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LINKING TRAINING EVALUATION TO TRAINING NEEDS ASSESSMENT: A CONCEPTUAL MODEL

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A critical linkage in training systems is the translation of training evaluation information for reassessing training needs and for making training program changes. This paper presents the development of a conceptual framework for examining the job relevancy and efficiency of training and the linkage of this evaluative information to training needs reassessment. How to integrate job performance information into the existing training evaluation system for identifying over- and undertrained tasks is also described. The Aerospace Ground Equipment (AGE) (AFS 423X5) Technical Training Program is used as a case analysis for this paper. Recommendations for future research to identify the content domain of an Airman Basic-in-Resident (ABR) Training program and to integrate performance information into the evaluation system are presented.

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SUMMARY

A critical linkage in training systems is the translation of training evaluation information for reassessing training needs and for making training program changes. This report presents the development of a conceptual framework for examining the job relevancy and efficiency of training and the linkage of this evaluative information to training needs reassessment. How to integrate job performance information into the existing training evaluation system for identifying over- and undertrained tasks is also described. The Aerospace Ground Equipment (AGE) (AFS423X5) Technical Training Program is used as a case analysis for this report. Recommendations for future research to identify the content domain of an Airman Basic-in-Residence (ABR) Training program and to integrate performance information into the evaluation system is presented.

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PREFACE

This research was initiated under the Air Force Office of Scientific Research 1988 Summer Faculty Research Program. The research is part of an integrated multi-year comprehensive research and development program being developed by the Training Systems Division of the Air Force Human Resources laboratory (AFHRL/IDE). The focus of this research direction is on training evaluation issues relevant to Air Force technical skills training.

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LINKING TRAINING EVALUATION TO TRAINING NEEDS ASSESSMENT:

DEVELOPMENT OF A CONCEPTUAL MODEL

I. INTRODUCTION

In fiscal year 1989, over 35,000 airmen received initial technical skills training at resident Air Training Command (ATC) schools to prepare them for first job assignments in the Air Force. This represents an enormous amount of resources devoted to initial technical training. Training that is irrelevant or inappropriate at the technical training level is therefore quite costly to the Air Force (Ruck, Thompson, & Stacy, 1987). Active steps must be taken to ensure that technical training programs are job-related and efficient.

The Instructional System Development Process

Each initial technical training program is planned, developed and conducted through a systematic and complex five step process. This Instructional System Development (ISD) process which guides the development and revision of technical training programs includes the following steps: (a) analyze system requirements; (b) define education and training requirements; (c) develop objectives and tests; (d) plan, develop, and validate instruction; and (e) conduct and evaluate instruction (AF Manual 50-2, 1979).

The fifth step in the ISD process specifies that a thorough evaluation of the training program must be conducted. The linkage between the evaluation phase (step 5) and the analysis of system requirements or training needs assessment (step 1) implies that training is a continuously evolving process that uses evaluative information to adapt and to improve its quality. Therefore, a critical linkage in the ISD process is the translation of training evaluation information into input useful for reassessing training needs and for making meaningful training program changes.

Objective of Project

As part of the ISD process, ATC has developed a formal training evaluation system to allow for the orderly development of change in the technical training programs. Given that the evaluation system was developed over 10 years ago, it would seem reasonable to examine and re-evaluate the comprehensiveness and effectiveness of the evaluation system. This examination focuses on whether or not the evaluation system is limited in its ability to succinctly and reliably answer questions about the quality of technical

training programs or to provide the type of information required for use by training managers in making course revisions and continuous improvements.

To critically examine the training evaluation system, a conceptual framework must be developed to guide the effort. The objectives of this project are to: (a) develop conceptual frameworks for understanding the components of a comprehensive training evaluation system, (b) describe the training evaluation system used in ATC training programs through a case analysis of a specific technical training program, (c) critically examine the training evaluation system in relation to the conceptual models developed, and (d) present recommendations for research to examine the complex issues of better linking training evaluation information to training needs reassessment.

II. A CONCEPTUAL FRAMEWORK FOR TRAINING EVALUATION

A comprehensive analysis of training needs is critical to training program development. Similarly, an initial assessment of training needs should also provide information for the development of a comprehensive training evaluation system. The key question asked during this evaluation development phase is "what do we want to know about the training program that will indicate the quality of the program?" In this regard, decision makers may be interested in answering one or more evaluation questions i.e., evaluation may be required for different purposes. To answer each evaluation question or to fulfill each purpose, different types of information or data must be gathered by an evaluation system. The conceptual framework relating training evaluation's purpose and types of evaluative information needed is presented below.

A Typology of Training Evaluation Purposes

The purpose of the evaluation drives the kinds of information that needs to be collected. Thus, if the purpose(s) behind the development of an evaluation system for a particular training program is not clearly specified during the initial analysis or needs assessment phase, it is unlikely that the appropriate information will be collected to link subsequent evaluation data with training needs reassessment. Without a clear sense of purpose, modifications to enhance the quality of the training program must rely on the intuition of the people who develop the training program (Montague & Wulfeck, 1986).

There are five major purposes for conducting training evaluation. Table 1 presents the five purposes, the questions asked for each purpose and the types of information needed to answer the questions posed by each.

TABLE 1

The Purposes for Conducting Training Evaluation

Purpose of Evaluation	Type of Question Asked	Information Required
1. Content Validity	Is Training Job Relevent?	Job Content Training Content
2. Training Efficiency	Are We Over- or Under Training Certain Tasks?	Job Importance Training Emphasis
3. Training Validity	Did the Trainees Learn the Material Trained?	Training Performance Criterion of Success
4. Transfer Validity	Are People Performing well on the Job?	Job Performance Criterion of Success
5. Predictive Validity	Does Training Performance Predict Job Performance?	Training Performance Job Performance

One purpose for conducting training evaluation is to determine the content validity of the training program (Goldstein, 1986). Content validity asks the question "is the training content job relevant?." To answer this question, information about the tasks being performed on the job must be matched with the tasks being trained in the training program. A content validity ratio can be calculated to determine the extent to which the content of the training program is job relevant (Ford & Wroten, 1984).

A second training evaluation purpose is to examine training efficiency. Training efficiency asks the question "is the training program over- or undertraining certain tasks (or Knowledges, Skills and Abilities (KSAs))?." To answer this question, information regarding the importance of tasks in the job domain and the emphasis of those tasks in the training program must be acquired. A matching technique can then be applied to examine areas of over- or undertraining (Ford & Wroten, 1984). One outcome of this analysis could be the elimination of certain tasks from the technical school training program that might be better trained on the job.

A third purpose for conducting training evaluation is to determine training validity. Goldstein (1986) states that this purpose asks the question "did the trainees learn the material that was being trained?." To answer this evaluation question, one must collect information about the performance of the trainees during and/or at the end of the training program. The analysis determines the extent to which learning has taken place in comparison to a specified standard or criterion of success.

A fourth purpose of evaluation is to determine transfer validity (Wexley, 1984). Transfer validity asks the question "are people performing well on the job after training?." To answer this question, information regarding performance on the job must be collected. Job performance must then be compared to some criterion of success to determine the extent of successful transfer. Experimental designs can be used to determine if the transfer of knowledges and skills have actually occurred and whether the change is attributable to the training program.

A fifth purpose of training evaluation is to determine the predictive validity of a training program. At times, training is used as a device to select or place individuals into a particular position or job. Therefore, the question that must be answered with this evaluation purpose is "does training performance predict job performance so that accurate selection/placement decisions can be made?." The information that must be collected to conduct this analysis includes training and job performance information.

Types of Training Evaluation Information

Two major dimensions of information available for answering the questions posited for each evaluation purpose are represented in Table 1. One dimension is the source of the information that is gathered. The two sources of information available for a comprehensive training evaluation system are from the job domain and the training domain. A second dimension is the type of information gathered. The type of information is conceptualized as being task-based or performance-based. Task-based information focuses on what an individual "does do" while performance information examines "how well an individual does the specified tasks."

Figure 1 presents a conceptual representation of the four domains that result from combining the two types of sources with the two types of information available. The four domains are the: (a) job content domain, (b) training content domain, (c) job performance domain, and the (d) training performance domain.

The job and training content domains are conceptualized as consisting of a task and an emphasis component. The "task" component of the job content domain involves the identification of what tasks (or KSAs) are performed on the job. The "task" component of the training content domain includes information regarding what tasks (or KSAs) are taught during training.

The "emphasis" component of the job content domain involves an analysis of how "important" the various tasks are for job performance. Importance can be operationalized in a number of ways including "importance to job performance" and "task difficulty." The "emphasis" component of the training content domain concerns the amount of effort devoted to training the various tasks included in the training program. Emphasis can be operationalized as a subjective assessment of effort devoted in training to each task or as the actual amount of time spent training each task.

The job and training performance domains are conceptualized as consisting of a knowledge and a performance component. The "knowledge" component of the job performance domain focuses on how well the individual knows the appropriate ways to perform job tasks. Job knowledge tests are often used to address this issue. The "performance" component specifies how well the individual actually performs the job tasks. Information from job

SOURCES OF INFORMATION

Job Content Domain

Task:
What are the tasks performed on the job?

Emphasis:
How important are the tasks to job performance?

Training Content Domain

Task:
What are the tasks taught in the training program?

Emphasis:
What is the emphasis placed on the tasks inicluded in the training program?

Job Performance Domain

Knowledge:
How well do individuals know how to do the job?

Performance:
How well do individuals actually perform job tasks?

Training Performance Domain

Knowledge:
How well have trainees learned the trained material?

Performance:
How well can the trainees perform the trained tasks?

Figure 1. The sources of information and type of information available to conduct training evaluation.

performance ratings, work samples and job indices such as quantity or quality of work can be gathered to determine the level of job performance.

For the training performance domain, the "knowledge" component examines how well the trainees have learned the material that has been taught. Paper-and-pencil tests on the material covered in the course are typically used to examine the knowledge component. The "performance" component focuses on how well the trainees can perform the tasks that have been trained. Performance ratings, work samples, and other objective indices can be used to determine performance level while the trainees are progressing through the training program.

Summary

In summary, the model in Figure 1 provides a conceptual framework for describing the information available to answer training evaluation questions. The specific information gathered is dependent upon the purpose(s) for conducting training evaluation (see Table 1). An examination of Figure 1 also indicates that a critical boundary condition surrounding these four domains is information quality. This means that the usefulness of any information collected for answering the evaluation question posed is heavily dependent upon the quality of that information.

III. ANALYSIS OF THE AF ABR TRAINING EVALUATION SYSTEM

The conceptual models developed in this paper highlight the important role evaluation systems have for enhancing the quality of training. This section describes the existing evaluation system relevant to the four domains of information presented in Figure 1. The Aerospace Ground Equipment (AGE) (AFS423X5) Airmen Basic-in-Residence (ABR) course at Chanute AFB, Illinois is used as a case study.

Training Evaluation Information

There are many documents in the Air Force that provide information that is useful in defining the job and training content and performance domains (see Appendix A for listing). Table 2 lists the four domains along with the sources of information available in the Air Force training evaluation system, the type of information they contain, and the level of specificity of the various types of evaluative information.

Level of specificity refers to the amount of detail in the evaluative information collected. The Air Force uses a task- based approach to needs assessment and training evaluation. An examination of this evaluation system reveals three levels of specificity in the task-based data that is collected. The basic component of the evaluation system is

Table 2. The Available Sources of Evaluation Information.

Domain	Source of Information	Type of Information	Level of Specificity
Job Content	OSR	Task	T
		Emphasis	T
	STS	Task	CT
		Knowledge	CT
	U&TW	Task	CT & T
Training Content	POI	Task	CT
Job Performance	QA Checks	Performance	T & TOSL
	TER	Task	CT
		Performance	CT
	TQR	Task	CT
		Performance	CT
Training Performance	Block Tests	Knowledge	TOSL
	Performance Progress Checks	Performance	T

T => Task, CT => Cluster of Tasks, TOSL => Technical Order Step

at the "task" (labeled T in Table 2) level. A task is defined as a unit of work activity or operation which forms a significant part of a duty (AF Manual 50- 2, 1979). An example of task level information is found in the Occupational Survey Report (OSR).

An OSR, a product of the Occupational Measurement Center (OMC), defines the job content of a career field and is based upon a comprehensive survey of airmen within a target occupation. The job inventory asks the respondents to indicate the tasks they currently perform. In the OSR, this information is recorded in one of three time-in-service categories, first enlistment (1-48 months), second enlistment (49-96 months), and career personnel (97+ months). Tasks are analyzed to reflect the percentage of airmen performing each task in each category. These data provide task information about the job content domain by time-in-service. Additional data collected include the relative time spent performing each task, the difficulty of learning each task and the emphasis that should be placed on training each task.

Tasks can also be grouped together in terms of co-performance. An example of tasks grouped into more general statements is found in the Specialty Training Standards (STS) (AF Regulation 8-13 & ATC Supplement, 1, 1987) that incorporate multiple OSR task statements into each standard. We have labeled this grouping as the "cluster of tasks" (CT) level in Table 2.

Frequently, tasks are broken down into requisite steps needed to perform a given task. An example is the steps found in Technical Orders (TO) that are the individual procedures required to perform each OSR task. The TOs provide step by step instructions for conducting all Air Force equipment maintenance. This includes maintenance provided for aircraft, electronic systems, support vehicles, and aerospace ground support equipment. In Table 2, this level of task specificity is labeled as Technical Order Step Level (TOSL).

Another way to examine the subcomponents of a task or cluster of tasks is to identify their underlying job elements (Primoff, 1975). This approach specifies the knowledge, skills and/or abilities (KSAs) needed to perform each task or cluster of tasks. An example of a job element approach for the cluster of tasks level is found in the STS. The STS not only lists tasks clustered by co-performance, but also identifies the knowledge required to perform duties at the 3-, 5-, and 7-levels of proficiency. An example of a job element approach for the task level of specificity is found in the Training Requirements Analysis (TRA) which accompanies each new OSR. The TRA, like the OSR, is a product of OMC. In the TRA, the underlying KSAs needed to perform each OSR task are identified. This provides

Training Development Branch personnel (TDB), who are responsible for designing technical training courses, with more specific information needed to refine course content.

The following is a detailed description of the level of specificity for the evaluative information gathered for each of the four domains described in Figure 1. While the information collected is similar across career fields, the AGE career field is used to illustrate the issues relevant to training evaluation.

The Aerospace Ground Equipment Career Field

The AGE career field maintains both powered and non-powered equipment used to support aircraft in the Air Force. The equipment varies from small jet engines used to start jet aircraft, to tow bars used by ground personnel when moving aircraft. The ABR course for AGE lasts 18 weeks. After completing this course, airmen are sent to an operational base and support a wide diversity of Air Force missions.

Consequently, the ABR course is required to teach a variety of different tasks that any one airman might encounter in his or her first job assignment.

Job Content Domain

The most recent OSR for AGE surveyed 2,629 airmen in 1983. About 75 senior AGE Noncommissioned Officers (NCOs) from different Major Commands (MAJCOM) completed two additional surveys. The purpose of these latter surveys was to gather "task difficulty" and "training emphasis" ratings information. Task difficulty is defined as the relative difficulty to learn a task and is rated on a nine point scale from 1 (extremely low) to 9 (extremely high). Relative difficulty represents the time needed, on the average, to learn to perform a task satisfactorily. Training emphasis is defined as the perceptions of the NCOs as to which tasks should be taught to first enlistment airmen in a structured training course. This scale ranges from 0 (no training recommended) to 9 (extremely high training emphasis). In relation to the conceptual framework presented in Figure 1, these two pieces of data are part of the emphasis component of the job content domain.

In addition to the OSR data, Specialty Training Standards (STS) are created (current STS 423X5, dated Aug 1987; Appendix B provides a portion of the current STS for AGE). The 1983 OSR had over 600 task items that defined the AGE career field. The AGE STS dated July 1982 consisted of 124 statements, of which 80 were statements at the CT level of specificity. The remaining 44 STS statements were general knowledge statements.

Finally, the job content domain also includes Technical Orders for the AGE career field that are used whenever a task is performed. The TOs include the equipment needed as well as all of the steps needed to correctly perform the tasks relevant to the AGE career field.

Training Content Domain

The job content domain is defined at three different levels of specificity; the CT level is defined by the STS; the task level is defined by the OSR; and the step level is defined by the TO. A TRA for the AGE career field has not yet been completed.

The training content domain is defined by the Plan of Instruction (POI). The POI is derived from a complex system of translating OSR and STS information into training objectives. This system is described below.

The OSR task information is the criterion standard used when making decisions about which tasks to include in an ABR training course. If the OSR reports that 30% of the airmen in their first enlistment perform a task then the task is considered for possible inclusion in the course. Also taken into consideration by the AGE TDB is the task difficulty and training emphasis ratings.

After an OSR is completed, personnel from OMC contact Subject Matter Experts (SMEs) to collect additional information to help define the training domain. The SMEs go through the OSR tasks one-by-one and determine within which, if any, STS statement the task belongs. In some cases, a number of OSR tasks are matched to one STS statement. For example, 50 OSR tasks fall within a single AGE STS statement: 18A. "operational fundamentals of gas turbine compressors." Some STS statements are knowledge, not task statements, and so do not match with OSR tasks.

As a next step, a Utilization and Training Workshop (U&TW) is convened to review the ABR training program and to make recommendations for content changes. The U&TW is composed of members from the MAJCOMS, ATC, and TDB. The STS is modified to reflect these recommended changes. This is a critical step as the STS indicates which statements are ABR course requirements and the level of proficiency the graduate is expected to obtain as a result of the training. The STS is a contract between the MAJCOMs and the AGE school. It sets the criteria for knowledge and performance of the ABR graduates. The statements are written in general terms (CT level) in order to be as useful to as many users as possible (e.g. AGE STS statement #11. Reciprocating Engines, b. Diesel Engines, (2) inspect.).

After the U&TW is completed, the TDB examines the new STS and other relevant material to identify the STS

statements that apply to the ABR course. OSR tasks that are listed under the applicable STS statement are reviewed in the following manner. If a task is performed by over 50% of the airmen during their first enlistment that task is recommended for knowledge and hands on training. If the percentage performing is between 30 - 49% then the task is recommended for knowledge training only. Below 30% tasks are generally not taught in the ABR course. The task difficulty and training emphasis ratings are also considered. A task is not recommended for training, no matter how high the percent performing rating is, if the task difficulty rating is statistically one standard deviation below the mean. A task is recommended for training if the training emphasis rating is statistically one standard deviation above the mean. The final criteria is the AGE school's ability to teach the task given the constraints the school faces with reference to time, equipment, qualified instructors, and building space.

SMEs are also used to match the OSR tasks to the Plan of Instruction (POI) objectives created by the AGE Training Development Branch (TDB). This is done to insure that the tasks identified as needing to be trained through the OSR process are actually trained in the ABR course. Once this matching of tasks to objectives is accomplished, this matching information is not retained. Thus, while the POI references STS statements for each objective, there is no information on which OSR tasks underlying each STS are actually incorporated into the training content. This is important when changes are made in training content (e.g., a new OSR is completed or a U&TW inititates course changes) as there is no linkage between OSR task information and training objectives.

The TDB personnel take the STS and the TOs in order to rewrite training objectives for the course. The TDB then develop criteria (e.g., similar equipment) for combining the objectives into blocks of instruction. Each block has one or more objectives and includes the time spent training on the objective, the STS statement reference, STS proficiency level, and the form of criteria testing, either written or progress check. For AGE there are 11 blocks of instruction which are further combined into five general instructional areas.

Training Performance Domain

The proficiency level of the trainers is examined through paper-and-pencil knowledge tests and hands-on performance tests. In the AGE ABR course trainees are given knowledge tests at the end of each of the 11 blocks. The questions are written by the course instructors and are directly related to the course objectives. A major criteria for determining a good test question is when less than 50% of the trainees get the question wrong. The average grade

on any given test is between 85% and 90%. Test questions are written at the sub-task level of specificity. As questions are written from steps in the TO.

Many objectives in the ABR course require a performance progress check. The progress check involves two or more trainees working together to perform a task on AGE equipment located at the technical school. The trainees use the relevant TO to complete the task and are observed at all times by an instructor. If no difficulties are encountered during the performance progress check the trainees are checked off as having completed the task. If the trainees do not pass, the instructor explains what was done wrong and trainees are allowed to perform the task again.

Job Performance Domain

Training Evaluation Reports (TERs) are produced annually or bi-annually by Training Evaluation Division personnel at each technical training command. The TER examines how well the ABR course is preparing graduates to perform their assigned tasks according to the proficiency level specified by the STS. Surveys are developed to collect this information with questionnaire items taken directly from the applicable STS statements.

For 1988, TER surveys were sent to 314 supervisors of recent AGE graduates asking them how satisfied they were with the graduate's performance and if the tasks taught in the course were being utilized. If less than 80% of the graduates perform the required tasks satisfactorily then training is considered inadequate. If less than 30% of the supervisors indicate the graduates are performing a task taught in training, consideration is given for removal of that task from the ABR course. A TER was recently completed (Feb 88) for the AGE ABR course. No recommended changes to course content were made based on this information.

Supervisors in the field have an additional method of providing technical schools with feedback about training effectiveness in the form of Training Quality Reports (TQR). TQRs are submitted by a supervisor and report a graduate's lack of proficiency in one or more tasks or the lack of knowledge that the STS states a graduate of the AGE ABR course should have. The school is required to respond to all TQRs. Between January 1985 and August 1988 7 TQRs have been submitted about the AGE ABR course.

In addition, performance checks, similar to the progress checks performed in the technical school, are conducted by the Quality Assurance (QA) branch personnel in field settings. On a regular basis, QA monitors airmen performing different tasks to check on their proficiency in those tasks. These are tasks they are used to certify proficiency. QA personnel insure that the tasks are

completed in accordance with the procedures laid out in the TOs and that there are no major discrepancies. If a major discrepancy is noted then recommendations are made which usually include decertification and/or additional training. This information is used by the MAJCOMs to monitor wing readiness, but is not presently used to provide performance feedback information to training programs.

IV. CRITIQUE OF THE TRAINING EVALUATION SYSTEM

Table 1 presented five purposes for conducting training evaluation. A critique of the existing training evaluation system in terms of these five purposes is clearly beyond the scope of this report. Instead, we have chosen to focus attention on the issues of content validity and training efficiency as they form the initial steps for answering questions regarding the three additional evaluation purposes.

Content Validity Issues

One of the purposes of an evaluation system is to insure that the training content is job relevant or content valid. ("is the training content job relevant?"). The information needed to address this question includes an analysis of the "task" components of the job and training content domains. Thus, the question of content validity must be answered through a direct comparison of the tasks (or knowledges and skills) being performed on the job with the tasks being taught in the training program. The greater the overlap between the tasks performed on the job and the tasks taught in the training program, the greater the content validity of the training. Tasks in the training program that are not important on the job are considered contaminants, while important tasks not included in the training program are considered training deficiencies.

Therefore, to determine the content validity of a training program, the content of the job in terms of tasks performed and the content of the training program must be identified. Currently, the job content domain is specified at the task level by the OSR. The ABR training content domain is most clearly identified at the task cluster level by the STS.

Therefore, it is difficult to determine training content validity at the task level of specificity. To more comprehensively evaluate content validity, the content of the training program must be clearly identified at the task level. Without direct information about the training content domain at the task level, there is no simple, systematic way of incorporating the new OSR information into the evaluation system to make meaningful changes in training content and training design. Instead, instructor knowledge of course

content is required to determine if an OSR task is currently taught in the AGE ABR course. Given duty rotations, it is highly likely that the instructors who helped make linkages between the old OSR and the POI are not available when the new OSR data is created. Thus, linkage information may be lost to the evaluation system.

Training Efficiency Issues

A content valid training program indicates that the tasks being performed on the job are the same tasks being trained. Once content validity is established, a second issue is training efficiency. Training efficiency asks the question "is the training program over- or undertraining certain tasks or KSAs?." Thus, a training program may have a high degree of job relevancy (training the appropriate tasks) but may or may not be placing an appropriate amount of emphasis on the various tasks during training to match their "need" for training. The information needed to address the training efficiency question includes an analysis of the "emphasis" components of the job and the training content domains (see Figure 1). The question of efficiency can be addressed through a direct comparison or matching of the emphasis placed on the tasks during training with training "needs" i.e., how important the task is in the job domain.

Ford and Wroten (1984) developed a methodology called the Matching Technique to link the "emphasis" components of the job and training content domains to determine training efficiency. The Matching Technique is conceptualized in Figure 2 as a matrix in which training emphasis is directly compared to training needs" (i.e., how important the task is for job performance).

The comparison of emphasis with needs identifies training "hits" and "misses." Training hits refer to those tasks where the emphasis received in training appropriately reflects training needs. Training misses can involve areas of deficiencies (undertraining) and excesses (overtraining). Training deficiencies are content areas whose high training needs are not matched by a high degree of emphasis in the training program. Training excesses are tasks that are receiving an excessive amount of emphasis relative to their need to be training. The greater the number of misses (both deficiencies and excesses) uncovered, the less efficient the training program is and the greater need for reassessment and redesign of the program.

Any measure of training "needs" or training "emphasis" can be used to apply the Matching Technique as long as the measures reliably quantify the extent to which areas need to be trained or emphasized in the training program. Nevertheless, as noted when discussing content validity, the

MATCHING TECHNIQUE TO EXAMINE TRAINING EFFICIENCY

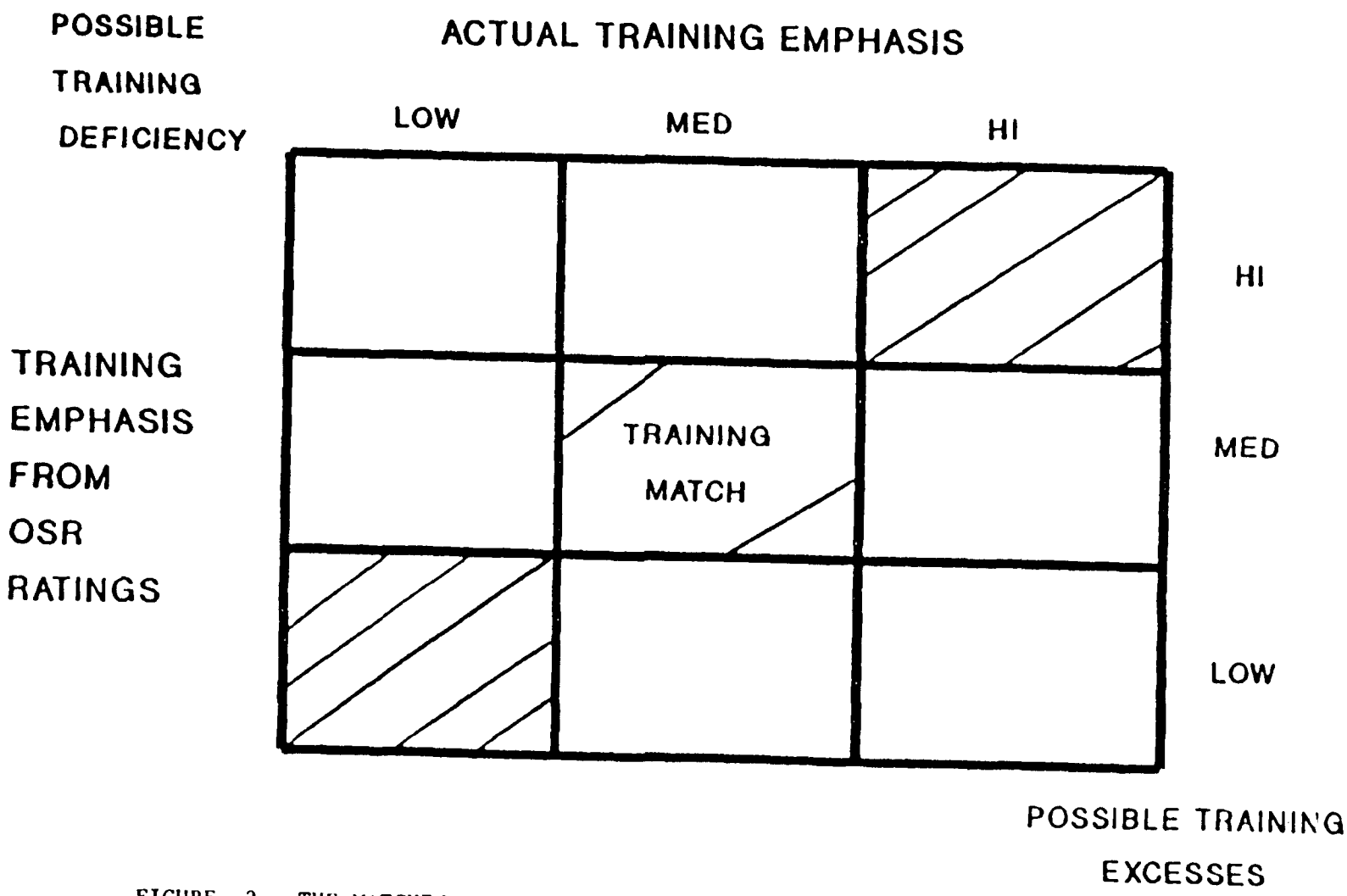

FIGURE 2. THE MATCHING TECHNIQUE

comparison of training "needs" (i.e., job emphasis or importance) and training emphasis can only be as good as the quality of the data collected. Also the type of information (tasks, KSAs) collected on the job and training content domains must be operationalized at the same level of specificity to make this direct comparison possible.

An examination of the evaluation information collected for the AGE ABR course reveals that the Matching Technique can not be completed as some of the information needed is not available. The training emphasis rating found in the OSR is the supervisor's perception of which OSR tasks should be taught in the AGE ABR course. The problem is that the training content domain has no comparable training emphasis information. Instructor ratings of the emphasis placed on tasks during training or the actual time spent in training on tasks are two ways of collecting emphasis information in the training content domain.

Another factor limiting the ability of the training system to adequately address the training efficiency issue is the lack of adequate training and job performance information. Although performance information is available in both the job and training domains, the information is neither used nor collected in a form that makes it useful to the training evaluation system. Performance information would be quite useful in determining over- or undertraining of tasks in the AGE ABR course. This issue is addressed further in the future research directions section below.

V. FUTURE RESEARCH DIRECTIONS

Based on the conceptual models developed and the analysis of the Air Force ABR Training system, two research needs are identified: (a) to systematically identify the training content domain in terms of tasks and emphasis placed on those tasks, and (b) to incorporate job performance information into the training system to address the issue of training efficiency.

Identification of Training Content Domain

The job content domain is defined through the OSR process in terms of the tasks performed on the job and the emphasis that should be placed on training those tasks during the ABR course. The OSR process represents a large commitment of resources to develop systematic data on the job domain which can be used for aiding training personnel of the ABR courses in updating training to maintain a high quality program.

A major problem identified in this review is that similar efforts to systematically identify the tasks taught and the emphasis placed on those tasks in the training content domain are lacking. Information about the ABR

course is available through the POIs and lesson guides but is not at the same level of specificity as the OSR data. In addition, no data are gathered on how much emphasis is actually placed on each task that is part of the training content domain. Without such information, decision makers can not link the job and training content domains to fully answer questions of training content validity and training efficiency.

Consequently, one research effort should be devoted to developing a methodology for identifying the training content domain in terms of tasks and emphasis. Training Branch personnel, instructors, students and recent graduates are all potential sources of information regarding the training content domain.

For example, TDB staff members from AGE can be used as SMEs and asked to independently examine the list of OSR task statements from the most recent OSR (i.e., 1983) and state whether the task is taught or not in the ABR course. Disagreements among SMEs can be resolved through consensus judgment to provide a preliminary list of OSR task statements that are taught in the ABR course. Given that the ABR course is divided into five training areas, the SMEs could then match the preliminary list of task statements to the area in which each task is taught (some tasks may be taught across a number of areas). This will provide a task matrix for each of the five training areas in the course. Once the matrix is created, instructors can then be used to verify the task list. Multiple instructors are assigned to each area and each instructor leads a class of graduates (usually 12) through his/her training area. Thus, surveys can be conducted to determine whether there is substantial agreement among the various instructors that the tasks identified are actually taught in the training program. This two step process (TDB staff SME judgments and instructor survey responses) would result in a list of tasks taught by area at the OSR task level of specificity. It would also allow for an examination of the extent to which instructors in the same area teach the same tasks.

Once the training content domain has been identified at the OSR level, the second phase of the research would be to develop a methodology for collecting information on how much emphasis is actually placed on each task trained in the AGE ABR course. Emphasis information can be collected from two sources. First, information regarding the amount of time actually spent training each task identified in Phase 1 can be determined through a survey of the AGE instructors. The survey would ask each instructor to independently estimate the amount of time spent training each task in his/her training area i.e., to distribute the total time available for training in an area across the tasks being taught in that area. This would allow for an analysis of the extent to which different instructors in the same training area

place the same amount of emphasis on different tasks trained in that area. Second, ratings of "relative emphasis" given to each task trained can be collected through a survey of recent graduates of the AGE ABR course. This would allow for a comparison of the instructor estimates of training emphasis with estimates of recent graduates.

Integrating Training Efficiency and Performance Information

The identification of the training content domain in terms of OSR tasks and the development of a methodology for determining training emphasis are prerequisites for using the Matching Technique (Ford & Wroten, 1984). The Matching Technique provides preliminary information that certain tasks may be training excesses (i.e., overtrained) or training deficiencies (i.e., undertrained). To more fully address the question of training efficiency (are tasks over- or undertrained?), performance information must be incorporated into the process.

Figure 3 presents a 2 X 2 matrix which combines information that is created from the Matching Technique with job performance information. An analysis of the Matching Technique identifies tasks that are excesses and deficiencies. In Figure 3, performance level is conceptualized at the group level of analysis i.e., how well the group of individuals trained are performing various tasks on the job. For purposes of this example, performance is dichotomized into the categories of "not performing well" and "performing well". The four components of the matrix in Figure 3 derived by combining the outcomes of the Matching Technique with performance level information provide data relevant to identifying over- or undertrained tasks. As an example, let us assume that a number of tasks were identified through the Matching Technique as being deficient. The next step is to examine how well recent graduates are actually performing those tasks on the job. If the tasks are not being performed well, then the need for more training emphasis during the training program is indicated. If the tasks are being performed well, this indicates that training deficiency is not an important issue to consider. Such a result may suggest that formal training of the tasks is not necessary.

The Matching Technique may also identify some tasks as training excesses. An examination of job performance may indicate that some tasks that are training excesses are performed well and others are not performed well (see Figure 3). If a task is not performed well on the job, this indicates that there is a serious problem that is best addressed through other means such as on-the-job training. If a task is performed well, this suggests that consideration be given to examining whether training emphasis placed on the task could be reduced without detrimental effects on job performance. Currently, job

TRAINING MISSES	JOB PERFORMANCE LEVEL: Not Performing Well (Few People can Perform the Task Well)	JOB PERFORMANCE LEVEL: Performing Well (Most people can Perform the Task Well)
Training Excesses	Eliminate from Training and Find Other Options	Reduce or Maintain Training Emphasis
Training Deficiences	Increase Training Emphasis	Maintain Current Emphasis

FIGURE 3. Model of Training Efficiency Information and Job Performance Information.

performance information is not used to make decisions regarding training efficiency. A new methodology called the Job Performance Measurement System (JPMS) developed by the AFHRL (Hedge & Teachout, 1986) provides the type and quality of job performance data needed to identify over- and undertrained tasks.

The JPMS contains three types of information. First, participants complete "a hands-on" portion of the Walk-Through Performance Testing procedure in which participants actually perform certain tasks and are scored by trained observers on whether the tasks are performed correctly. A second portion of the Walk-Through Performance Test is an interview portion which asks participants to explain how they would go about completing certain tasks rather than actually performing those tasks. These responses are scored by trained interviewers. Both the hands on testing and the interview method are scored at the TO (Step) level (subtasks are performed correctly or not) which are then summed for each task to provide a score at the OSR (task) level. The third type of information is a Specialty Job Knowledge Test which covers a number of tasks in the career field. Participants must respond to a number of multiple choice questions derived from the task content domain at the task level of specificity.

Given the development of the conceptual model, the next step is the development of the methodology to integrate JPM data into the training evaluation system to address issues of over- or undertraining. If the training content domain is specified at the task level of specificity, then the integration of performance data must be at the task level also. Nevertheless, for tasks that are identified as over- or undertrained, job performance at the TOSL can then be examined to determine which procedural steps are most problematic. Research could examine the impact of feeding back job performance information to training personnel on ABR course changes.

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Appendix A: SUPPORTING AIR FORCE DOCUMENTS

Specialty Training Standard	423X5	July 1982
Occupational Survey Report	AFPT 90-423-459	May 1983
Training Extract	AFPT 90-423-459	May 1983
Training Evaluation Report	TER C 85-5	February 1986
Training Evaluation Report	TER C 86-28	February 1987
Training Evaluation Report	TER C 87-22	February 1988
AGE Utilization and Training Workshop	Minutes	December 1983
Study Guide/Workbook	C3AIR75135	June 1987
Plan of Instruction	C3ABR42335	August 1987
Training Plan	C3ABR42335	June 1987
Instructional System Development	AFM 50-2	July 1986

APPENDIX B

DEPARTMENT OF THE AIR FORCE
Headquarters, USAF
Washington DC 20330-5000

STS 423X5
(For AFSCs 42335/55/75)
August 1987

AEROSPACE GROUND EQUIPMENT MECHANIC
AND
AEROSPACE GROUND EQUIPMENT TECHNICIAN

1. The implementation of the STS for technical training provided by Air Training Command is with the class entering 871005 and graduating 880209.

2. Purpose of this Specialty Training Standard (STS). As prescribed in AFR 8-13, this STS:

a. Lists in column 1 of attachment 1 the most common tasks, knowledges, and technical references (TR) necessary for airmen to perform duties at the 3-, 5-, and 7-skill level AFSC in the Aerospace Ground Equipment ladder of the Airman Aircraft Accessory Maintenance career field. These are based on the analysis of the duties in AFR 39-1, effective 31 October 1986.

b. Provides OJT certification columns in attachment 1 to record completion of task and knowledge training requirements. Certification is accomplished as outlined in AFR 50-23.

c. Shows formal training requirements. Column 3A(1) of attachment 1 shows the proficiency to be demonstrated on the job by the graduate as a result of training in Course C3ABR42335 000 (PDS Code ABU) described in AFR 50-5. When two codes are used in column 3A(1), the first code is the established requirement for resident training on the task/knowledge. The second code is the level of training provided by the course due to resource constraints. Column 3C(1) of attachment 1 shows the proficiency to be demonstrated on the job by the graduate as a result of training in Course C3AAR42375 000 (PDS Code A8J).

d. Becomes a job qualification standard for on-the-job training when placed in AF Form 623, On-the-Job Training Record, and used according to AFR 50-23. For OJT, the tasks in column 1 are trained and qualified to the go/no go level. Go means the individual can perform the task without assistance and meet local requirements for accuracy, timeliness, and correct use of procedures.

e. Indicates in column 3B(2) career knowledge provided in the 5-skill level CDC. See ECI/AFSC/CDC listing maintained by the unit OJT manager for current CDC listings.

f. Is a guide for development of promotion tests used in the Weighted Airmen Promotion System (WAPS). Specialty Knowledge Tests (SKTs) are developed at the USAF Occupational Measurement Center by senior NCOs with extensive practical experience in their career fields. The tests sample knowledge of STS subject matter areas judged by test development team members to be most appropriate for promotion to higher grades. Questions are based on study references listed in AFP 39-8. Individual responsibilities are in Chapter 14 of AFR 35-8.

g. Attachment 2 provides the electronic fundamental requirements for this specialty. Only those items coded are required by this AFSC.

3. Proficiency Code Key. Attachment 1 contains the proficiency code key used to indicate the level of training and knowledge provided by resident training and career development courses.

4. Recommendations. Report unsatisfactory performance of individual course graduates as prescribed in AFR 50-38. Report inadequacies of this STS through channels to HQ ATC/TTO. Reference specific STS paragraphs.

BY ORDER OF THE SECRETARY OF THE AIR FORCE

OFFICIAL

LARRY D. WELCH, General, USAF
Chief of Staff

NORMAND G. LEZY, Colonel, USAF
Director of Information Management
and Administration

2 Atch
1. Qualitative Requirements
2. Electronic Fundamentals/Applications

Supersedes STS 423X5, May 1984.

THIS BLOCK IS FOR IDENTIFICATION PURPOSES ONLY		
NAME OF TRAINEE		
PRINTED NAME (Last, First, Middle Initial)	INITIALS (Written)	SSAN

PRINTED NAME OF CERTIFYING OFFICIAL AND WRITTEN INITIALS	
N/I	N/I
N/I	N/I
N/I	N/I
N/I	N/I
N/I	N/I
N/I	N/I

QUALITATIVE REQUIREMENTS

PROFICIENCY CODE KEY		
	SCALE VALUE	DEFINITION: The individual
TASK PERFORMANCE LEVELS	1	Can do simple parts of the task. Needs to be told or shown how to do most of the task. (EXTREMELY LIMITED)
	2	Can do most parts of the task. Needs help only on hardest parts. (PARTIALLY PROFICIENT)
	3	Can do all parts of the task. Needs only a spot check of completed work. (COMPETENT)
	4	Can do the complete task quickly and accurately. Can tell or show others how to do the task. (HIGHLY PROFICIENT)
*TASK KNOWLEDGE LEVELS	a	Can name parts, tools, and simple facts about the task. (NOMENCLATURE)
	b	Can determine step by step procedures for doing the task. (PROCEDURES)
	c	Can identify why and when the task must be done and why each step is needed. (OPERATING PRINCIPLES)
	d	Can predict, isolate, and resolve problems about the task. (ADVANCED THEORY)
** SUBJECT KNOWLEDGE LEVELS	A	Can identify basic facts and terms about the subject. (FACTS)
	B	Can identify relationship of basic facts and state general principles about the subject. (PRINCIPLES)
	C	Can analyze facts and principles and draw conclusions about the subject. (ANALYSIS)
	D	Can evaluate conditions and make proper decisions about the subject. (EVALUATION)

EXPLANATIONS

* A task knowledge scale value may be used alone or with a task performance scale value to define a level of knowledge for a specific task. (Examples: b and 1b)

** A subject knowledge scale value is used alone to define a level of knowledge for a subject not directly related to any specific task, or for a subject common to several tasks.

\- This mark is used alone instead of a scale value to show that no proficiency training is provided in the course or CDC.

X This mark is used alone in course columns to show that training is required but not given due to limitations in resources.

1. TASKS, KNOWLEDGE AND TECHNICAL REFERENCES	2. CERTIFICATION FOR OJT				3. PROFICIENCY CODES USED TO INDICATE TRAINING/INFORMATION PROVIDED					
	A	B	C	D	A		B		C	
	Start Date	Completion Date	Certifying Official's Initials	Trainee's Initials	3 Skill Level		5 Skill Level		7 Skill Level	
					(1) Course	(2) CDC	(1) Course	(2) CDC	(1) Course	(2) CDC
Note 1: Users are responsible for annotating training references to identify current references pending STS revision.										
Note 2: "Tactical Air Control Systems (TACS)/Ground Launched Cruise Missile (GLCM) Electronic Generating Equipment training in STS elements 24(a) through 24(f) is accomplished in Courses C3AZR42355 001 and C3AZR42355 002 as supplemental training for personnel assigned to TACS/GLCM units. This supplemental training does not apply to normal AFSC resident training (C3ABR42335), Career Development Course (CDC), or Specialty Knowledge Tests (SKTs). However, basic TACS orientation and advanced electronic principles are incorporated in the CDC, and may be included in the SKTs.										
Note 3: Items marked with an asterisk (*) are the training standard elements that are supported when determining the wartime course lengths in resident courses.										
1. AEROSPACE GROUND EQUIPMENT CAREER LADDER PROGRESSION TR: AFR 39-1					B		-			
2. OPERATIONS SECURITY (OPSEC) SPECIFIC OPSEC VULNERABILITIES OF AFSC 423X5 TR: AFR 55-30					A		-			
3. AIR FORCE OCCUPATIONAL SAFETY AND HEALTH (AFOSH) PROGRAM TR: AFRs 127-2, 127-12; Applicable OSHA and AFOSH standards										
a. Supervisory responsibilities					-		-		C	
*b. Individual responsibilities					B		-		C	
*c. Practice job safety					2b		b		4c	
*d. Fire Prevention					b		-		-	
*e. Occupational Health					B		B		C	
4. TECHNICAL PUBLICATIONS										
*a. Fundamentals of TO System TR: TO 00-5-1					B		B		-	
*b. Use Index Type Tech Orders TR: TOs 0-1-01, 0-1-02, 0-2-1, 00-5-1, 00-5-2					a		b		-	
c. Use Tech Manuals as source of information for performing: TR: TO 00-5-1, TOs for specific equipment and applicable abbreviated tech orders										
*(1) Maintenance					2b		b		4c	
*(2) Inspections					2b		b		4c	
d. Use methods and procedures Technical Orders TR: TO 00-xx Series										
(1) Maintenance information					-		b		-	
(2) Management information					-		b		-	

NO CDC REQUIREMENT

1 TASKS, KNOWLEDGE AND TECHNICAL REFERENCES	2 CERTIFICATION FOR OJT				3 PROFICIENCY CODES USED TO INDICATE TRAINING/INFORMATION PROVIDED						
	A Start Date	B Completion Date	C Certifying Official's Initials	D Trainee's Initials	A 3 Skill Level		B 5 Skill Level		C 7 Skill Level		
					(1) Course	(2) CDC	(1) Course	(2) CDC	(1) Course	(2) CDC	
4. TECHNICAL PUBLICATIONS (continued)											
(3) Administrative information					-			b	-		
e. Use Standard Publications to determine the following information pertinent to maintenance TR: AFRs 0-xx Series, Subject Series 50, 52, 66, 122, and applicable OSHA and AFOSH Standards											
(1) Policies					-			b	-		
(2) Procedures					-			b	-		
(3) Instructions					-			b	-		
f. Initiate TO Improvement Report					b			b	-		
*g. Comply with TCTOs					b			b	-		
5. SUPERVISION AND TRAINING											
a. Supervision (1) Obtain information for: TR: AFM 67-1 (vol II, part 1, chaps 5 and 7); AFRs 66-1, 67-23 (chaps 3 and 4); TO 00-20-3 (sec II)											NO CDC REQUIREMENT
(a) Special requisitions					-			b	-		
(b) Issue slips					-			b	-		
(c) Turn-in slips					-			b	-		
(2) Prepare equipment authorization list TR: AFM 67-1 (vol IV, part 1, chap 7); AFRs 66-1, 67-23, (chap 3, sec B)					-			b	-		
(3) Statement of charges TR: AFM 67-1 (vol IV, part 1)					-			A	-		
(4) Report of Survey TR: AFR 177-11; TO 00-35D-780 (Sec III)					-			A	-		
(5) Coordinate work with other personnel TR: AFRs 39-6, 66-1					-			-	-		
(6) Plan TR: AFRs 39-6, 66-1											
(a) Work assignments					-			-	-		
(b) Work priorities					-			-	-		