpower needed to create and maintain the courseware and audit trail of support documentation required for weapon system training programs.

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PREFACE

In dealing with the Integrated Maintenance Information System (IMIS)[1] we set out to develop a training application for the job-aid by applying an intelligent tutoring approach. That first attempt at finding a training use for IMIS met with limited success because we focused on the wrong thing, i.e., developing a training application that ran as an integral part of IMIS.[2] Furthermore, we wish we could report that we planned from the beginning of this project to do everything described here, but to be entirely honest, that is also not the case. As with some inventions or scientific discoveries, planning had little to do with what happened. Our original intent was narrow in scope and focused entirely on providing a training solution for a new device, IMIS. Initially, all attempts appeared to be ill-fated. Applying tutoring concepts to IMIS provided a very low payoff for the Air Force, i.e., IMIS probably wouldn't be used for training on-the-job since it already was a very good job-aid. In addition, creating a tutor that could do anything useful within the existing structure of IMIS would require considerable programming. Once we changed our focus from designing a training application to run on IMIS to exploring other possibilities for using IMIS content, we found ourselves like skiers who start down a gentle slope but suddenly find it has turned into a steep precipice. Things began happening so fast that we rarely had time to document one interesting notion before we were moving on to something else even more interesting.

PROBLEM

According to regulation, weapon system developers and manufacturers are required to provide DOD agencies with technical information about the systems they develop. In the course of system development, front-end analyses are routinely conducted. These analysis efforts frequently result in voluminous data such as task analyses, technical manuals,[3] and other job-related documentation. While these analyses are costly, they produce data that should be, and usually is used for development of training courseware. Recently, DOD has begun to specify that such data be delivered in electronic format (MIL-STD-1840, MIL-HDBK-59).[4]

Routinely, task analyses and other training documentation are created by weapon systems developers and other contractors and delivered to the systems program office (SPO) in paper and electronic format. Later in a system's life-cycle when computer-based training courseware is being developed, many of the paper-based documents are used as source material. To describe what goes on now in the development of computer-based training might look something like Figure 1. In short, 1) an analyst creates technical data including graphics from engineering specifications and drawings; 2) these data are stored in electronic format as an IETM; 3) the IETM database is

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[1] IMIS is a computer based maintenance information and management system and intelligent diagnostic aid to assist flightline technicians performing maintenance activities. It has automated capabilities that are expected to greatly improve the accuracy and efficiency with which technicians perform their jobs. For more information see Link, Von Holle, & Mason, 1987, and Cooke, Maiorana, Myers & Jernigan, 1991.

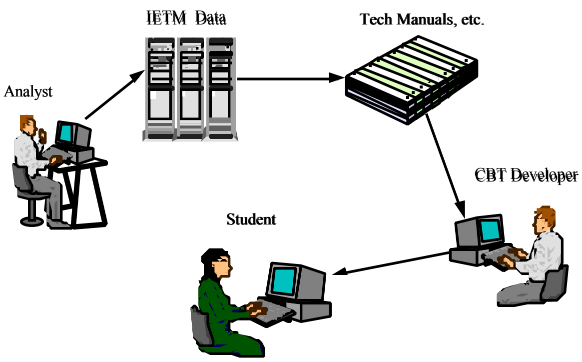
[2] For details regarding training applications for IMIS see Hicks, Gugerty, Young and Walsh, 1993, Gugerty, 1994 and, Walsh, Wilson and Qasem, In press.

[3] Normally called Technical Orders (TOs) by the Air Force.

[4] DOD has been calling a portion of this data which constitutes TOs Interactive Electronic Technical Manuals (IETMs).

used to create paper-based technical information, e.g., TOs; 4) paper data are used by many, including computer-based training developers, who re-enter the data in electronic format again; 5) the re-keyed data are presented to students as computer-based training lessons. In other words, paper copies of technical data that have been printed from electronic sources are used as a basis for re-entering the same or similar data into another electronic format, i.e., computer-based training courseware. If, instead of this process there were ways to automatically link electronic data throughout system development and instructional systems development (ISD), DOD could benefit by achieving:

Figure 1. What happens now.



1. True concurrency in weapon system documentation and the training that supports it, by establishing a dynamic electronic link between weapon system documentation and training, such that a change or modification in the documentation would result in a corresponding change in all products derived from it, including training.
2. Elimination of the need for extensive, repetitive paperwork documenting the training development process as specified by ISD.
3. Simplification of the long logistics trail following acquisition of a weapon system.
4. Streamlining the ISD process.
5. Cost savings as a result of decreased time and personnel to create and maintain courseware and the audit trail of support documentation required for training programs.

ARMSTRONG LABORATORY GOALS

The original Laboratory goal was to examine the uses of the Integrated Maintenance Information System (IMIS) for training with the hope that procedural and diagnostic information contained in the IMIS database would be useful to train novice technicians at tech-school or more experienced technicians at the job site. Initial efforts focused on using the IMIS portable maintenance aid (PMA)[5] and generic troubleshooting strategies, i.e., shells, which could be built around IMIS procedures. The shells would provide several levels of coaching advice to technicians, i.e., apprentice, journeyman and expert. This approach, called "COACH," had distinct limitations: It utilized generic troubleshooting strategies for training interventions. It was by nature a plain approach to training since it was designed with the limitations of the PMA in mind. Finally, it was totally non-diagnostic, (Gugerty, 1994), i.e., the system had no intelligent student model to direct when or how training interventions occurred.

The Laboratory goal soon expanded beyond simply using the IMIS system, specifically the PMA, as a delivery mechanism. Laboratory researchers recognized the value of using electronic technical data for training purposes on other than the PMA. Indeed, research indicated that IMIS data in standard generalized mark-up language (SGML) format could be uniquely identified and directly accessed for whatever purpose a user desires. Since Armstrong Laboratory has been prime developer of several intelligent training systems (Hall, 1993, Towne & Munro, 1988, 1991, Wiederholt, Browning, Norton, & Johnson, 1991), a logical step is to utilize technical data to feed one (or several) of these systems. Since members of the research team were already working on the eXperimental Advanced Instructional Design Advisor (XAIDA) program, it was identified as the first candidate.

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[5] The PMA is a hand-held computer which can be linked with the aircraft to access built-in test (BIT) information. It has a limited keyboard, small screen size, limited color capability, no multi-media capability, etc.

TECHNICAL APPROACH

Laboratory Initiatives

What is Armstrong Laboratory doing? Several Laboratory initiatives are currently underway which can coalesce in the concept described here.

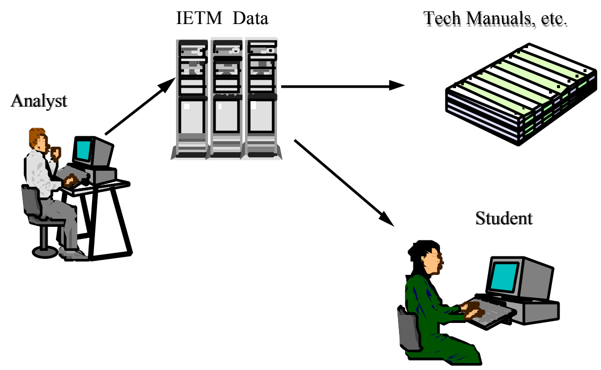
1. Armstrong Laboratory has been examining potential use of the IMIS job aiding system for training, with high potential for payoff.
2. Several intelligent training systems have been and are still being developed and tested by Armstrong Laboratory.
3. An effort to link electronic data from IMIS with an intelligent training system (XAIDA) is ongoing and resulted in a concept demonstration in April 1995.

Current Work. Armstrong Laboratory has been conducting research in the use of IETM data for job aiding and for training.[6] Recent work with IMIS, (Hicks, Gugerty, Young and Walsh, 1995 and Gugerty, 1994) demonstrated an application of electronic technical orders to procedural and troubleshooting instruction for maintenance technicians. Since contractors now develop and deliver IETMs with all new DOD weapons systems as part of the contractor-integrated technical information system, and since these data have textual steps and reference graphics attached, they have powerful instructional potential. While initial efforts to utilize IETMs focused on integrating an instructional capability into the IMIS job aid, more recently the Laboratory has expanded this research to determine the feasibility of establishing a link between IETM data, like that contained in IMIS, and any one of a number of intelligent training systems under development.

Another Laboratory program, XAIDA, (Hickey, Spector and Muraida, 1992, Walsh, 1994), has produced a prototype system that automatically generates computer-based training courseware when given system information by a subject matter expert (SME). XAIDA also has other features that make it an appealing program to partner with. XAIDA is capable of reducing authoring time significantly, i.e., approximately a ten-fold reduction of authoring time (Walsh, 1994). By linking these two programs, the Laboratory will demonstrate the feasibility of using IETM data as a basis for automatically generating computer-based courseware.

[6] Human Resources Directorate, Instructional Design Branch (AL/HRTC) in conjunction with Logistics Research Division (AL/HRG) have projects which investigate various uses of IETMs. For further information contact Capt. Paul Daly, (210)536-2981.

Figure 2. What should happen.



Under the concept described in this paper, the chain of tasks, events, and data transformations during the creation of computer-based training is simplified (see Figure 2): 1) an analyst creates data once, 2) data are stored in an electronic format, e.g., as IETMs, (the same data may be used over again many times for many purposes, including printing tech manuals), 3) the electronic data are accessed in the original electronic SGML format by an intelligent training system to automatically generate computer-based training lessons for students.

Approach. Researchers are working to identify IETM database elements with potential instructional applicability for maintenance training. To do this they must first define the most effective ways to access data elements and apply them within the framework of an appropriate instructional strategy. Currently, three principal instructional uses are envisioned for IETM data. First, individual graphics and steps of a T.O. procedure can be extracted and used to provide discreet examples within an instructional context, e.g., declarative knowledge. Second, components can be accessed grouped by system or subsystem to explain the functions and interrelations of components in the system, i.e., theory of operation knowledge. Finally, an entire test or replacement procedure can be extracted directly from the IETM including steps, cautions, warnings, notes, test criterion, and technical drawings showing test points and connections. In this case, the entire procedure could be parsed along with its referenced graphics as the basis for a complete procedural lesson or drill and practice. One additional instructional use of IETM should be considered, namely troubleshooting, however generating troubleshooting lessons requires additional research. Table 1 shows the status of automated creation of each kind of maintenance lesson at this time. As can be seen from the chart, researchers have only had partial success in creating procedural lessons and have not yet accessed the kind of data necessary to test the creation of theory of operations lessons.

Table 1. Automation Now.

Type of XAIDA Lesson	Maintenance Training Addressed	Ready
Identify	Nomenclature, location, parts, task steps, etc.	Now
Interpret	Theory of operation	Plan
Execute	Procedures, manipulation	Plan
Troubleshoot	Fault isolation	TBD

Researchers have already demonstrated the ability to link IETM data with XAIDA to automatically generate identify lessons for F-16 maintenance training (see Tables 1 and 2). The estimated time frame for other major research events are as indicated in Table 2. The research team developed a prototype parsing engine that extracted task data and associated reference graphics from the SGML IETM database and automatically generated an instructional database within XAIDA including sequenced procedural steps and associated graphic resources. Individual steps were extracted as text and linked with graphics referenced in the TO (marked-up SGML). The current version works slightly differently. IETM data are extracted from the target IETM database and stored in an intermediate database by the parser. From the intermediate database specific data items needed by XAIDA for a specific lesson are extracted and fitted into its lesson database. This two step approach allows the Air Force the flexibility of parsing any number of IETM database formats and providing that data to any number of instructional delivery systems. Another change from the prototype parser to the current version is the ability to pre-parse an IETM database. Pre-parsing allows instructors to pick and choose those subtasks embedded in a task for presentation. In other words, the instructor can choose to present tasks like “Remove PSP” or “Install PSP” without continuously repeating embedded tasks such as “Make Aircraft Safe for Maintenance” or “Open Door 1202” each time one of these subtasks appears. Finally, once the file has been given a name and a portrayal[7] selected, the lesson is ready to present to students.

Table 2. Research Schedule[8]

Event	Complete
Demonstrate feasibility (F-16)	Apr. 95
“ “ “ “ (medical)	Jun. 95
Deliver Parsing Engine	Sep. 95
Evaluate effectiveness	Jan. 96
Cost-benefit analysis	Jun. 96
Expand to other domains/systems	Sep. 96
Establish dynamic link	Jan. 98

A second demonstration (Jun. 95), also showed the feasibility of using un-tagged[9] word processor files to produce training for medical specialists. First, a manual process was used to create these lessons by entering the data into XAIDA just as we did to prove the concept. Then, the word processor files were marked with tags and saved as SGML so they could be parsed automatically. This demonstration showed that other kinds of electronic data could also be modified and used to automatically generate computer-based training.

EFFECT OF IETM DATA ON AUTHORING TIME

Although we did not set out to develop a way of reducing computer-based training development time, reductions were significant. The overall reduction of man-in-the-loop time has gone from the industry standard minimum of 100 to 200 hours for conventional computer-

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[7] Each XAIDA lesson has a portrayal. The portrayal is normally some graphic overview of the subject of the lesson. Portrayals include locators for each component, designations for inputs/outputs and links to display system relationships, etc.

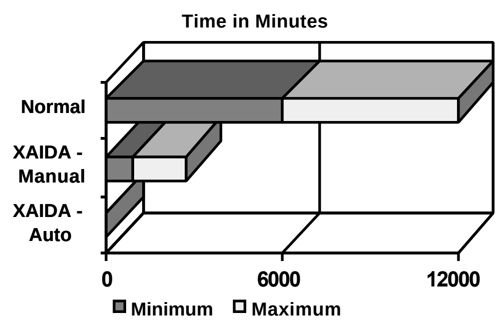
[8] The double line in the table separates current efforts (above) from planned activities (below).

[9] Tagging is a term used to indicate whether a document has been marked for general use as SGML. When coupled with a document description tagged elements can be formatted for a specific function.

based training,[10] to a few hours, e.g., about 30 (see Walsh, 1994) in automated mode using a pedagogical tool like XAIDA to generate a lesson, to just a few minutes using IETM data with the parser to automatically generate lessons. Actually, in automated creation of our prototype lessons no human intervention was necessary other than for us to wait while the parser created the lesson databases for us. All we had to do when the parser had finished its work was give the lessons names, select a graphic for portrayal of each task and do some minor clean up work. Essentially, the parser had taken all of the grunt work out of creating the lesson; we didn't have to re-key all of the TO text or re-create the graphics that go with each step. The parser made all of this data part of the lesson automatically. An instructor's task becomes adding special touches to lessons like personal experiences or unique problems which might be encountered performing the task.

Put in quantum terms (see Figure 3), the development of a computer-based training lesson has gone from bare-bones minimum of about 6000-12000 minutes (100-200 hours, i.e., industry standard), to 1800 minutes (>30 hours using XAIDA in a manual mode), and finally to 4 1/2 - 7 minutes (fully automated using the IETM parser and XAIDA). Put another way, the reduction in developer resources required can be projected as potentially an order of magnitude less using XAIDA manually, i.e., a reduction of at least 70% to 90% and again another order of magnitude using the parser and IETM data with a reduction of greater than 99+% of current times. While no one on the research team actually believes that such a sustained reduction in development time will be possible for all lessons or lesson types, they are convinced that the use of IETM data for training can produce a new computer-based training paradigm. In the new paradigm (Kuhn, 1962), instructor or lesson developer time spent entering text and creating routine graphics is drastically reduced. They are freed up allowing them to concentrate on making unique enhancements to lessons such as video clips, animations, simulations, specific examples or additional support information. They can focus more of their attention on developing lessons for those topics that are especially difficult to teach rather than on those which can be automatically generated using TO data, the parser and XAIDA.

Figure 3. Development Time.



Streamlining ISD. The new paradigm will not only be marked by reduced development times, it will also be significant in that the traditional ISD audit trail will also be drastically compressed. Traditional ISD approaches to computer-based training require an audit trail that shows the linkage between job-tasks and lesson objectives. Traditional ISD approaches make use of storyboards, lesson specifications and other paper-based documentation that serve the function of getting SME buy-in on instructional strategies for lessons, verifying that content is correct, extracting common errors for examples, verifying that training matches job requirements, and many other similar functions. While documentation of instructional decisions is important and necessary, it is rarely useful after lessons have been fielded, providing another box of papers to be stored for project history. Under the new paradigm paper documentation can be bypassed since proven instructional strategies are built into XAIDA's courseware generation system, and the front-end analysis that has already been performed by a SME and approved by the Air Force is reflected in the IETM data. Just as a direct connection between IETM data and computer-based training is being made, so too is the connection between the ISD Analysis and Delivery Phases being made. Instructional strategies appropriate to IETM content are automatically assigned so that one of four kinds of computer-based training lessons can be created from the IETM data.[11] Results are: audit trail established, direct link from **task** to **lesson**; paper documentation created to

[10] At a recent visit to the F-22 SPO, we were informed that computer-based training was running between 450 to 1200 developer hours per hour of instruction (average about 550).

[11] For the four types of lessons see above and Table 1.

support the lesson, **none**. The same team of analysts and SMEs who produced the ISD analysis has also implicitly produced the computer-based training lessons!

Why is Automation Possible? If linking IETM or other electronic data with a computer-based training system can bring about such a significant reduction in authoring resources required, why hasn't it been done before? Perhaps, the answer to this question will also provide some insight into why such a drastic reduction in authoring time is possible at all. This phenomenon is made possible because of the coupling of electronic data, in this case IETMs, with a pedagogically intelligent instructional generation system (XAIDA). Briefly, to understand the significance of coupling automated authoring and electronic data, we should examine the underlying systems that make it possible.

eXperimental Advanced Instructional Design Advisor. XAIDA was designed to work something like this: a SME provides domain information regarding a specific aircraft system and XAIDA builds a knowledge structure from this information. Elementary instructional decisions are made by the instructor/SME such as the kind of lesson to be presented, i.e., simple facts about the system, theory of operations, a procedure, or troubleshooting. If the instructor does not make any decisions, XAIDA will create lessons based on its defaults for the kind(s) of data it has in its knowledge base. XAIDA assigns an instructional strategy to each lesson that determines both the kind of information used in the lesson and how it will be presented to the student. XAIDA can be described as a pedagogically intelligent system. In other words, XAIDA requires no instructional design input from an author (that's what XAIDA provides), only subject matter input is required (XAIDA is naive about subject matter). XAIDA also provides instructional strategies to control presentation of lesson information to a student based on the kind of data that is provided and how the student outcomes are defined, i.e., matching one of the four basic lesson types available for maintenance training. Since the pedagogy[12] is built into XAIDA, instructional design of the resulting computer-based training lesson is predictable, therefore, no need to have another redundant SME review.

Interactive Electronic Technical Manuals. IETMs are normally SGML text that has been tagged for a specific function, e.g., usually on-screen display or printing of a TO. Since SGML is generic, it can be used in multiple applications as long as the tagging scheme provides the right data for the application.[13] In the IMIS application mentioned in this paper, the TO data were tagged to indicate elements such as:

- Task name and TO reference
- Steps of a task
- Equipment required
- Personnel required
- References
- Time to complete task
- Associated graphic(s)
- Etc.

While weapon system developers have been looking for ways to use their own electronic data to produce training, either in the form of paper documents or computer-based training, no efforts have really successfully merged the production of technical data with the creation of courseware. Because of the intrinsic pedagogical features of XAIDA, it can make use of electronic technical data immediately and directly to generate courseware with little or no SME intervention. This powerful combination eliminates the bulk of work involved in creating computer-based training, namely providing the SME's technical input on a topic as well as the instructional designer's pedagogical approach to the subject matter. If, incidentally, graphics, and other resource materials are available and referenced by the electronic data, they can be automatically linked into the lesson also. These new tools allow the SME to focus on the more important issues such as what are the best examples to use in presenting domain information to students. They also permit the instructional designer to concentrate his/her efforts on developing special purpose lessons for those topics which XAIDA lessons are not easily generated, or to refining XAIDA lessons so that they are tailored even more to the precise needs of the student target population. Therefore, both instructional developers and SMEs can focus more of their attention on hard to do simulations rather than spending time on

[12] In addition to the features mentioned, XAIDA also has a student model which keeps track of what a student has seen in a lesson and what content has been mastered.

[13] For details on ways of using IETM data in training applications see Wilson, 1995.

developing routine computer-based training lessons. In summary, use of electronic data with XAIDA permits the entire courseware team to concentrate on what needs most attention, rather than on the time consuming, repetitive tasks involved in creation of computer-based training.

Training versus TO Viewers. Some users of IETMs may argue that lessons generated by XAIDA are no different than using SGML viewers to read IETM files. We take exception to this assertion. It exhibits a lack of understanding of what training really is and how XAIDA structures IETM data into coherent intelligent courseware with embedded questions and exercises generated from the data. While SGML readers may present IETM data to users in an attractive form, they cannot ensure understanding of the material except by assuming that re-reading a TO many times equates to some level of understanding. Training does not equate to simply presenting TO data to a user. Rather, training consists of ensuring by means of pedagogical artifices and devices that learning has actually occurred. Users of SGML readers may acquire information but they do not normally achieve learning. Just as we can gain some information about repairing an automobile from reading a book on auto repair, we often find it difficult to apply that information because we have not formulated concepts, practiced procedures or been tested on either. Training differs from reading in that we are allowed to practice what we are learning and we are evaluated on whether we have mastered what we were attempting to learn.

Concurrency. Another aspect of training that emerges by using electronic technical data with XAIDA is maintaining concurrency of training materials with the weapon system. By the very fact that XAIDA can make use of the same data from which TOs are developed, some measure of concurrency has already been achieved. Under normal circumstances, once developed, computer-based training has a very short shelf-life. As soon as the weapon system changes, training that supports the effected system(s) must also be changed. Working in the new paradigm, shelf-life is irrelevant. With a link to the IETM, all a system like XAIDA has to do is verify that the data which is being used in the lesson is still current. If lesson data is not current,[14] 1) the parser can compare the current version of the database with the previous one, 2) determine if they are the same, 3a) if the same, no lesson update is required, 3b) if not the same, update specific portions of the lesson by parsing the database again. By performing this simple look-up function, we can ensure that concurrency with the weapon system is maintained. As an alternative, to this static approach to database linking, highly important, time-critical lessons can be dynamically linked to a source database. Dynamic linking implies that XAIDA would access an IETM database directly during lesson presentation.[15] This would be similar in function to accessing data in real-time via the Internet. Whenever a change is made in the IETM data a corresponding change would be made automatically to the XAIDA lesson the next time it is presented. Access to the IETM database implies that such lessons would be quite versatile. Classes could be presented over existing Air Force distance learning networks with immediate practice lessons available. Many other combinations could be thought of to employ such an economical system.

REMAINING RESEARCH ISSUES

Since it has been demonstrated that generating courseware based on a link between electronic data and intelligent training systems is feasible, a number of research issues still need to be resolved prior to full-scale implementation of this technology. Some issues are:

1. Modify IETM data. An initial step must include determining the kind of training that can be generated from current IETM data, i.e., what kind of lessons can/should be automatically generated from existing IETM data. Implications are: it may be necessary to either add tags to the IETM or modify the existing tagging scheme of the IETM data.

2. Modify Intelligent System. Concurrently, it will be necessary to evaluate the kind of instructional strategies required to present instruction based on existing IETM data.

[14] By "not current" we mean the time-stamp on the source database does not match the XAIDA database.

[15] Such a dynamic link as described here is possible, but would require some modification of XAIDA. Furthermore, with dynamic linking there may be a trade-off of speed for accuracy.

We may need to modify or upgrade instructional strategies of intelligent training systems to accommodate data found in the IETMs. New instructional strategies may need to be built into intelligent training systems, e.g., either XAIDA or any other pedagogically independent system, to automatically generate training for unique domain(s).

3. New IETM data. As part of these research issues the Laboratory should determine the kind of IETM data needed to the support instructional strategies currently employed by XAIDA or other intelligent training systems. In other words, are additional IETM data and/or tags needed to generate training.

4. Resources. A key element of research is determining whether additional IETM data types are useful or needed. This should include determining all types of data with potential instructional value such as video, audio, 3-D renderings, photos, etc.; and description of kind of instructional strategies they support. Ultimately, the usefulness of an automated intelligent system depends upon its ability to make use of as much electronic data as is available. Even if a lesson doesn't need to use all of the data available, the intelligent system should be able to access the data (resources) and point out to an instructor what is available. As an appropriate intervention into the automated process, the instructor can decide which resources are needed for lesson effectiveness and which are useful for remediation or enhancement.

5. Evaluation of effectiveness. Critically important to the Air Force is the task of evaluating the effectiveness of automatically generating training based on electronic data. In other words determining instructional effectiveness, cost effectiveness, procedural efficiency, reduction in documentation, etc. as a result of automation of the development process will demonstrate the utility of such a program to the Air Force and DOD.

FUTURE PLANS

Immediate plans for these tools are to document and package them with XAIDA Version 5.0[16] so that they are relatively seamless to use and need little or no assistance from the developers. As depicted in Table 2, these activities should be completed by the end of September 1995. Furthermore, in the documentation we will describe in more detail the research issues specifically associated with the parsing tool as well as the interface of electronic data with automated authoring. Near term goals for the Laboratory are to find additional domains to test as potential applications besides the maintenance and medical areas. This will include not only testing automated authoring tools with other IETM data, but investigating expansion of their applicability to electronic data-sets that do not fit the typical IETM definition.[17] Furthermore, Laboratory interest in expanding the use of electronic data with other intelligent systems should be explored.

[16] Version 5.0 begins its Air Force testing cycle late in 1995.

[17] In other words, can automated authoring be expanded to include use of word processing files, or scanned text, etc.

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