

A RAND NOTE

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Developing an Initial Skill Training Database:
Rationale and Content

James R. Hosek, Christine E. Peterson

November 1988

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→ This Note suggests training and performance data that the Training and Performance Data Center (TPDC) should collect in an ideal training database. It presents recommendations and guidelines on the kind of data that should be collected on initial skill training, discusses possible applications of the data, and offers advice on constructing an effective database. The authors suggest that the TPDC should collect at least five categories of data relating to five types of policy functions: (1) selection of individuals into military occupations, (2) individual performance of recruits in initial skill training, (3) performance of personnel during duty assignment, (4) productivity on the job, and (5) relationship of individual performance to unit performance. The authors also recommend that a TPDC database on initial skill training should contain a series of files that can be linked in different combinations suitable for different kinds of research and analysis. In addition to existing file identifiers, the authors recommend creating a unique identifier for each time an initial skill training course is taught. (KR)

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James R. Hosek, Christine E. Peterson

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PREFACE

In 1983 the Secretary of Defense created a new defense agency, the Training and Performance Data Center (TPDC). The Center is intended to serve as a repository for data on a wide variety of activities for officers and enlistees, actives and reserves. The data will cover many aspects of individual and unit training and include information on training equipment and teaching aids such as simulators. As they become available, data on individual job performance and unit productivity will also join the TPDC database.

TPDC faces the task of identifying the highest payoff data to collect. In addressing this task, TPDC has sought guidance from the services on key training issues and data availability and is sponsoring a survey of their relevant databases. Further, TPDC requested that RAND describe the kind of data that would be particularly useful in the area of initial skill training of individuals--the subject of this Note.

This research was sponsored by the Office of the Assistant Secretary of Defense for Force Management and Personnel. The research was conducted by the Defense Manpower Research Center, part of RAND's National Defense Research Institute, a Federally Funded Research and Development Center sponsored by the Office of the Secretary of Defense.

SUMMARY

In light of its past research in manpower, personnel, and training, The RAND Corporation was asked to suggest training and performance data that the Training and Performance Data Center (TPDC) should collect in an ideal training database. This Note presents staff recommendations and guidelines on the kind of data that should be collected on initial skill training (IST), discusses possible applications of the data, and gives advice on constructing an effective database.

TPDC requires a database that is comprehensive and that allows for maximum flexibility in the storing and use of data files. Such a database would promote the efficiency and effectiveness of defense training programs. The nascent TPDC database could be improved to facilitate policy analysis and reporting, providing management benefits for the Office of the Secretary of Defense as well as the services. Just as the Defense Manpower Data Center built a database that has proved highly valuable over the last decade, so the TPDC could develop a database that would be extremely useful for many purposes.

TOWARD A USEFUL DATABANK ON INITIAL SKILL TRAINING

Some principle of selection is needed for collecting data from among the myriad of initial skill training and training-related data. The principle should guide the collection effort in order to compile subsets of information adequate to support many different topics and analyses. We recommend the following principle: Training should be considered an investment in human capital meant to sustain or increase military capability. As a guide for selecting data for the TPDC databank, this principle suggests that data should be collected on aspects of personnel training that relate to or affect military capability. This orientation is broader than the ordinary description of training activities and requires that trained personnel be followed into the field, in order to judge the effect of their training as it is applied on the job. A database rich enough for analyzing the

relationship between training and capability would also support many other studies and most existing reporting requirements. Further, the principle suggests that data would be desired in at least five categories relating to five types of policy functions.

- Selection of individuals into military occupations
- Individual performance of recruits in initial skill training
- Performance of personnel during duty assignment
- Productivity on the job
- Relationship of individual performance to unit performance

Each of these categories includes many possible data elements. An additional, and extensive, category of desirable information for IST data collection is training costs; such a file would support the costing analyses associated with policy decisions made by the training commands.

It is important to know not only what data to collect, but on what subjects to collect data. Some general data should be collected for all subjects, but given the effort required to sustain an extensive, detailed database, additional collection should be selective, at least during the initial years of database development. Rather than collect data for all specialties, it should be obtained for only a selected subset determined by factors such as the cost of recruiting individuals into a specialty, the cost of training, criticality and difficulty of the skill, and the representativeness of the specialty within the skill area. Training and training-related data should be collected on both the active duty and reserve forces.

To enhance the advantages of a central database, it should interact with data sources such as the services' training databases. Moreover, a TPDC database should permit maximum linkage among its files. Using four identifiers would promote the desired linkage and permit great flexibility in accessing the database: these identifiers are (1) the individual's Social Security Number (SSN), (2) the Unit Identification Code (UIC), (3) the Military Occupation Specialty code (MOS), and (4) an identifier which we propose be created--an IST class number (ISTN) unique for each class given. These identifiers plus time period

indicators would allow linkages among five primary IST-related files that form the core of the database: files containing data related to the individual, the course, the occupation, the unit, and the training resources.

POSSIBLE APPLICATIONS OF THE IST DATABASE

The IST database is designed to contain information on the course, students, and training outcomes. Variables relating to equipment, training devices, instructors, curriculum tests, and student characteristics can be combined to analyze the effects of natural variation in those variables on test scores and, potentially, subsequent outcomes on the job. The data also provide an extensive quantitative background for controlled experiments dealing with changes in training policies and programs. Moreover, the database can support other applications, some directly and others closely related to training issues. For example, the IST database could play a significant role in the following five areas of analysis.

Determining Training Loads for Budgeting

A better estimate of a training course's attrition rate--used to compile the training load for each IST course and justify manpower authorizations for training--would be possible if an IST database were available to construct an attrition model. More comprehensive data on occupation selection criteria, on course-related information, and on attrition policy would provide insight into the causes of attrition. A better model of training (course) attrition would also help clarify how many recruits are needed to meet a given requirement. A clearer understanding of attrition determinants would help hold down recruiting and training costs.

Matching Weapons System Acquisition and Training Requirements

The greater military capability that should accompany new weapons systems could be reduced by the inordinate personnel demands of those systems, which are often complicated to operate and maintain. By law, manpower estimates must be made during the early stages of the weapons

system acquisition cycle. The IST database could help estimate the manpower requirements for a new system by providing an occupation profile for new items and indicating the required change in the number of trained personnel by occupation, the skills possessed, and the impact on training load. The cost of alternative manning and training options should also be computed to see whether the marginal costs of accessions, training, compensation, and benefits indicate that system requirements should be changed.

Managing Skill Shortages

The TPDC databank for IST could help TPDC build databases that would support service and OSD efforts to solve problems that are a routine part of the services' planning and programming of training resources. As the database acquired information on IST courses, number of students, training equipment, equipment shortages, and the like, a record of IST responsiveness would emerge, documenting how skill shortages were eliminated in the past and indicating how to deal with prospective or present shortages. To assess IST flexibility in responding to shortages, it would also be useful to track the response to anticipated and unanticipated variations in the training load. These data could form a valuable baseline for determining how greater training availability might facilitate enlistment in less popular occupations. IST cost data could aid in the reenlistment bonus allocation process in times of skill shortages. Finally, the database could help plan for shortages consequent to mobilization.

Selecting Personnel into Military Occupations

The databank can help determine whether the allocation of recruits across military occupations is efficient and whether the level of efficiency attained is sensitive to moderate changes in the allocation. Such changes may reflect changes in eligibility criteria or in recruit "quality" given eligibility, i.e., predicted performance based on individual characteristics observable at the time of enlistment. The services and OSD have work under way to develop improved measures of job performance in selected skills, and the proposed TPDC files could

provide a useful foundation for the continuation of such work on a regular, rather than special effort, basis.

Evaluating the Individual's Return to Military Training

Finally, if information were gathered about civilian employment and earnings for personnel leaving the service, the TPDC databank could inform the military about the value of training to the individual. A side product of this kind of analysis would be results on whether attrition is lower and reenlistment higher for personnel with superior measured performance.

CONSTRUCTING AN EFFECTIVE TPDC DATABASE

In the long-term development of the IST database, one aspect of content and three aspects of structure must be considered in constructing a high-quality, easily accessible database. The aspect of database content is caution about the use of criterion testing as a measure of performance: although practical in many ways, the pass/fail system has disadvantages for use in statistical analysis. It is a poor indicator of the *degree* of competence, as it does not differentiate among the quality of those who pass. We, therefore, recommend that data on pass/fail scores--the direct outcome of criterion testing--be accompanied by data on raw scores and perhaps on the number of attempts and time elapsed until success or failure.

The first aspect of structure is the necessity for *interaction with service databanks*. TPDC must work with the services--the source of most training data--to devise common specification for data elements, periodicity, format, and transmission. Also, protocols for transmission need to be devised. Existing service databases can provide a good start for building the TPDC database and for developing the necessary protocols.

The second aspect of structure is the essential *requirement that the data be longitudinal* to allow for comparisons of cohorts, evaluation of policy changes, studies of changes in skill requirements over time, and similar analyses. Since the services may not keep information for long periods, the TPDC can be the repository of long-term data. Hence,

the frequency of transmission of data from the services to TPDC is a crucial consideration.

The third aspect to be considered in constructing an effective database is that it must be an *intelligent database*. It would have an automated codebook; the data would be automatically edited, according to programmed instructions and documented criteria; and the summary statistics would be readily available to browsers. Information across files would be combined automatically. The database system should keep track of file locations and be able to write out requested data in specified formats to data files useful for statistical analyses.

CONCLUSION

The TPDC database on IST should contain a series of connectable files that can be linked in different combinations and serve different kinds of research and analysis. A central database of the kind described here would have many large benefits both for OSD and the individual services.

Compiling this kind of database is a vast effort that is likely to proceed incrementally at best over many years. We emphasize that the successful creation of an efficient, flexible, useful database will require the cooperation of all the services, as well as of OSD. Their cooperation will depend on two conditions: (1) evidence that useful studies can be done from the kind of data in an IST database, and (2) assurances that the content and consequences of these studies will not threaten the services' mission to increase their capability. The Defense Manpower Data Center illustrates the value of such cooperation; its data files have provided a detailed record of personnel trends and the effects of policy and economic changes on those trends, and both the OSD and the services have used the files for many valuable studies.

The architecture we propose for the TPDC databank would accommodate various kinds of information from, and useful to, all the services. The services should find many fruitful uses for this kind of database as it grows and evolves. Furthermore, it should support experimentation in different kinds of research and analysis and yield heretofore unexpected findings of benefit to military managers and planners.

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I. INTRODUCTION

The Training and Performance Data Center (TPDC) has asked RAND for advice on developing an "ideal" database on initial skill training. In response, this Note documents recommendations on the kind of data that ought to be collected, discusses diverse applications of the data, and suggests requirements for constructing an effective database. RAND's advice and recommendations were communicated to TPDC in 1985, and the subsequent interaction between RAND and TPDC indicates that TPDC's data collection strategy has progressed along lines consistent with RAND's suggested approach. We suggest that a TPDC database on initial skill training should contain a series of connectable files that can be linked in different combinations and be suitable for different kinds of research and analysis. A central databank of the kind recommended here would have benefits both for the Office of the Secretary of Defense (OSD) and the individual services.

A primary purpose of TPDC is to be the DoD focal point for defense training data, and to become a main repository for that data. It was set up in 1984 to collect and maintain integrated training-related information and make it available to the DoD training community. Data selected for the TPDC database must be current and useful, and the methods of collecting and storing the data must allow for maximum interaction among data files. In short, if it is to help, the database must be comprehensive and flexible.¹

In general purpose and usefulness, TPDC is somewhat analogous to the Defense Manpower Data Center (DMDC). In fact, the creation of TPDC has certain parallels to the establishment of DMDC a decade earlier. Demand for the DMDC grew from the earlier national debate over the draft, as policymakers and analysts were driven to recognize the value of a central databank for defense manpower data. The lack of such an

¹G. Thomas Sicilia, "Centralizing the Management of Defense Training Data," *Defense Management Journal*, Vol. 20, No. 4, 1984, pp. 9-11.

archive delayed analysis and limited the range of issues that could be investigated. As a consequence, the Gates Commission recommended establishing an agency that would draw manpower data from all services, and soon thereafter DMDC was established by the Secretary of Defense. DMDC files have improved continuously over time in coverage and quality; they provide a detailed record of personnel trends and, implicitly, the effects of policy and economic changes on those trends. The large number of studies based on DMDC data attest to their high value, although the specific studies were probably not foreseen by the framers of the DMDC charter.

The limited training and performance data that exist now are for the most part kept separately by each service, as was the case with personnel data before DMDC. Protocols to facilitate the sharing of training information have not been written. Except for information required in the annual budget process, the services have so far had little impetus to forward data to OSD, exchange it among themselves, or supply it to others. But now, with increasing interest in topics concerning force structure and capability--such as Navy and Air Force growth, Army reserve growth, weapons system modernization, and the role of manpower and training in the weapons system acquisition process--the circumstances have changed. Defense planners have greater incentive to learn about training and its relationship to force effectiveness because more trained and experienced personnel will be needed, even though defense budgets are not expected to grow as much in real terms over the next five years as they have in the past five. This assessment, first put forward by the 1982 Defense Science Board recommendation supporting the creation of TPDC, seems at least as valid today as then.

TPDC provided two guidelines in its request for RAND to help organize its data holdings:²

²A separate TPDC-sponsored project has reviewed the usefulness of existing service-maintained databases in constructing a training database; see Hammon and Horowitz (1987).

- To focus on initial skill training and
- To consider data appropriate for research and policy analysis, without limiting the discussion to currently available data.

To this end, Sec. II defines initial skill training and lists a general set of data files worthwhile establishing for an IST database. Section III discusses a number of policy-related applications that a training and performance database might be expected to support, and the concluding section discusses factors leading to the construction of an effective TPDC initial skill training database.

II. TOWARD A USEFUL INITIAL SKILL TRAINING DATABANK

The TPDC is interested in data on initial skill training (IST) in the services that might be useful for research and policy analysis. We begin this section by defining initial skill training. We then discuss a principle that will help guide the kind of data collection effort called for and help define the data requirements. After discussing training costs, we consider selective data collection and discuss how the data files can be linked.

INITIAL SKILL TRAINING

All services offer IST. As the most common form of specialized skill training for enlisted personnel, it involves instruction in job-related technical specialties. It is usually given after recruit (basic) training and before the first duty assignment. Each service offers IST in approximately 300 different specialties, and the courses serve actives and reservists. For the most part, a service teaches its own courses, but interservice courses are not uncommon; for instance, the Marine Corps and Air Force subscribe to the Army course in "Tracked vehicle repair," and both the Navy and Air Force offer cryptologic courses to the other services. In a few cases, such as infantryman, IST has been combined with recruit training into an integrated course referred to as "one-station unit training" (OSUT). The duration of IST varies with the specialty, ranging from roughly a month to a year. The Army and Navy have specialized skill training facilities at over 30 bases each, the Marine Corps at seven bases, and the Air Force at nine bases. The bulk of these facilities offer IST. In FY 1987 the services expect to supply IST to 454,000 enlisted personnel in active, guard, and reserve forces, producing 420,000 graduates--a completion rate of 92.5 percent.¹

¹From *Military Manpower Training Report, FY 1987, Volume IV: Force Readiness Report*, p. V-4. The Report is an excellent source of information about the scope of individual and unit training activities.

PRINCIPLE FOR GUIDING DATA COLLECTION

There are many kinds of training data, and data can be used for different purposes. Data on IST, for example, can help inform policy-related questions ranging from descriptive to analytical. Should Congress and the services want to know how many soldiers are being trained where and by whom, information is needed on students, facilities, and instructors. There are questions about determining training budgets and personnel flows (e.g., accession requirements, skill shortages or excesses), and beyond those are topics concerning course design, the balance between schoolhouse and on-the-job training, and training effectiveness. A training database should be capable of supporting such a variety of topics. But among the myriad of training and training-related data that exists, how does one determine which data are needed or most useful?

Some principle must guide the data collection effort in order to select a subset of information adequate to support many topics. We suggest the following principle: Training should be considered an investment in human capital meant to sustain or increase military capability. As a guide, this principle directs that data should be collected on aspects of training that relate to or affect military capability. In particular, the principle extends the scope of training data collection beyond training schools and into the field. It thereby provides a more complete quantitative vision of training and its consequences than would otherwise be available, or, for that matter, appears to be available in today's training data systems. We use "military capability" in a broad sense, including tactical and strategic activities involved in force employment and deterrence, and the many support and service functions needed to sustain them.

The principle stipulates broad data requirements. In all likelihood, a database rich enough to explore the relationship between training and capability would also support other studies and most existing reporting requirements. The principle also governs long-term data collection: Major portions of desired data, particularly data on job performance and productivity, are not readily available today, but it is important to know what those future requirements are.

Obtaining the required data will be burdensome, but linking the data on training and capability should have a substantial payoff: Such data can yield insight into the effectiveness of alternative defense resource allocations, as witnessed in practice, and can help support experiments for the same purpose. Results from analyses based on the data should be useful for existing weapons systems and, by extrapolation, for new ones in the process of acquisition.

The principle further suggests that data would be desired in at least five categories:

- Selection of individuals into military occupations
- Individual performance of recruits in initial skill training
- Performance of personnel during duty assignment
- Productivity on the job
- Relationship of individual performance to unit performance

Each of these categories includes many possible data elements, and decisions will have to be made about which elements to collect. For instance, across the services there are over a thousand distinct occupations, and every occupation can be described in terms of its required duties and eligibility criteria, which may change over time. Further, as operation and maintenance patterns change or new weapons systems are phased in, occupations may be created or eliminated. The duty content of an occupation can thus change gradually or abruptly over time, as can the qualifications of entering personnel. Similarly, other data elements include the many factors bearing on IST performance. It would be useful to have data collected from each class on individual student characteristics, instructor characteristics, course content, course and training devices, tests and standards, individual student performance including test scores and class rank, and overall class performance.² Training devices include examples of field equipment

²Detailed class information also helps ameliorate the problem of variation in course instruction and tests among training schools. A study of 11 Army specialty training courses conducted by the Army Research Institute (Oxford-Carpenter et al., 1984) found that in some

(radios, rifles, armor, antennas, tools, parts, etc.) and simulators and other teaching aids (movies, interactive video disks). Many tests are given during IST, some hands-on and some written, and the content of these tests will change from year to year as changes in weaponry, tactics, and mission occur.³ Documentation of such changes is needed, for example, when course planners want to understand why the concordance between IST performance and job performance might have become stronger or weaker.

Specifying data for job performance and productivity is equally demanding. Job performance underlies productivity in the sense that performance indicates proficiency in the skill for which one has been trained. A soldier's job performance is measured through his capability to accomplish a set of specialty-specific tasks; thus, it is first necessary to define the tasks and develop test instruments. To analyze job performance as a function of IST performance, data on other, possibly correlated, factors such as job experience and on-the-job training must also be obtained. These factors raise questions of item definition in the course of database development--can experience be measured simply as time on duty assignment? How should on-the-job training be measured?

In contrast to job performance, which is individual-specific, the notion of productivity extends to the unit and the efficiency of its configuration to accomplish its mission. A soldier's competence to perform his required tasks is one element of this; another is how unit personnel compensate for existing deficits in equipment, experience, or training. The ability to compensate probably involves familiarity with the equipment, shared experience, an ability to assign correct priorities to a workload, and an ability to make allocative decisions

instances two courses covering the same job were taught differently at different training installations, although the same final test was administered. The study found many differences across schools and courses in the way course materials and test materials were handled.

³From the viewpoint of analyzing the effectiveness of IST, we at RAND are concerned about the growing use of criterion testing in which the test outcome is recorded merely as pass or fail. For further discussion of criterion testing and the problem it presents, see Sec. IV.

rapidly and creatively. Thus, measures that capture the ability of a whole unit are necessary, in addition to measures of individual job performance within the unit. To learn how mission capability changes in response to changes in unit manning, skill level and mix, equipment, and facilities, data on these variables must be recorded along with measures of unit capability. A unit's mission capability may also be affected by the level of on-the-job training (OJT) conducted within the unit and whether it has the resources available to provide adequate OJT.⁴ Thus, unit-level data might include information on the unit's monthly training load and training resource availability.

What types of data might be useful in measuring productivity for the unit? Results from field exercises may provide information on the ability of the unit to meet its mission. The maintenance management data systems within each of the services might provide productivity information for units involved in maintenance. Table 1 lists the maintenance management systems that provide the information needed to

Table 1

MAINTENANCE MANAGEMENT SYSTEMS

Service	System	Level of Identification
Army	The Army Maintenance Management System (TAMMS)	Unit
Air Force	Maintenance Data Collection System (MDC)	Work center
Navy and Marine Corps	Maintenance and Material Management System (3-M): one for aviation, one for ships	Work center

⁴Reuter et al. (1980) found a negative relationship between the amount of training conducted by aircraft maintenance, transportation, and supply units in the Air Force and the units' mission performance.

manage the maintenance of weapons and support equipment such as the availability of spare parts and the types of equipment failures. The systems provide information on the conduct of all maintenance tasks-- what equipment was maintained, why maintenance was required, what was done, how long it took, and who did it.⁵ Maintenance management file data are useful at the unit level, but because they were not designed to evaluate the performance of maintenance technicians, they may not contain the name of the individual who performed the repair, and thus may be of limited use for individual productivity.⁶ We recognize that these systems are not perfect, but they do represent a promising start. Improvements in data validation and accuracy in recording how time was spent by maintenance task would contribute to the reliability of the data.

⁵Aggregate level studies using data from maintenance management systems have shown that the information contained within those systems can provide measures that reflect productivity such as readiness of equipment. A study by Orlansky and String (1981) suggests that inadequate performance by maintenance technicians is a factor that contributes to the "not ready" status of military equipment. Horowitz and Sherman (1980) used ship maintenance and ship personnel records to examine the relationship between productivity (as measured by ship downtime for a given subsystem, e.g., boilers) and personnel characteristics, controlling for ship characteristics which can affect the level of downtime. Their results suggest that more experienced crews and crews with more formal school training had less ship downtime.

⁶The potential usefulness of maintenance data in measuring productivity has led to an interest in modifying such data systems to include technician identifiers. These identifiers would permit the linking of maintenance and training data systems. McConnell and Jones (1985) looked into the feasibility of combining maintenance management data systems and training data systems within the services. They concluded that, generally, with the addition of information to identify individuals performing maintenance, these systems could be linked and thus provide information necessary to carry out analysis of maintenance-related training. (However, it should be noted that problems arise when the work on a specific piece of equipment involves more than one person or is performed over more than one shift.) In response to this interest, the Army Research Institute developed the Army Maintenance Performance System (MPS) to record the work experience (time on each technical task in the maintenance battalion) and training (courses and qualification tests) of each maintenance technician. This database may provide useful information for the TPDC training database.

The guiding principle of training as investment in human capital suggests an additional data category not mentioned above. That category deals with the value of the training to the individual and, among other things, requires data on his post-service employment and earnings. Such data would improve the ability to analyze the value of military training in post-service employment and presumably bear on the individual's willingness to enter the service in the first place. It would also help depict the role of the military as a provider of trained personnel to the civilian sector.

TRAINING RESOURCES

Training resources comprise an additional category for IST data collection from which training cost estimates can be made. As with job performance and unit productivity measurement, careful thought will be needed to determine what resource information ought to be obtained. The appropriateness of such data depends on the problem at hand; for purposes of policy analysis, for instance, it will probably not suffice to collect only the operations and maintenance resources of formal training. These may or may not address the full resource consequences of the policy change and in any case might not represent the opportunity cost of the change. Elaborating, there are many distinctions to keep in mind when specifying the requirements for training resource data: fixed versus variable resources; budgetary versus economic (or opportunity) cost of the resources; the resources used in training versus the total resources used to produce trained manpower; and the resources for formal training versus on-the-job training. Fixed resources become important when new training facilities are contemplated. They may involve land acquisition, architectural planning, construction, and major equipment purchases, for example. Since these expenditures will vary across sites and over time, it seems unrealistic to propose that they be maintained in a routinely updated file, as opposed to being collected as needed on a case by case basis. Still, once collected, they would afford valuable documentation of the alternatives evaluated and the decisions made.

The distinction between budgetary and economic costs poses a dilemma. Economic theories of decisionmaking, which underlie much policy analysis, emphasize that the relevant costs of a decision are opportunity costs, i.e., the costs of the best forgone (alternative) use of the resources involved. But economic cost data are typically not readily available, and indeed considerable time and effort may be required to obtain them. Budgetary costs, in contrast, often are available, yet unfortunately they may bear little relation to the economic costs of a policy action. For example, if ten trainers are added to a training brigade, the budgetary cost to the training establishment equals their military compensation. (If endstrength is unchanged and the personnel were merely transferred from another activity, the budgetary cost to the *service* is unaffected because the total number of people on the payroll is the same.) But the economic cost of the ten trainers is the value of their best alternative use; this shadow price could be higher or lower than the budgetary cost. The trainers conceivably might have been diverted from a crucial mission, or they might have been underutilized in their previous duty.

Budgetary costs can be obtained from the various accounting systems that keep track of expenditures under current year budgets and aid in justifying outyear budget requests. At times budget data are assumed close enough to economic costs to rationalize their use in a policy cost analysis. Whereas their appropriateness is an issue for analysts and policymakers to decide when evaluating specific policy alternatives, it seems advisable for TPDC to develop files of training resources and related files of their budgetary cost. The files might itemize personnel, facilities, and equipment, and do so by course. Subsequent effort might focus on estimating resources applied to on-the-job training.

The term "training cost" is frequently used in reference to the cost of trained manpower, but the two kinds of cost may be distinct. The cost of trained manpower includes recruiting, formal and on-the-job training, personnel compensation, and change of station. It is a lifecycle cost concept, whereas training cost typically refers to a

training course. For instance, consider a directive requiring five percent more trainees from a course, to be achieved through lower attrition. The training cost of this directive would include the incremental IST resources required for the additional graduates. If the incremental cost per graduate of these resources equalled the average cost per graduate, and if post-course attrition remained constant, the incremental cost of trained manpower would not change. However, if marginal cost exceeded average cost or if post-course attrition rose, the incremental cost of trained manpower would increase. Thus, training cost can refer to training resources and how they vary as the scale or content of training changes (e.g., number of trainees, instructors, or amount and kind of training equipment), while the cost of trained manpower is a lifecycle concept about the replacement cost of trained personnel with given years of experience.

The distinction between formal and on-the-job training is well known but difficult to implement. It is generally thought easier to develop resource estimates for formal training because training is the exclusive activity, whereas on-the-job training may be a joint product with the unit's regular activities. As a result, special assumptions may be required to estimate the incremental or total resources related to on-the-job training--again, this will require careful consideration.

SELECTIVE DATA COLLECTION

The level of detail suggested for the IST database precludes collection for all individuals and specialties. Thus, thought must be given not only to what data to collect but on what subjects to collect data. While some general training data may be collected for all, more detailed information--especially that related to post-training performance and productivity--should be obtained only for a selected subset of specialties. That selection could be based on factors such as the cost of recruiting individuals into the specialty (including enlistment incentives), the cost of training (including direct costs plus student's time and costs imposed by attrition), criticality and difficulty of the skill, and the representativeness of the specialty relative to other specialties in the skill area. Over time, as the database evolved, it might be desirable to broaden the selection.

Training and training-related data should be collected on both the active duty *and* the reserve forces. Reserve training has become a prominent issue as the reserves' role in the total force has grown. At present, databases are not adequate to analyze the effectiveness of reserve training and the readiness of the reserve forces. However, much of the data suggested for the IST database could be collected for the reserves as well. Reservists attend the same classes as their active counterparts or may take correspondence courses for which course description data could be obtained. On-the-job training is a major component of reserve training⁷ and job performance measures developed for the actives would apply as well. Reserve units have assigned equipment and perform in periodic exercises which can provide information on unit performance and mission capability. In addition, personnel records are maintained for reservists. Although there are some questions about data quality, they would be resolved through increased demand for that data by the training community, plus more organized and standardized collection.

The above information could be collected for a selected subset of reserve specialties chosen by guidelines similar to those for the active forces. An overlap in specialties would be desirable to compare training and readiness between the actives and reserves.

LINKING THE DATA

The advantages of a central databank lie in quick accessibility to data, uniformity of data records across services and skills and over time, and the concentration of individuals knowledgeable about the data. The database should have connections to data sources, such as the services' training commands and training bases, to handle questions about data quality and content and to suggest improvements. Moreover, the value of the TPDC database would be greatly enhanced by a system permitting maximum linkage among the files.

⁷This refers to the Selected Reserves; the Individual Ready Reserve has little required refresher training.

Four identifiers may suffice to promote the desired linkage among files. The first three already exist--the individual's Social Security Number (SSN), the Unit Identification Code (UIC), and the Military Occupation Specialty code (MOS).

We propose creating a fourth identifier: a unique number for each IST class given--an "ISTN." The ISTN could encode information about the service offering the course, its location, and date, and would be attached to the student's personnel record, along with UIC and the MOS.

Because unit and MOS characteristics can change over time, a time indicator should be included as an additional identifier. These characteristics could be collected at set intervals, such as every year, for example, or they can be collected whenever there is a significant change related to policy or personnel. Thus, the unit- and MOS-related files would have multiple records per unit or MOS, each representing a specific time period or interval. The time variable might simply be a year indicator (or six month or quarterly indicator, depending on the data) or it might consist of a begin date and an end date for the period over which the data are relevant. Personnel records should contain dates as individuals move in and out of units and MOS's, so that unit- and MOS-related information can be merged in from the appropriate time period. The ISTN already would have a time factor for course-related data incorporated into its code.

The SSN, ISTN, MOS, and UIC plus time indicators would permit great flexibility in accessing the database. For instance, matching personnel records by ISTN would result in a roster of students in the class, whereas matching the ISTNs on an individual's record with course-related files leads to data describing course objectives, skills taught, teaching aids, equipment, length, location, time, instructors (themselves denoted by their SSNs), tests and grading standards, and attrition rate. Matching class graduates' UICs would show the units they were assigned to and, implicitly, whether these duty assignments conformed to the training. In addition, DoD could house files on individual performance in IST and on the job, and these performance files could be linked via SSN to personnel records, class information,

and unit information. The MOS, for example, allows linkage between "end item" files containing MOS profiles for every end item in the defense inventory (e.g., vehicles, weapons systems) and personnel, unit, and training course records.

Table 2 presents a list of IST-related files which would form the core of the IST database. Examples of the types of data that would be included in each file are also listed to suggest the potential contents of the files. These files, with the exception of personnel records, could be kept at TPDC^{*} pending service and OSD agreement and coordination.

The files can support reports and analyses on the scope and scale of training activities. Reasons for including individual and course-related information have been mentioned above, and the unit files could help in assessing the effectiveness of IST and on-the-job training with respect to job and unit performance. An additional file, the end-item file, contains data on the occupation profile of personnel needed to operate and maintain items in the defense inventory. This file can be used to gauge the manning and training requirements of new weapons systems. The versatility of the proposed files can be best illustrated by example, and the next section discusses a number of possible applications.

^{*}A good deal of data on students and military instructors can be obtained from DMDC personnel files; for civilian instructors it would be necessary to query federal civilian personnel files. TPDC might keep in house a subset of data from the personnel records maintained at DMDC. Information such as age, race, sex, education, AFQT, years of service, and paygrade might be kept at TPDC, with updates every six months or annually, as opposed to DMDC's quarterly updates. This would enable cursory analyses and tabulations to be performed while more specific personnel data is being obtained from DMDC.

Table 2

INITIAL SKILL TRAINING DATABASE FILES

A. DATA RELATED TO INDIVIDUALS (identifiers: SSN, ISTN, MOS, UIC)

1. PERSONNEL RECORD
 - AFQT
 - Demographics
 - Attrition
 - Promotion history
 - Term of enlistment
 - Reenlistment
 - Occupation
 - Length of service
 - Dates for MOS and unit changes
2. PERFORMANCE IN IST
 - Test scores
 - Rank in class
 - Attrition
 - Pass/fail status
 - Recycle status
3. PERFORMANCE ON THE JOB
 - Promotion
 - Performance reviews
 - Supervisor rating
 - Skill qualification test scores
 - Dates for tests and review
4. POST-SERVICE EXPERIENCE
 - Earnings
 - Employment history
 - Occupation
 - Location

B. DATA RELATED TO COURSES (identifiers: ISTN, MOS, time period)

1. OCCUPATION DESCRIPTION
 - Skill codes (MOS, DOT, DOD)
 - Required skills
 - Eligibility criteria
2. COURSE DESCRIPTION
 - Content
 - Skills taught
 - Prerequisites

Table 2--Continued

-
- 3. CLASS INFORMATION
 - Date
 - Equipment
 - Number entering
 - Location
 - Instructor characteristics
 - Number graduating
 - Length
 - Instructional methods
 - 4. TESTS AND GRADING STANDARDS
 - Test type
 - Content
 - Passing scores
 - Administrative procedures
- C. DATA RELATED TO OCCUPATION (identifiers: MOS, time period)
- 1. OCCUPATION DESCRIPTION
 - Skill codes
 - Promotion requirements
 - Required skills
 - Grade distribution
 - Duties
 - 2. ELIGIBILITY REQUIREMENTS
 - ASVAB cutoff scores
 - Physical requirements
 - 3. END ITEM FILE
 - MOS profile
 - Number of personnel/MOS
- D. DATA RELATED TO UNITS (identifiers: UIC, MOS, time period)
- 1. UNIT MISSION AND LOCATION
 - Required tasks
 - CONUS/NONCONUS
 - Size of base
 - Personnel requirements
 - 2. UNIT READINESS
 - Exercise scores
 - Maintenance performance
 - Staffing status
 - Equipment status

Table 2--Continued

-
- 3. EQUIPMENT
 - Type
 - Quality
 - Whether at authorized levels
 - Age
 - 4. PACE OF OPERATIONS
 - Average workload
 - Amount of downtime
 - Amount of time performing assigned tasks
- E. DATA RELATED TO TRAINING RESOURCES (identifiers: MOS, ISTN, time period)
- 1. PERSONNEL COSTS
 - Student's pay
 - Relocation
 - Instructor's pay
 - Accession
 - Time spent in on-the-job training
(not readily available; would have to be estimated)
 - 2. EQUIPMENT COSTS
 - Acquisition
 - Maintenance
 - Depreciation
 - 3. COURSE COSTS
 - Design costs
 - Course materials
 - 4. BASE OPERATIONS
-

III. APPLICATIONS FOR AN INITIAL SKILL TRAINING DATABASE

In the previous section, we described the kind of information desirable in the TPDC databank. That information fits into five broad categories or possible IST data files related to: (1) the individual, (2) courses, (3) occupation, (4) unit, and (5) training resource. The IST database is designed to contain information on the course, students, and training outcomes. Variables relating to equipment, training devices, instructors, curriculum, tests, and student characteristics can be combined to analyze the effects of historical variation in those variables on test scores and, potentially, subsequent outcomes on the job. In other instances, experimentation may be necessary to properly evaluate changes in training programs and policy. The data collection mechanisms established for the IST database would make the experimentation process simpler and cheaper since fewer special data collection efforts would be needed beyond those already in place.

The IST database can support analyses other than those directly related to the evaluation training programs and policies. Indeed, there are applications for the database that can aid training management, help develop future training requirements, and provide insights helpful to recruiters and personnel managers. To illustrate the varied uses of the IST database, we have chosen to focus on several areas where, in addition to the evaluation of training program effectiveness, the database could play an important role in helping the services and DoD address critical training problems.¹ These areas include:

¹Whereas the IST database is designed to focus on issues and problems related to initial skill training and first-term performance, the database can also provide useful information for examining broader issues such as the impact of different career mixes on the capability of the unit to meet its mission. These broader issues include factors that go beyond the data suggested for the IST database, and while the database can supply input to analyses of those issues, we have chosen to confine our illustration of applications to those specifically related to IST performance.

- Determining training loads
- Matching weapons system acquisition and training requirements
- Managing skills shortages
- Selecting personnel into military occupations
- Evaluating the individual's return to military training

Table 3 is a guide to the following discussion of applications. The table illustrates the interface between the IST data files and the five applications and summarizes which data files could support each application. As can be seen, each of the data files would be used in nearly all of the applications, reflecting the wide variety of research topics to which a single file contributes.

Table 3
APPLICATIONS FOR IST DATABASE FILES

	Determination of Training Load	Weapons System Acquisition	Shortage of Manpower	Selection into Occupations	Individual's Return to Training
Data related to individual	x		x	x	x
Data related to courses	x	x	x	x	x
Data related to occupation	x	x	x	x	x
Data related to unit	x	x	x	x	x
Data related to costs	x	x	x	x	

DETERMINING TRAINING LOADS FOR BUDGETING

Each year the Office of Secretary of Defense issues a *Military Manpower Training Report* giving information that supports the Department of Defense request for authorization of average military student training loads and, indirectly, the training budget. The training load is defined as the number of manyears of training provided during the fiscal year. Roughly, it equals the average number of students in a course times course length expressed as a fraction of a year. The enlisted IST training load was estimated to be 82,730 in FY 1987, which is comparable to the amount of instruction time provided by three 35,000 student universities operating on a nine month academic year. In a sense, the process of determining training load begins with a determination of the requirement for newly trained personnel, indicating how many graduates the course should produce, and the construction of the course itself, implying course duration. Most courses are 9 to 16 weeks long, the average being 11 to 12 weeks. The next ingredient needed is the attrition rate. Given the attrition rate and desired number of graduates, one computes the necessary number of starting students; the average number of students, then, equals (approximately) the simple average of starters and graduates. Training load (average number of students x course length) is computed for each IST course and aggregated to obtain the total training load. The services offer over 1100 IST courses each year for enlisted personnel.

What figure should be used for a course's attrition rate? Current practice employs the average rate observed in recent classes, but more accurate estimation seems possible by constructing a model of IST attrition. The model could analyze the effect of factors on course attrition, including student socioeconomic background and aptitudes, occupation selection criteria, instructor characteristics, course length, and tests and grading criteria. If there were changes in the curriculum, equipment, and teaching aids, they too might affect attrition, as might the number of students being recycled through the course.² The purpose of the model would be twofold. In the short run

²Furthermore, course attrition must be viewed in the context of service policy toward attrition and current manning pressure to increase

it would assist in the estimation of training loads, depending on the way courses are structured and taught. In the long run it would contribute a deeper understanding of the variables influencing course attrition and possibly suggest changes that would significantly lower the rate while maintaining course content and quality.

In the very short run, gains from more accurate attrition forecasts might be minor. This is because historical extrapolation--the use of recent attrition rates to forecast near-term future rates--is reasonably accurate when the underlying structure is constant. That is, if eligibility requirements, instructors, equipment, length, and course content remain the same, then there should be little change in course attrition. But in the longer run, naturally occurring variations in these factors would affect attrition, and data on such changes would provide a foundation for their quantitative analysis. Such analysis and forecasts seem most important for hard-to-fill occupations and for occupations with long, complex training where up to a third of the students might not complete the class.³ In comparison, the overall IST attrition rate for enlisted personnel is 7.5 percent.⁴

The vast majority of existing attrition studies are limited to information on student descriptors and aptitudes such as age, sex, race, high school graduation, and aptitude scores from the Armed Services Vocational Aptitude Battery (ASVAB). Probably the strongest and most consistent finding of these studies is that the attrition rate of high school non-graduates is twice as high as that of graduates. The contribution of the other variables is usually minor, and predicting attrition therefore begins simply with knowing the percentage of students who are high school graduates. Ironically, the recruiting successes of the 1980s have diminished the value of this approach: In recent years about 90 percent of the recruits have been graduates, but attrition rates have fallen much less than has been expected.

or reduce the number of first-term personnel as a buffer to meet and not exceed endstrength goals.

³*Military Manpower Training Report FY1987*, p. V-7.

⁴*Ibid.*, computed from Table V-2, p. V-4.

Further insight into the causes of attrition will not be gained unless more comprehensive data become available on occupation selection criteria, course-related information, and attrition policy. (See Table 3 for the data file types used for determining training loads.) More comprehensive data require the development of several data files, including an occupation selection file and course files. An occupation selection file would give eligibility information for selection into an occupation. For example, if selection criteria were tightened over time, the course's attrition might decline as more students passed the tests. Course files would describe the class and its equipment, training devices, instructors, and testing. The course descriptors would specify course objectives, skills taught, and duration. Information on skills taught could be compared with an occupation file describing the duties and the necessary skills pertinent to each occupation. A comparison between the occupation skills and course skills would differentiate those skills taught during the course from those presumably learned on the job.

The file on course equipment would show the specific kind of equipment used in training. A unit file, cataloging the equipment in the unit to which the student is subsequently assigned, could be used to compare whether training equipment was the same as encountered in the field. The file on training devices--teacher aids and simulators--would document any special items used during instruction; for example, changes in the presence of simulators could affect course attrition. The instructor file would contain information about the instructor's education, teaching experience (for instance, the number of times the person has taught the course), and SSN, permitting a tie to the personnel record. Such linkages would enable analyses of how instructor quality affects course attrition. The test file would contain a description of the testing regime; there might be ten weekly written tests, three hands-on tests, and a final, and perhaps all would be graded pass/fail. The tests themselves might be (required to be) kept on file at the course site.

Another useful file would contain information on service attrition policies and practices over time. Most attrition analyses focus on the relationship between the individual's characteristics and attrition behavior. However, equally important are service attrition policies. The most striking evidence of this is the fact that training attrition rates did not fall when the percentage of high-quality recruits (i.e., those who are high school graduates and in the 50th percentile or higher of the AFQT) increased dramatically in the 1980s. Previous attrition studies showed a strong positive relationship between attrition and non-high school graduation status. The expected result of a large increase in high school graduates among the recruit population would be lower attrition rates for such cohorts. However, this was not the case. Service attrition practices apparently played a major role in maintaining attrition rates at or above the rates when the proportion of high school graduates was lower.⁵ The Army, alarmed by the continued high attrition among high quality recruits, instituted a study which recommended a new training attrition program to lower attrition through such actions as retraining of drill instructors; better evaluation, counseling, and remediation efforts; remedial physical conditioning; and an emphasis on positive leadership encouraging reasonable progress and standards for recruits. Six-month attrition fell sharply after the Army began to institute the new recommendations. This program provided evidence that service policies as well as recruit quality have an important effect on attrition rates.

The importance of service attrition policies suggests that thought be given to the bookkeeping conventions for attrition. The main concerns of such bookkeeping are to distinguish course attrition from service attrition and improve the way service attrition is recorded. Course attrition need not lead to service attrition; the student might

⁵Buddin (forthcoming) found substantial differences in attrition rates among training bases and among entering cohorts for recruits of comparable quality. Thus, while recruit characteristics may be used to rank prospective recruits according to their potential risk of attrition, service policies and practices have a critical effect on the determination of the actual attrition level.

be recycled through the course. Recycling, as well as performance in the course, could be tracked by a student training file, i.e., the "individual performance in IST" file listed in Table 2. However, course attrition and service attrition are often one and the same, if only because the latter necessitates the former, so the Interservice Separation codes used to designate a reason for attrition should be able to discriminate poor classroom performance as a reason for service attrition from other reasons. Otherwise, it is impossible to tell whether an increase in course attrition derives from changes internal or external to the course. At present there are 70 or so assignable reasons for discharge, which may be too many. Categories should illuminate the causes of attrition; when there are too many the reasons for discharge tend to obscure rather than clarify the attrition picture. Too many codes creates ambiguity in designating "the" reason for discharge, so creating a few broad categories seems preferable (e.g., failed training, discipline, health status, attitude, legal infraction).⁶ Effecting such a change will require training and procedures for uniform implementation of the categories across the services, a considerable undertaking.

Aside from helping to improve estimates of training loads, a better model of training attrition would could help recruiters. Reducing training attrition through a clearer understanding of its determinants will help hold down accession requirements. In addition, accurate forecasts of training attrition foster accurate forecasts of accession requirement forecasts, aiding commanders in determining quotas for their individual recruiters. Also, by knowing the individual factors that correlate with training attrition, the recruiter can better judge which recruiting prospects are likely to complete training and which ones are not.

⁶Subcategories could be designated within each of the broad categories, but again, ambiguity of assignment should be avoided.

MATCHING WEAPONS SYSTEM ACQUISITION AND TRAINING REQUIREMENTS

A prominent element in the debate over weapon systems acquisition is the role of manpower. There is fear that new weapons will be too complicated to operate and maintain, so their potentially greater military capability will be reduced or nullified by inordinate personnel demands. In light of growing concern, the Secretary of Defense must now present manpower estimates tied to any new weapons system to Congress before full-scale engineering or production and deployment of that system can be approved.⁷ These estimates focus on whether there will be enough properly trained people available to operate and maintain the system and what the cost will be, both to achieve and to maintain it. Because manpower becomes a sizable factor in the lifecycle cost of a weapon system, it is argued that greater attention to manning requirements during design and development will result in lower system cost without degrading system performance, reliability, and maintainability. The directive to include manning considerations in the early phases of the acquisition process has proved difficult to implement because manning requirements are inherently imprecise so long as weapon technology and mission are in flux. Still, if alternative or existing designs could be rapidly translated into a reasonable range of manning requirements, the opportunity would be improved for using manning requirements to determine or reconceive design.

The IST database, as described in Sec. II, could lend support to the individual services and to OSD in estimating the requirements for a new system. In its "Footprint" project, TPDC suggests that first-round manning estimates could be readily derived in many cases. The TPDC approach, which is the basis for the present discussion, uses an existing file of "end items" and their occupation profile as the basis for interpolating manning and training requirements from present systems

⁷The MANPRINT system is the Army's response to the Congressional requirement. It is designed to be a comprehensive management and technical program to improve total system performance by the continuous integration of human factors engineering, manpower, training, system safety, and health hazard considerations throughout the materiel development and acquisition process.

to proposed systems. Every end item in the current defense inventory--jeep, bazooka, radio, missile, field hospital--has a profile showing the number of personnel by occupation required to operate and maintain it, and many of the end items in a new weapon system may be similar to existing items. If so, the occupation profile and manning requirements of the new system can be approximated, and they in turn can be related to training requirements. For example, suppose a new system requires an end item similar to a combination of two existing end items; the planner must designate which existing end items will serve as the basis of comparison and what weight should be given to each. This leads to a rough occupation profile of the new item, say half a person in occupation "a" and a full person in occupation "b". As mentioned above, for each occupation there is also a file describing its tasks and skills and a course file listing those skills taught in IST.⁸ Thus, this approach yields information on the required increase in trained personnel by occupation, the skills they possess, and the impact on training load.

A more complicated example can easily be envisioned. Using the previous example as a first round, the planner could refine the occupational requirements by specifying the subset of skills that would be needed from each occupation. This might entail restructuring occupations "a" and "b" into a hybrid "c" and the development of a new course that taught the relevant skills from the courses for "a" and "b". Of course, skills not taught during IST would have to be learned on the job, but the more skills taught during IST, the longer the course and the greater its cost (including student pay). Possible refinements relate to teaching aids, training devices and simulators, the equipment that would be needed for the new course, and the specification of occupation selection criteria. Again, if the new course mainly taught skills already taught, then current experience would be a good guide to new training requirements.

⁸There are other kinds of formal training that could be considered, the most common being Skill Progression Training. It is most frequently given after servicemembers have gained experience through actual work in their specialty.

These examples suggest the usefulness of the end-item/occupation profile information coupled with files describing occupations, skills required, and skills taught in IST. While greater flexibility results from the possibility of restructuring occupations, courses, and selection criteria, the more detailed projections come at a higher cost. They are perhaps better done as second-round estimates of manning requirements for variants of a new system.

The cost of alternative manning and training options should also be computed. To do so, a cost estimation methodology must be specified and files created containing the relevant resource information. If the costs of trained personnel for a given system are high, planners might want to respecify system manning requirements. The costs will depend on direct IST resources such as instructors, courseware, equipment, and space, and also on the quantity and quality of accessions required. If the requirements of the new system parallel those of the system being phased out, perhaps few new resources would be needed; existing resources would be shifted around to meet the new requirements.

MANAGING SKILL SHORTAGES

Skill shortages occur by occupation and are inherently transitory because the system responds, eventually, to correct them. Shortages ought to be measured in terms of employment, so, for example, a shortage may exist at a given level of military compensation but disappear when a bonus or benefit is introduced. Still, the response may be slow or inadequate and there may be a lag before it takes effect, all of which prolong the shortage. Shortages might arise from unanticipated increases in manning requirements, high attrition, or low reenlistment. Depending on the causes, shortages may occur in a single skill or be far broader. In the late 1970s, for instance, military pay fell below civilian pay at a time when the unemployment rate was low, leading to lower retention overall which in turn caused higher enlistment requirements. Although recruiters often managed to achieve their enlistment targets, they enlisted lower quality recruits who were far harder to train.

The usual adjustments to a shortage occur through recruiting, retention, and retraining.⁹ From the perspective of IST, recruiting and retraining have an immediate impact on training activities: Training must be provided to the additional recruits and retrainees channeled into the shortage occupations. Extra training leads to questions about how readily a particular IST course can be expanded, or, if the shortage is widespread, how readily IST courses can be expanded in general. Other adjustments may also be made, such as reconfiguring units to substitute higher or lower skilled personnel for the short skill, or adding labor-saving equipment (e.g., maintenance aids), but such adjustments take longer to implement and may require IST course restructuring.

These questions raise details that are a routine part of the services' planning and programming of training resources. However, the services' responses and the conditions affecting those responses are virtually unrecorded. It is, therefore, difficult to benefit from that experience. As a positive step, TPDC could acquire information on the planned number of courses of a given kind of IST offered each year, the number actually given, the planned and actual numbers of students (entrants and graduates), the training equipment available for the course, and an indication of equipment shortages. As these data accumulated, a record of the range of IST responsiveness would emerge. Preferably, the data could be tied to a file indicating when IST was responding to a skill shortage, helping document how specific shortages were eliminated.

To assess IST flexibility it would also be useful to track the response to anticipated and unanticipated variations in the training load. Under current practice, the supply of training seats (i.e., the rate at which a course is offered) is governed by the objective of maintaining a fairly steady flow of newly trained personnel as replacements for losses due to attrition and non-reenlistment. Since the supply of applicants is seasonal, with peaks during the summer

⁹The recruiting and retention paths may employ bonuses and benefits as well as greater effort by recruiters and reenlistment counselors.

months and at the turn of the year, smoothing often means longer waits in the Delayed Entry Program (DEP) before the enlistee accesses and begins training. There is also some variation in IST offerings to fit the pattern. The file on course offerings mentioned above would depict the IST pattern and show the peak student load accommodated. That would presumably indicate the manageable load if a short-run expansion of the force were required.

Recruiting success in overcoming shortages might depend on the availability of training. An interested recruit might choose not to enlist if the wait until training (DEP length) were long, say six months instead of two. As it is, the most highly sought occupations have long DEP lengths and shortages are rarely a problem. In contrast, the effect of greater training availability on enlistment might prove important in less popular occupations. Experimentation might be required to determine this, and data on the flexibility of IST--variation in courses per quarter, students per course--could form a valuable baseline.

In dealing with skill shortages, the IST data are not necessarily restricted to the retraining and recruiting options. IST data can also help with retention: information on training resources and costs in the IST database might aid the reenlistment bonus allocation process. Given that reenlistment bonus multiples are in part determined by training costs, IST training cost data might enable more accurate methods of Selective Reenlistment Bonus (SRB) allocation in times of skill shortages.

Finally, files containing information on course attributes would be helpful in planning for shortages consequent to a mobilization. Depending on a course's resource requirements for instructors, equipment, teaching aids, facilities, and duration, and its capacity to increase its student load, the course might or might not represent a bottleneck in a given scenario.

SELECTING PERSONNEL INTO MILITARY OCCUPATIONS

Training data can help address the questions of whether the allocation of recruits across military occupations is efficient and whether the level of efficiency attained is sensitive to moderate changes in the allocation. These questions generally arise in a context that assumes the set of occupations and their courses is given. The problem is therefore similar to a classical matching problem: find an allocation of personnel that is superior or preferable to other allocations in producing the highest expected value to the military. This problem, which can be stated and solved formally, becomes difficult to solve in practice because a solution cannot be achieved without an explicit measure of the value to the military of placing a given individual in a specific occupation. Lacking an explicit valuation, the military approaches the matching problem indirectly. Its approach can be characterized by three objectives:

1. Make sure every occupation is fully manned;
2. Make sure every occupation gets a reasonably representative distribution of recruits by "quality;"
3. Minimize the chance that anybody assigned to an occupation will perform inadequately, i.e., be unable to complete training or perform required tasks.

Recruiters employ enlistment incentives to accomplish the first two of these objectives. In conjunction, the third objective is addressed by an occupational assignment system. Automated occupation assignment systems review the current manning status and quality distribution of occupations and recommend, via a CRT screen, the "best" occupational choices for a recruit given his aptitudes. To make this recommendation, programmed information relates aptitudes to probable completion of training. Personnel with low aptitude scores could be deemed unlikely to complete training, and hence would be denied eligibility to enter an occupation. The cutoff aptitude scores for an occupation are based on past experience, specifically, the statistical relationship between recruits' aptitude scores and completion of IST.

The services conduct their own analyses of the relationship between aptitude and training completion, yet TPDC files could complement their efforts by promoting an exchange of methods and information across the services and to OSD, and possibly enlarging the scope of analysis. Relevant files would include the IST and job performance files, course files, and unit files mentioned in Sec. II, as well as DMDC personnel records. It would be important to distinguish between attrition from the service stemming from poor performance in the course and attrition from other reasons unrelated to the course. The simplest approach, then, would be to relate passing status to aptitudes. But a more comprehensive approach would include educational attainment and physiologic variables (height, weight) and control for changes in course content, test content, grading standards, equipment, teaching aids, and service attrition policy. Moreover, the statistical framework would distinguish course-related attrition from other attrition--both kinds of attrition are relevant to predicting the number of trained personnel, but for different reasons. If other attrition were high, it might be because the course drew attrition-prone recruits (those with low education, for example) or because attrition was generally high. By careful assessment of these other factors, a clearer picture would emerge of the correlates of success in the course per se. Further, controlling for the other factors facilitates the year-to-year and service-to-service comparability of relationships between aptitudes and training success.

A joint service effort has been under way for five years to link job performance to eligibility criteria.¹⁰ This effort represents an expansion in scope from training success to performance on the job, which many consider a more meaningful criterion for determining eligibility. The effort is directed to a subset of military occupations

¹⁰The Joint-Service Job Performance Measurement/Enlistment Standards Project was undertaken in response to a Congressional mandate urging the military services to establish a research and development program to link enlistment standards with job performance. Annual reports from this project have been submitted to Congress since 1982. In addition, the Army has a major project in this area.

and seeks to develop suitable performance measures and tests. As the effort matures, it should provide data for analysis, together with the data described above. The results may reveal whether narrow or wide changes in cutoff scores degrade training success, i.e., graduation from IST. The analysis may also show how variations in the average quality of personnel entering an occupation affect training and job performance on average. If so, that would constitute a significant broadening of the third objective, help to minimize the chance that anybody assigned to an occupation would perform inadequately. Rather than just minimizing the chance of failing training or performing inadequately, the emphasis would expand to how well those admitted are expected to do.¹¹

Still, the opportunity for such analysis comes at a cost of greater data requirements and analytical complexity. Just as training analyses should control for course-related variables and attrition, analyses of job performance require data on on-the-job training, which may depend on time in the unit, its pace of operations, and its equipment and manning, and on factors affecting attrition from the service.

EVALUATING THE INDIVIDUAL'S RETURN TO MILITARY TRAINING

The previous discussion of occupation selection implicitly falls under the heading of the service's return to training, which in general will differ from the individual's return to training. It is up to the service to establish personnel procurement, selection, training, and assignment policies, including compensation policy, that permit the attainment of its military capability objectives at least cost. These policies, therefore, must induce a sufficient number and quality of men and women to enter the service and accept training and duty assignments consistent with the service's objectives. But individuals will do so only if they believe the military career path is preferred to other paths they could choose. Since only 25 or 30 of every 100 enlistees

¹¹Subjective judgment will still be required to decide what levels of average performance are optimal across occupations, or stated differently, when to increase average performance in one skill and perhaps reduce it in others from which personnel are drawn.

reenlist for a second term of service, the "military career path" is frequently a one-term affair followed by work or schooling in the civilian sector. Holding military compensation and enlistment incentives constant, the military's ability to attract high-quality enlistees and channel them into specific occupations depends on the value of formal and on-the-job training to the individual. For many that training has value because it is transferable to civilian jobs. Military occupations that have a higher civilian value will be more attractive to recruits.¹²

It is useful for the military to recognize the value of training to the individual for several reasons. First, demonstrating that military training is valuable in the civilian sector substantiates recruiting claims to that effect (the truth-in-advertising argument).¹³ Second, the more appealing the military occupation, the greater the prospective supply of recruits overall, including high-quality recruits; the fewer enlistment incentives needed to meet enlistment quantity and quality targets; the greater the opportunity to channel recruits into less desirable occupations; and the higher the eligibility criteria can be set. Third, bringing in more high quality personnel implies a higher quality pool of trained personnel from which to draw reenlistees. In effect, an occupation has value as a recruiting instrument; although the value may be perceived differently by different recruits and, from a policy perspective, is not readily changed (because course content is dictated by requirements for trained personnel, not by recruiting exigencies), it is a recruiting tool nonetheless. It may, therefore, be worthwhile to consider whether the training regimen can be altered to increase the value of training to the individual without reducing its value to the service.

¹²This is not to say that other factors are unimportant in the enlistment choice, e.g., patriotism, adventure, sense of national duty.

¹³Existing studies of post-service earnings tend to be based on veterans from the draft era, e.g., Danzon (1980), DeTray (1981), and Warner and Goldberg (1987). The differences in the composition of recruits under the All Volunteer Force (AVF) and in the greater average technical skill requirements in military occupations suggest that studies focusing on AVF veterans be undertaken.

The TPDC files needed to address this topic are essentially the same as described in the preceding subsection. They include the personnel record, individual IST performance, course-related information, individual job performance, and unit-related information. But there is a further data requirement--information about civilian employment and earnings for those leaving the service.¹⁴ The latter should be longitudinal data beginning with the transition from the service to the establishment of a career in the civilian sector. School attendance and educational benefit usage would also be relevant.

How these data would be collected and on whom are unresolved issues. Should all separatees be followed or just a selected subset? Should information be obtained through yearly in-person interviews or mailed interview instruments? Could earnings information be obtained from other government sources such as the Social Security Administration? Should selected separatees be made part of the annual CPS survey? Creating this file is a longer range goal than the others discussed in this paper, but one to which future consideration might be given.

Because this analysis entails a statistical model encompassing attrition and reenlistment behavior, a side product would be results on whether attrition is lower and reenlistment higher for personnel with superior performance. Of course, there must be some measure of superior performance. In addition to job performance tests, speed of promotion may serve as an indicator; however, it has some problems, for speed of promotion is not only a function of the individual's technical competence, and leadership, but also of the given job, the service's own manning requirements, time in grade, and time in service. Thus individuals with similar characteristics and performance may be promoted

¹⁴Analyses of post-service earnings must also consider what the individual would have earned had he not joined the service, and how he compares with others in his civilian occupation who did not receive military vocational training. This requires using TPDC files in conjunction with databases such as the Current Population Survey (CPS) and the National Longitudinal Surveys (NLS) to estimate counterfactual earnings.

at different rates because they entered in a different year or because their occupation's aggregate manning tables called for different numbers of, say, E4s and E5s. Thus, promotion information should be accompanied by information that controls for these confounding factors.

With detailed demographic and employment information on enlistment prospects, one could also determine whether changes in the content and timing of military training affect the supply and quality of recruits. For example, if military training content were adjusted to emphasize civilian counterparts that utilize similar training, would more individuals be attracted to the military and, if so, who would they be? If training seats were more readily available in skills with high return to the individual, would the services be able to draw more recruits from the employed sector? Finally, the information requirements described here would be an excellent foundation for analyzing data from a demonstration or experiment modifying IST courses.

We have presented five areas of application for an IST database and discussed some of the tasks and problems various data files could help solve. The applications encompass many issues of interest, and the seeming feasibility of the database to span the breadth of the issues offers encouragement that other, emerging issues could be supported as well.

IV. CONSTRUCTING AN EFFECTIVE TPDC DATABASE

The previous two sections have discussed files to include in the TPDC database and applications that would be supported by them.¹ But we recognize that many aspects of IST data potentially available to TPDC must be considered fixed in the short term. Therefore, in this section we discuss an aspect of database content and several aspects of database structure that must be considered in the long-term development of the IST database. The aspect of database content is a caution about using criterion testing as a measure of performance. After treating that topic, we present the three structural matters:

- Interaction among service databanks
- The requirement for longitudinal data
- The creation of an intelligent database

Each aspect is different and our comments on it are diverse, but the discussions all serve the intent of constructing a high-quality, easily accessible database.

A CAUTION ABOUT CRITERION TESTING AS A PERFORMANCE MEASURE

One possible performance measure is the results of criteria testing, used in many IST classes. In this form of testing the student is passed or failed depending on whether his test results demonstrate some acceptable level of competence in the skill taught. Since the test is based on task(s) associated with a given skill, the content validity of the test is typically not a problem. But criterion testing may be a poor indicator of the individual's *degree* of competence. This method does little to differentiate quality among those who passed in terms of, for example, how long it took to complete the task and how well the

¹Also, as mentioned at the outset, a separate effort to survey IST-related databases in the services is under way; when completed, this survey will be a valuable companion to the present piece.

individual understands the role of that task in his job overall. Additionally, the pass/fail grading system limits the range of performance scores, so statistically it becomes difficult to differentiate the better trained from the less well trained. Insufficient variation in training grades may make them statistically inadequate for linking IST performance to future job performance.²

Criterion testing is very practical in several ways. However, its potential costs to IST research may be largely unrecognized or underestimated. IST course design commonly relies on the notion that mastery of a skill is taught by reducing it to elementary subskills which can be taught step by step. Each step, then, is either learned competently or not, and the steps are small enough so that, once competence is demonstrated, there may be little remaining from which to judge the degree of competence, especially for skills that emphasize doing a task rather than understanding the principle behind it. In instances when competence can be judged through hands-on performance, criterion testing may be preferred to more complex and harder to administer grading schemes.

At least two steps can be taken to overcome the potential research disadvantages of criterion testing. First, where possible the raw scores on tests should be retained; although this will frequently be irrelevant for hands-on testing, it should apply broadly to written testing using a pass/fail criterion. In addition, the criterion itself should be retained, preferably with an explanation of why it was chosen. Second, when a student must demonstrate skill knowledge by hands-on or computer-aided testing, it seems desirable to record the number of actual and allowable attempts, or how long it took the individual to complete the test. These steps might provide more information about a student's degree of competence than a single pass/fail indicator when linked to job performance measures. For example, one could test statistically to see if those who took more attempts to obtain a "pass"

²An Army study (Popelka, 1982) on the utility of criterion testing in 62 job specialties found that over 50 percent had sufficiently limited variance in the frequency of test scores applicable to the specialty to question whether meaningful statistical analyses could be performed.

do not perform as well subsequently on the job as those who needed fewer tries.

INTERACTION AMONG SERVICE DATABANKS

Because most of TPDC's training data would come from the services, TPDC must work with them to devise specifications for data elements, periodicity, format, and transmission. To enable cross-service comparisons, the specifications should evolve toward commonality rather than being service specific; therefore, it is useful at the outset for TPDC to specify a general database architecture, even though it may be revised over time. In the long run, the greater data commonality promoted by this effort should assist the services in their own training research and management.

Some of the information that would be contained in the data files discussed in Sec. II is now, or soon will be, collected by the services in different databases. These collection efforts simplify the process of data collection for TPDC, since it can tap into existing databases instead of having to wait for the services to devise collection schemes for TPDC-desired data. However, the nature of the databases vary, so protocols for extraction and transmission of data to TPDC would have to be devised for each individual database. Therefore, the coordination between the services and TPDC is a crucial issue.

The following list includes some of the relevant service databases related to training from which TPDC might draw and the types of information they contain.

I. AIMS: Automated Instructional Management System (Army)

The system is designed to provide the U.S. Army Training and Doctrine Command (TRADOC) automation of much of the training support effort required at each Army school. Participation in AIMS by each installation will provide TRADOC with automated reports of training schedules, training activity, and training resource requirements.

The system keeps track of individual attributes and military career history data, individual training experience (including training date, course name and length, grades and class standing, training location), training course description (including prerequisites, type of instructional program, course length and class size limits, information on attendees such as number entered, number recycled, number graduated, and the Social

Security numbers of graduates which facilitates linking records with personnel files), and training resource requirements such as facilities, equipment, instruction, and support staff.

II. MPS: Maintenance Performance System (Army)

The MPS system was developed by the Army Research Institute as a training needs information system for use at the battalion level. MPS is designed to be used by work supervisors and training managers within maintenance skills. The system records the work experience and training of each maintenance technician. Included are the time on each technical task performed in the maintenance battalion, courses taken, and results of qualification tests. However, it does not appear that the MPS would contain information about effective and ineffective performance such as time to diagnose malfunctions and success or failure to diagnose malfunctions of various types.

III. SMART: Simulation Model for Allocation of Resources for Training (Air Force)

This database serves a similar purpose to that of the Army's AIMS, although it contains only course-level as opposed to individual-level data. Course description data include prerequisites, training location, course length, and class size, among other data. Resource requirements data consist of course-level requirements for facilities, equipment, and personnel.

IV. BLTMS: Branch Level Training Management System (Air Force)

Under development, this system is to be an on-line system maintained at the branch level with the exact content of the data subject to the local training manager's needs. Among the data to be included are information on instructors such as personnel information, teaching status qualifications, and teaching schedule. Also to be included are information pertaining to graduates, and information on students, including personal data, student status, test scores, and other.

V. ORDB: Occupational Research Data Bank (Air Force)

This is an occupational information system that provides information on a wide variety of specialties and the people who perform in them. Included in the data bank is a history of job codes and their training patterns, including courses required and elective, OJT requirements, and progression of training.

The list is not exhaustive, but exemplifies the kinds of databases already in existence (or soon to be). Not all skills are covered and the type and detail of data vary across services. However, the above databases and others like them can provide a good starting point for developing the necessary data protocols and administrative coordination between TPDC and the services.

Not all of the information in databases such as those listed above need be included in the TPDC database system. A routine extraction of a selected subset of variables could be devised and executed as each new wave of data arrives; the output could be transmitted to TPDC on a regular basis. The extraction program could contain any recodes or reformats necessary to make the data comparable across services, or such revisions could be done by TPDC once the data has arrived in-house. As stated above, ideally, if the individual service databases collected and kept data in the same format and codes, the combining of training data across services would be much easier for TPDC. However, if commonality is difficult to achieve, then protocols will have to be developed with each service to transform the data either before transmission to TPDC or upon arrival at TPDC.

REQUIREMENT FOR LONGITUDINAL DATA

Acquisition of longitudinal data is a key requisite for an effective training database.³ Longitudinal data enable, for example, comparisons of cohorts, evaluation of policy changes, studies of changes in skill requirements over time, and comparison of different methods used over time in the same course. Information collected by the services may not be kept over a long period of time. Old data may simply be replaced as updated versions come in. Thus, the frequency of transmission of data between the services and TPDC is a crucial consideration. Frequency of data transmission will depend on the particular database from which the extraction is being made, on the length of time that data are kept, and on the work

³The date and time period indicators discussed in Sec. II enable the linking of longitudinal data across files.

requirements/schedules of the service personnel handling the data extraction and transmission. Data which change only annually need only be sent once a year, whereas data which come in every month might be transmitted quarterly or even more frequently if the system cannot store data for that long.

CREATION OF AN INTELLIGENT DATABASE

The concept of "intelligent" databases is being advocated by information processing experts as a way to assist the assemblage and use of large-scale databases. Whereas an ordinary database typically consists of computer data files and printed codebooks, an intelligent database has an automated codebook including variable definitions and commentaries about data sources and quality; the data are automatically edited according to programmed instructions and criteria which themselves are documented; and summary statistics are readily available to browsers, either in tabular or graphic form.

An intelligent database management system might have the linkages among files already set up so that the user could simply select data elements from the various files; the information across files would be combined automatically. The database management system might also perform aggregations from, say, individual-level to course-level or unit-level or MOS-level, course-level to school-level or MOS-level or instructor-level, and so on, for sets of variables for which such aggregations might commonly be done.

The enormity of the training database discussed in this Note almost certainly requires tape data storage. Having the database itself keep track of what is on which tape would be a valuable feature. The user would only need to specify, say, the time periods needed from a given file and the system would locate the data. The same would be true for drawing data across files--the system would keep track of where the data are and call them up for the user.

The database system should also be able to write out the data requested in specified formats to data files that can be used for statistical analyses or reports. Combined with the automated linkage and aggregation and data location, this feature would ease the burden of

the TPDC programming staff when responding to simple or standard data requests by research analysts. More complicated requests would have to be handled by uniquely written data extractions, but might have quicker response since simple extractions can be done through automation of the system.

V. CONCLUSION

Our proposed architecture for a TPDC database on initial skill training has been guided by a single, overarching principle of selection that determines what, from all the possible collectible data, should constitute the proper content and design of a useful and flexible databank. That principle: Training should be considered an investment in human capital meant to sustain or increase military capability. In essence, data should be collected on aspects of personnel training that relate to or affect military capability. Moreover, data should be collected on a selected subset of specialties, as well as on both active duty and reserve forces. A TPDC database should also permit maximum linkage among its files through the use of several identifiers.

The TPDC database provides a foundation for the evaluation of IST effectiveness. Researchers can capitalize on natural experiments or utilize the database to provide an extensive quantitative background for controlled experiments. The complex and varied nature of the database also allows for applications beyond the evaluation of training effectiveness. Some applications are directly related, some indirectly related to training issues. To illustrate, we discussed five applications for the relevant files in the IST database: (1) determining training loads for budgeting, (2) matching weapons system acquisition and training requirements, (3) managing skill shortages, (4) selecting personnel into military occupations, and (5) determining the value of military training to the individual.

An effective TPDC database--that is, one allowing for varied applications over time--must take into account certain structural aspects in its long-term development: the necessity for interaction among the different services' databanks, the requirement that the data be longitudinal, and the necessity for an intelligent database. In short, the TPDC database should contain a series of files that can be connected or linked in different combinations to serve different kinds of research and analysis.

Compiling the kind of database we have outlined and discussed is a vast effort that is likely to proceed incrementally at best over many years. We are not certain of the best place to begin, but it seems that the most readily accessible data pertain to the course and the individual. In contrast, it may take many years to develop measures of job performance and unit productivity, so the TPDC database is likely to evolve slowly in those directions. Still, it is important to begin with a unified perspective to ensure that incremental efforts result in an integral whole. As emphasized, selective data collection by occupation may prove to be the most cost effective way to proceed. Between the various areas of application mentioned above, it is risky to assign priorities for data collection. Today, with high personnel quality and retention, it may seem least important to assemble data on the value of military training to the individual. But over the long term, retention could become a problem, and given the long lead times in data base development, it seems prudent to pursue all five areas of application simultaneously. This suggestion becomes more practical the narrower the band of occupations selected for extensive data collection. We stress that the successful creation of an efficient, flexible, useful database will require the cooperation of all the services, as well as of OSD. Their cooperation will depend on two conditions: (1) evidence that useful studies can be done from the kind of data in an IST database, and (2) assurances that the content and consequences of these studies will not threaten the services' mission to increase their capability. The services may find some reassurance in the example of the Defense Manpower Data Center, created 10 years earlier; its data files, assembled with the help of the services, have provided a detailed record of personnel trends and the effects of policy and economic changes on those trends, and both the OSD and the services have used the files for a large number of valuable studies.

Another problem in creating an IST database is the lack of general agreement on how to measure performance. The cooperation of the services--for their individual and collective benefits--will also be needed to overcome such difficulties. Despite such problems, the

architecture we propose for the TPDC databank would accommodate many kinds of information from, and useful to, all the services, including data on course training, the selection of individuals into military occupations, recruit performance in IST, on-the-job performance, unit productivity, and the relations among these areas. The services should find many fruitful uses for the database as it grows and evolves. Furthermore, it should support experimentation in different kinds of research and analysis and yield heretofore unexpected findings of benefit to military managers and planners.

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