AUTOMATION IN THE TRAINING ANALYSIS PROCESS

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Abstract

Automated processes are providing training analysts with the capability to generate training system requirements rapidly. The training analysts interact with appropriate computer systems and data bases through video terminals to enter and review vast amounts of data, make decisions about the data and arrange tasks to be trained into common groups. Through displayed menu selections and specific search criteria, the data base can be manipulated and analyzed as required by the analyst. The analysts can then generate training requirements while reviewing and analyzing data on the video screen. Training system requirements are generated in a similar manner to meet training requirements and both are entered directly into the data base by the analyst. Training system requirements that are developed in this manner are more complete and more efficiently produced than by commonly used manual procedures. Training analysis products can then be compiled by the computer for any logical grouping of tasks and printed as necessary to meet the requirements of the project.

Introduction

The objective of a task and training analysis is to develop a description of the training systems, either classroom or hands-on, which are required to teach people to perform a given set of tasks. In the majority of projects, specifying those training systems requires the collection and analysis of extremely detailed data. Data of this detail accumulates in vast quantities and can quickly become uncontrollable, usually requiring an inordinate amount of time and manpower just to collect, store, retrieve and review. To minimize this problem, an accurate, rapid and highly streamlined methodology that is fully responsive to analysts' needs is required. Unfortunately, no matter how systematic, streamlined or reactive a methodology has been, the manpower and time requirements have always been high. Analysis of this problem shows a need for a capability to collect and store large data bases, and more importantly, to manipulate and group data as well. In addition, data must be analyzed and the results of that analysis must be stored, categorized, reviewed and described as necessary to meet the requirements of the client. The most often occurring client requirements have been functional descriptions of training systems, to include both hands-on and classroom training.

Background

By mid-1984 Eagle Technology, Inc. (E-Tech), had developed a sophisticated capability in the field of automation that was directed primarily at engineering support tasks. This capability was developed using a VAX 11/730 system with complementary software and a highly skilled team of experienced software and hardware engineers, programmers and system analysts. Dialogue between two teams of professionals, those in automation and 'those in instructional development, led to the creation of an in-house model to automate certain of the high resource consuming training analysis functions. The ISD personnel "fine tuned" the analytical model and the software engineers, utilizing corporate resources, programmed a generic software package that provided an automated tool to support this model. This prototype methodology was based on several data base management systems which address the requirement for reduction of labor and time in collection and analysis of training data. It became evident that this automation tool could substantially reduce the laborious searching, sorting, analysis and manipulation required of large data bases generated during training system analysis activities.

The opportunity to test this tool was provided through an Air Force effort funded by the B-1B Systems Program Office (SPO) and conducted under the auspices of the Air Training Command's (ATC) Training Technology Applications Program (TTAP). The specific task was to conduct an analysis of the B-1B armament system loading and repair tasks. The technical proposal and the cost estimate to undertake this task were based on utilization of the E-Tech developed automation tools. To a degree, both parties shared the inherent risks of using untested tools. E-Tech's risk was in bidding the effort assuming that time and labor costs would be substantially reduced. The Air Force's risk was in accepting the premise that use of these automated tools would result in a successful analysis accomplished within their stringent time requirements. It was expected that automation would systematize the analysis process by standardizing the data collection format, provide a consistent methodology for analysis of data and put data required for the analysis literally at the fingertips of the analyst. The software tools functioned as predicted and provided a complete audit trail for each of over 100,000 individual data items, including attributable sources and the date and place of original recording in the field. Although data collection was not necessarily easier using automation, more rapid and accurate access to this collected data was made possible. In addition, the analysis methodology provided the capability to quickly examine analysis results for such things as evaluation of the potential use of existing trainers and rapid review of audit trails to determine disposition of specific equipment training requirements. By provision of these capabilities, in addition to meeting the basic system design requirements, the system exceeded all expectations, justified the risks and is now the basic vehicle currently being used for further development.

Analysis Process

The analysis process used by E-Tech is based on a wide range of instructional system development theories. Basically, all of these theories consist of a central theme; a systematic approach to analysis of tasks with the goal of identifying the most efficient and effective methodology to meet the defined training requirements. E-Tech

utilizes the procedures and concepts in AFP 50-2[1], AFP 50-58[2] and an AFHRL publication of <u>Maintenance Training Simulator Design and Acquisition</u>[3] as a basis for a complete analysis process. All these documents contain the steps of the analysis process; identifying the training need, listing the tasks to be trained and examining each task in detail to identify skills and knowledge which require training. Completion of the analysis process requires going beyond identification of skills/knowledge to be trained, by developing training objectives and then selecting and describing the media and/or training hardware necessary to support the required training. Automation of the process is based on the systematic and structured analysis steps which sequentially identify:

- Steps and Activities (S/A) for each Task

- Skills and Knowledge (S/K) for each S/A

- Hands-On training (HOT) requirements for each S/K

- Identification of tasks not requiring hardware

- Identification of tasks to be incorporated into training systems

- Training requirements for each HOT objective and classroom objective

- Training objectives

- Training media analysis

- Training system requirements to meet training objectives

- Alternative training hardware configurations and classroom descriptions which will meet the training system requirements

- Trade-Off analysis of alternate training system configurations using client approved criteria

- Physical and functional descriptions of student and instructor training hardware and classroom media

Process Description

The automated analysis uses a complete process in which the data are gathered in one session with a Subject Matter Expert and review of appropriate documentation. As depicted in Figure 1, the process is used to break each task into all steps/activities (S/A) required to perform the task and skills/knowledge (S/K) for performance of each S/A. Training required to learn each S/K is identified through subsequent analysis which uses automation techniques to review quickly any portion of the data base resulting in development of the training requirements. Next, the analysis process is used to further manipulate the data to separate the hands-on training requirements from the classroom training requirements. Then, training objectives are developed, followed by identification of training system requirements necessary to meet the objectives for both hands-on and classroom training.
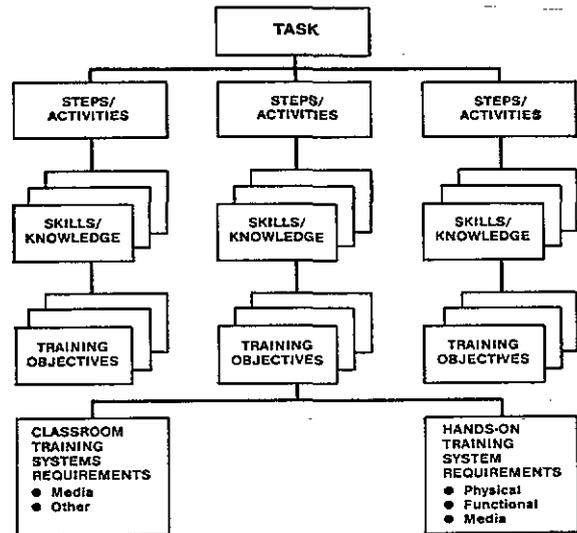

Figure 1. Analysis Process.

Because the process is linear and interrelated, computers can be used to gather and analyze data, and to control and manage the analysis activity. The automated process catalogs relationships of tasks, S/A, S/K, objectives and training system descriptions, and formats the analysis results.

The process also provides an audit trail which can be used to determine cause and effect relationships. For instance, any component or element of a given training system requirement can be tracked back through training requirements, objectives, S/K and S/A to identify what task, skill or step drove the development of that training system requirement. Time is saved because: a) Training system requirements can be printed immediately after development; b) Analysis is done "on line" very efficiently due to rapid access to data; and c) Reformatting/typing of handwritten data is eliminated. In addition, the summation of training system requirements can be grouped according to any client need or criteria in order to provide functional specifications for training hardware or develop classroom training descriptions.

The tools of the process, E-Tech Task and Skill Correlation (ETASC) and E-Tech Training Analysis (ETRAN) systems, work in hand-in-glove fashion during the data collection and data analysis portions of task and skill analysis. Both ETASC and ETRAN are based on data base management systems and are specifically designed for training analysis data collection and manipulation.

The data collection process uses ETASC and is performed on portable computers. These portable computers can be of any type with the capacity to handle a data base management system such as dBase II or III. E-Tech uses Columbia PC and Compaq computers for this phase of the effort. The portables are taken to the field where data

is gathered on site and recorded directly onto diskettes. The data is entered pro forma using protocols designed for the specific analysis project. For example, in the B-1B project, it was necessary to collect data structured by duty, tasks under each duty, steps necessary to perform each task and the necessary skills and knowledge for each step. Also, skill levels for each task were required and recorded. These data requirements and the specified end product were used as a guide for development of the data collection format. This format was programmed and provided the data collection guide for the analyses. In this manner, there is assurance that the data collection will be complete and consistent throughout the data collection process regardless of differences in the techniques of the individual collectors.

The collected data is transferred into ETRAN which resides in a Digital Equipment Corporation VAX 11/730 computer. Basically, ETRAN absorbs, into a single large data base, task data from the mini-data bases collected on portable computer diskettes. Once all the task data is in the large computer, ETRAN permits rapid access to the data and can be used by analysts for development of training requirements and objectives. ETRAN then provides a decision support system for the derivation and design of viable alternative training systems for both hands-on and classroom training. Decisions concerning formulation of objectives and training systems can be quickly reached using this process. The process allows the analyst to gather data from any of over 25 fields in the data base. This data then can be grouped, analyzed or reviewed to create new data fields for required information. The results of these activities can be produced in the form of training objectives, functional descriptions or other similar products. Additionally, task data can be accessed as required for analysis updates as changes occur to the task listing or the operational system during the project.

The results of the automated analysis process can be used to develop overall training curricula and training systems design. Specifically, the data base can be accessed to develop:

- Alternative training systems

- Training objectives

- A cost benefit analysis

- Functional specifications of viable hands-on approaches to training systems

- Required classroom training environment and media

Results of Automated Analysis

The savings in time using automation in training analysis have been demonstrated to result in an approximate 30-35% reduction in per task costs. However, the benefits of using a well designed automated approach, such as ETASC and ETRAN, go beyond time and money savings. Since analysis of any set of tasks will provide the same type of data; steps, skills and knowledge, conditions and criteria, the data can be synthesized using a preprogrammed automated format to pull data from data fields, arranging and analyzing it as required. Thus, the processes

can be tailored to fit the product needs of the client. The products of the process can include content descriptions for any given training lesson, descriptions of required training hardware or classroom media, a list of objectives for any task or group of tasks, or any of many other related products.

This automated analysis has been used to advantage on projects other than the B-1B. For example, the process has been used to analyze the content of an existing course in non-destructive inspection at Chanute AFB, Illinois, again under the ATC TTAP project. The objective was to determine suitability of the course matter for computer based training. The results of the analysis were synthesized and objectives developed, sequenced and grouped by related course content. The results were then used to develop CBT lessons to validate the applicability of CBT to this content area.

Currently, automated analysis processes are being used to gather and collate task data for production of survey questionnaires, and to develop job performance measures (JPMs) and Individual Training Standards (ITS) for more than 60 military occupational specialties.

During the B-1B analysis, another valuable use of the automated process was discovered. This involved examination of the developed data base to determine if existing or specified devices could be used to train any of the tasks analyzed. To determine if existing training devices could be used, the specifications of the devices were reviewed to identify their capabilities in terms of simulated hardware and skills trained. These capabilities were entered in ETRAN and synthesis of the results produced a printout of the tasks, steps, skills/knowledge and training requirements in the 500 task data base which could be met by the existing training equipment. The entire process, from specification review to printout, took one person less than one workday.

Future Applications

Future applications being planned for automated analysis efforts include "conceptual" analysis work and application of expert systems to data bases.

Conceptual Analysis

Since a data base is automated and can be revised quickly and easily when required, automated systems can easily adapt to a "conceptual" front-end analysis (FEA) environment. Tasks which are only a "first cut" and developed at a very early stage in weapons system design before any prototype is built can be entered into the data base. These "first cut" tasks can be borrowed from task lists of similar systems which already exist. For example, a list of procedures for operation of a new aircraft could be based on operation of any similar existing aircraft. This "first cut" list would then be reviewed with engineers and/or test pilots to eliminate unrelated tasks and/or to insert new and different tasks. Tasks can then be analyzed and conceptualizations of training systems can be developed at this early stage of weapon system design. From these conceptualizations, training system costs, personnel requirements and facili-

ties can be estimated early enough to get into the POM process. As the task lists and descriptions become more defined, changes to the data base and resulting changes to the training and support systems can be identified. The update of training designs and budget inputs can be efficiently and effectively completed with relatively minimal effort. Several projects can be tracked simultaneously with histories of past estimates maintained. This application would be repeated as necessary, until final training system design specifications and other results are required. At such time, the final analysis process would again update the data base, identify the final training system requirements, generate the required functional descriptions, delineate manning requirements and specify necessary support for the new system.

Expert Systems

Expert systems are particularly inviting as a labor reduction tool. Current efforts involve use of an expert system to develop training objectives from the collected data. The expert system uses predetermined rules to generate tentative objectives which are reviewed and corrected by the analyst. These corrections result in development of further rules. These are used by the expert system for further development of objectives. The result is a greatly reduced requirement for analyst time for development work and more application in analysis and decision making.

Since future application of expert systems will most likely be in the development of instructional products such as lesson plans, storyboards or system specifications, development of these advanced instructional products using expert systems requires the availability of "raw materials" to include not only the basic data such as equipment lists or skills and knowledge, but derived products such as training requirements and objectives. In addition, since training systems use a variety of media, it would be economical to use expert systems to select media, thereby providing more data for construction of system specifications or lesson plans. These applications will further reduce the labor required in analysis of tasks and result in the use of analyst time for more creative efforts as well as further reduction of the overall cost and time required for task analysis and training system development.

References

1. AF Manual 50-2, Instructional System Development, Washington, DC: Department of the Air Force, 31 July 1975.

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3. Technical Report, Maintenance Training Simulator Design and Acquisition - Handbook of ISD Procedures for Design and Documentation, U.S. Air Force Human Resources Laboratory, Lowry Air Force Base, Colorado, March 1980.

About the Author

Mr. Jorgensen is a program manager for Eagle Technology, Inc. (E-Tech), in Orlando, Florida, and is responsible for technical management of instructional development and training projects. He is currently responsible for technical direction of a project developing Individual Training Standards for over 60 Marine Corps Military Occupational Specialties. Mr. Jorgensen has been with E-Tech for over five years, during which time he has managed training analysis projects for all four services and has been the senior training analyst on Air Force projects involving maintenance training on the B-1B and F-16 aircraft. He has managed projects resulting in computer based training products, training device specifications and recommendations for a wide variety of training systems. Mr. Jorgensen holds degrees in Instructional Design and Technology, Mathematics, Science Education, and Media Design. He has authored papers for several education and training conferences and has produced several reports in the field of vocational education and training simulation and design.