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Simulation Networking/Training Requirements Relational Database

User's Guide

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STRICOM, Orlando Field Unit, Florida
Training Systems Research Division

U.S. Army Research Institute for the Behavioral and Social Sciences

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The Simulation Networking/Training Requirements Relational Database was developed to support analyses and training research projects for applying networked simulators to collective training. The collective tasks, subtasks, and standards described in armor platoon-, company team-, and battalion task force-level Mission Training Plan (MTP) documents form the core of the database. This core is supplemented with three types of data on each of over five thousand collective performance standards. The first type of data rates the extent to which the unit can perform the activities associated with each standard in the current simulation networking (SIMNET) environment. The second type of data provides information on how each of 41 potential enhancements to SIMNET would change the extent to which units can perform activities associated with each standard. This type of data ensures the utility of the database as new generations of network simulators are fielded. The third type of data identifies the source or sources of the data required to assess whether a unit meets performance standards in the networked simulator training environment. These data sources include data broadcast over the simulation network, unit plans for

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performing the mission, terrain data, tactical communications, and direct observation of behavior. The contents of the database can be exported to any database management system capable of loading ASCII files. Potential applications of this database include estimating the benefits of adding specific enhancements or combinations of enhancements to existing networked simulators; developing and applying measures of collective performance; and describing the behavioral requirements for Semi-Automated Forces (SAFOR).

Research Product 94-01

Simulation Networking/Training Requirements Relational Database

User's Guide

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Training Simulation

FOREWORD

The networking of combat vehicle simulators, as illustrated by SIMNET, provides a cost-effective method for collective training that supplements field exercises with operational equipment. The extent to which potential benefits of networking are realized depends on the design features of the networked simulators and the strategies for applying networked simulators as part of overall training programs.

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) developed an on-line database to support research on fidelity requirements and training strategies for networked simulators. This database focuses on collective training requirements at the armor platoon, company team, and battalion task force levels. This report provides guidance for training developers and researchers to use in applying this database. The work described in this report is a portion of the research task Training Requirements for Combined Arms Simulators. This task supports a Memorandum of Agreement entitled "The Effects of Simulators and Other Resources on Training Readiness," signed 16 January 1989. Parties to this agreement are the U.S. Army Training and Doctrine Command (TRADOC), the U.S. Army Center at Fort Knox, the U.S. Army Materiel Command, and ARI.

Users are encouraged to submit suggestions for improving this guide to the author. Comments, questions, and requests for copies of the database should be addressed to Chief, USARI STRICOM Field Unit, 12350 Research Parkway, Orlando, Florida 32826-3276.

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SIMULATION NETWORKING/TRAINING REQUIREMENTS RELATIONAL DATABASE: USER'S GUIDE

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SIMULATION NETWORKING/TRAINING REQUIREMENTS RELATIONAL DATABASE: USER'S GUIDE

Introduction

Army Training and Evaluation Program (ARTEP) Mission Training Plan (MTP) documents define the collective tasks and subtasks on which units need to be trained, and they provide standards for assessing unit performance (U.S. Army Training and Doctrine Command, 1984). The unit training goals presented in MTP documents may be addressed by a mix of training methods, and deciding how to apply a particular method is an important issue. The relational database described in this guide was designed for use in making decisions about applying one training option, networked simulations, to the training of MTP tasks.

Unlike individual skills training requirements, the collective training requirements defined in MTP documents tend to remain relatively stable with changes in weapon systems (Meliza and Knerr,1991). The Army is just beginning to apply networked simulators to collective training. Successive generations of these simulators are expected to become a major collective training method in the future. The stability of collective training requirements, combined with many years of decision-making regarding the design and use of networked simulators, suggests that a networked simulations/training requirements database will be a useful tool for many years to come.

Personnel from the U.S. Army Simulation, Training, and Instrumentation Command (STRICOM) and the U.S. Army Training and Doctrine Command (TRADOC) responsible for formulating training device concepts (Department of the Army, 1986), as well as organizations like ARI that conduct research in support of the concept formulation process, are expected to be the primary users of this database. It can also be used by those involved in developing and revising training strategies, such as the Battle-Focused Combined Arms Training Strategy (CATS) for Armor (Department of the Army, 1991). Finally, the database can be used by organizations responsible for operational testing of training devices (Department of the Army, 1986).

The goals of this user's guide are to

- define the objectives of the database;
- describe information sources used to build the database;
- define the contents of the database; and
- provide guidance for using the database to address key research and development issues.

The Evolving Application of Networked Simulators

Simulation Networking provides a means of conducting collective and combined arms training that can supplement field-based training exercises (Thorpe, 1988). The networking of simulators makes it possible for crews to interact with one another on a common terrain database. Information produced by each simulator, such as its location on the terrain database and the location of its firing engagement target, is broadcast over a network and picked up by other simulators on the network. The graphics generator for each simulator employs broadcast data and data from a common terrain database to present a current "out-the-window" view of the battlefield for crew members.

The current networked simulators are known as SIMNET. SIMNET supports the training of armor units, and to a lesser extent, mechanized infantry and rotary wing aviation units. Future generations of Army networked simulators, generically referred to as the Combined Arms Tactical Trainers (CATTs), will incorporate more combined arms elements, such as engineer and air defense artillery units.

The levels of physical, functional, and psychological fidelity required to train many collective tasks are often lower than those required to train individual skills and gunnery tasks. Networked simulators can therefore support collective training without employing high resolution graphics generators and other costly options. However, the lower levels of fidelity associated with SIMNET are estimated to restrict the collective tasks that can be trained (Drucker and Campshure, 1990; Burnside, 1990; Kerins, Atwood, and Root, 1990). For example, SIMNET does not allow units to modify terrain. This deficiency prevents units from being able to dig positions for vehicles, emplace obstacles and minefields, and mark paths through minefields. Future CATTs will include enhancements in fidelity to support the training of collective tasks more effectively. The first of the CATTS, the Close Combat Tactical Trainer (CCTT), for example, will include dynamic terrain as a preplanned product improvement so that units can modify terrain during an exercise (U.S. Army Armor School, 1990).

Database Objectives

The database was designed to satisfy three objectives. The first objective is to estimate the benefits of specific enhancements to networked simulators. The second is to support performance measurement in the simulation networking environment, and the third is to aid in the description of performance requirements for Semi-Automated Forces. These objectives are described below.

Estimate the Benefits of Simulator Enhancements. The concept formulation process for a device begins with identifying the range of training device options (including the option of training on operational equipment) that might be applied to satisfy a training requirement, such as the requirement to train units on MTP tasks (U.S. Army Training Support Center, 1989; Department of the Army, 1986 and 1987; U.S. Army Project Manager for Training Devices, 1986). The U.S. Army Simulation, Training, and Instrumentation Command (STRICOM) is responsible for developing information about those options to be considered in comparing them in a process known as Trade-Off Determination (TOD). The information developed during the TOD is applied by Army schools and STRICOM, during a Trade-Off Analysis (TOA), to select the best technical approach for meeting a training requirement. The most important trade-offs considered during concept formulation are those between fidelity levels and the cost of developing a device, because device fidelity is a major cost driver (Meliza and Lampton, 1991).

Data on the benefits that accrue from specific enhancements to the fidelity of networked simulators are required in order to decide whether the benefits are justified by the costs. These data may be used in formulating the concept for a training device, and they may be used to assess the value of subsequent improvements in the device.

The value of a potential SIMNET enhancement should be assessed, in part, on the basis of the number of collective training objectives that can be trained more effectively. In order to support decisions on the value of enhancements in SIMNET fidelity, a database is required that contains information on the extent to which the training of MTP training objectives are supported by the current SIMNET. The database must also contain information on how specific enhancements in the fidelity of SIMNET would influence its ability to support training. In addition, the database should provide information on the comparative value of training specific tasks and subtasks. Given the magnitude of the collective training requirement, combined with the magnitude of the information relevant to applying networked simulators to the requirement, an on-line database is preferable to one that is paper-based.

Support Performance Measurement. Unit collective performance measurement within the SIMNET environment is needed to support operational testing of networked simulators, to collect training effectiveness data as input for training device product improvements, and to provide feedback to exercise participants. A database is required to provide at least two kinds of information to support performance measurement. First, the database should help the user to identify those collective tasks, subtasks, and standards that are supported by networked simulators. Second, the database should help the user identify

the data sources that might be used to apply performance standards. Each of these requirements is discussed in greater detail below.

Identification of tasks and standards appropriate to networked simulators is necessary to focus data collection efforts. The utility of an on-line database in identifying appropriate tasks and standards becomes apparent when one considers there are 59 tasks, 320 subtasks, and 1,193 standards at the armor platoon level alone. Appreciation for the potential utility of the on-line database grows when one considers that the subset of appropriate tasks and standards increases each time that enhancements are made to improve the fidelity of networked simulators. To the extent that the database is designed to reflect the capabilities of successive generations of networked simulators, it will be useful far into the future.

The application of unit collective performance standards involves using five data sources; data broadcast over the network, tactical communications, terrain data, unit planning data, and direct observation of soldier performance. One of the major problems confronting trainers and researchers is deciding how to integrate data from these five sources in a timely manner (Meliza and Tan, 1991).

Describe Performance Requirements for Semi-Automated Forces. SIMNET's capability to support low cost collective training has been further enhanced with Semi-Automated Forces (SAFOR) workstations that allow the generation of large numbers of interactive friendly and enemy player vehicles (Thorpe, 1988). The behavior of the SAFOR is a critical fidelity issue. The purpose of the SAFOR is to provide the stimuli that cue and reinforce the behavior of the unit involved in a simulation networking exercise.

The SAFOR behaviors of interest are those required to train the tasks and standards appropriate for the simulation networking environment as a function of changing fidelity levels. Information about the required SAFOR actions are found in the MTP training objectives. Some of this information is contained in the statement of the collective task to be performed by the unit, some of it is found within the description of the conditions under which the task is to be performed, and the rest is contained within the performance standards for the task.

On-Line Database

The Simulation Networking/Training Requirements Database was developed to support SIMNET training strategy research. The collective tasks described in MTP documents for armor platoons, company teams, and battalion task forces form the core of this database. Three components were added to this core. First, ratings of the extent to which SIMNET supports the application of each of over 4,000 performance standards were added. Second, ratings of the effects of 41 possible enhancements to SIMNET on its ability to support the application of each standard were added. Third, ratings of the data sources required to apply each standard were added.

The Simulation Networking/Training Requirements Database is an on-line database maintained on a personal computer (PC) using XDB Database Management System software (XDB Systems, 1990). XDB allows the user to analyze a database using structured query language (SQL). To run XDB, you must have an IBM compatible PC with DOS 3.0 or higher. The Simulation Networking/Training Requirements data tables require approximately six megabytes of memory.

The data tables within this database can be saved as ASCII files and loaded into virtually any commercial database management system. However, much of the guidance for using this database assumes that the user employs a system accessible by SQL.

Sources of Information Used in Developing the Database

ARTEP Mission Training Plan (MTP) Documents

ARTEP MTP documents contain information pertinent to developing a training strategy. MTPs define each collective task to be trained by: describing the tactical conditions calling for task performance; listing the subtasks that should be performed; providing one or more standards of performance for each subtask.

MTP documents also contain information that can be used to estimate training value. MTPs identify subtasks considered by subject matter experts to be "critical" and subtasks that are leader tasks as opposed to unit tasks. In general, more is gained by training critical unit subtasks in SIMNET than is gained by training non-critical or leader subtasks. MTPs also identify the missions supported by each task as offensive, defensive, or both. The more missions supported by a task, the greater the benefits of training that task. Finally, MTPs identify the Situational Training Exercises (STXs) supported by each collective task. STXs are exercises that, by definition, have a high pay-off in terms of their progressive training value (U.S. Army Training and Doctrine Commande, 1984). All other features being equal, tasks that support many STXs have greater value than those supporting few or no STXs.

Training requirements from the Armor Platoon, Company Team, and Battalion Task Force MTP documents (Department of the Army, 1988a,b, and c) form the core of the SIMNET/Training Requirements Database. Table 1 shows the number of tasks, subtasks, and standards at each echelon included in the database.

TABLE 1.

Number of Tasks, Subtasks, and Standards in Database at the Armor Platoon, Company Team, and Task Force Levels.

Level	Tasks	Subtasks	Standards
Platoon	59	320	1,190
Company Team	55	370	1,701
Battalion	53	343	1,489
Total	167	1,033	4,380

Estimates of the Ability of SIMNET to Support Training

Four recent reports have addressed the issue of what collective tasks are potentially trainable in the SIMNET environment (Drucker and Campshure, 1990; Kerrins, Atwood, and Root,1990; U.S. Army Armor School, 1989; Burnside, 1990). Two of these efforts (Drucker and Campshure, 1990; Kerrins et al.,1990) used task classification schemes and performance standards that differ from those employed in MTP documents. The reports of Burnside and the Armor School use the MTP task structure.

Burnside's report offers two additional benefits that warrant including his ratings in the database. First, Burnside's ratings were applied at the standard rather than at the task level. This means that the rating scheme identifies specific standards and subtasks that are supported poorly by the current SIMNET. Second, Armor School Directorate of Training and Doctrine (DOTD) personnel repeated the procedures used by Burnside and produced a set of ratings for each standard that agreed with Burnside's ratings in ninety-eight percent of the cases.

The criteria used by Burnside and the DOTD to to rate the extent to which standards are supported by SIMNET are shown in Table 2. This table also provides examples of standards falling into each category.

Burnside used the ratings of the extent to which standards are supported to rate performance of tasks and subtasks in SIMNET. The criteria used to assign ratings to subtasks and tasks are shown in Tables 3 and 4 from Burnside's report. Ratings of SIMNET support for tasks, subtasks, and standards were included in the on-line database.

Table 2.

Criteria for Rating Extent to Which ARTEP MTP Standards Are Supported by SIMNET, from Burnside (1990).

HIGHLY SUPPORTED (H) - The standard can be met entirely. All required actions can be performed realistically (i.e., much like they are performed in field training or combat).
Examples: Issue a warning order.
Maintain interval and speed in accordance with METT-T.

PARTIALLY SUPPORTED (P) - The standard can be met to a large extent. The majority of required actions can be performed realistically. The remainder must be performed under artificial conditions (i.e, not like they are performed in the field), due to limitations of the simulation.
Examples: Analyze the five military aspects of terrain.
Use authorized frequencies and call signs from the unit SOI.

MINIMALLY SUPPORTED (M) - The standard can be met to a limited extent. The majority of required actions must be performed under artificial conditions. The remainder can be performed realistically .
Examples: Resupply vehicle.
Reload main gun.

OUTSIDE SUPPORT REQUIRED (O) - The standard can be met in the SIMNET facility, but at least half of required actions must be performed outside the simulation. Users must provide support for actions that are not directly supported by the simulation.
Examples: Redistribute personnel.
Prepare casualties for evacuation.

NOT SUPPORTED (N) - The standard cannot be met in the SIMNET system or facility. A significant portion (more than 25%) of the required actions cannot be performed in the simulation and is not appropriate to perform in the facility.
Examples: Camouflage vehicles and equipment.

Table 3.

Decision Rules for Combining Standard Ratings into Subtask Assessments, from Burnside (1990).

Rating	Rules
H	- Majority of standards H, and no standards N or O.
P	- If 3 or more standards, majority H and P and no more than 1 N or O.
	- If 2 standards, ratings of PP, HP, or HM.
	- If 1 standard, rating of P.
M	- If 3 or more standards: majority not H or P and no more than 1 N or O, or more than 1 N or O, with at least 1 N, but no more than 25% of standards N or O, or more than 1 O and no N, but less than 50% of standards O.
	- If 2 standards, ratings of MM, MP, PN, HN, PO, or HO.
	- If one standard, rating of M.
O	- If more than 3 standards, at least 50% of standards O, and no more than 25% N.
	- If 3 standards, at least 2 standards O.
	- If 2 standards, ratings of MO or OO.
	- If 1 standard, rating of O.
N	- If more than 3 standards, more than 25% of standards N or O and at least 1 N; if 50% or more of standards O, then more than 25% N.
	- If 3 standards, at least 2 standards N or 1 N and 1 O.
	- If 2 standards, ratings of NN, NM, or NO.
	- If 1 standard, rating of N.

Table 4.

Decision Rules for Combining Subtask Assessments into Task Assessments, from Burnside (1990).

H - Major of subtasks H, and no subtasks N or O, and all critical subtasks H or P.

P - If 3 or more subtasks: majority H and no subtasks N or O, with at least 1 critical subtask M, or majority H or P and no more than 1 N or O and no critical subtasks N or O

- If 2 subtasks, ratings of PP, HP, or HM.

M - If 3 or more subtasks: majority H or P and 1 critical subtask N or O, or majority not H or P, and no more than 1 N or 1, or more than one N or O , with at least 1 N, but no more than 25% of subtasks N or O and no more than 1 critical subtask N, or more than 1 O and no N, but less than 50% of subtasks O.

- If 2 subtasks, ratings of MM, MP, PO, HO, PN, or HN, with no critical subtasks N.

O - If more then 3 subtasks, at least 50% of subtasks O, and no more than 25% N.

- If 3 subtasks, at least 2 subtasks O.

- If 2 subtasks, ratings of MO or OO.

N - If more than 3 subtasks, more than 25% of subtasks N or O and at least 1 N, or more than 1 critical subtask N; if 50% or more of subtasks O, then more than 25% N.

- If 3 subtasks, at least 2 subtasks N or 1 N and 1O.

- If 2 subtasks, ratings of NM, Nm, or NO; or ratings of PN or HN with critical subtask N.

SIMNET Enhancements Effectiveness Estimates

Burnside's report offers the unique benefit of starting to consider the effects of enhancements in networked simulators on the ability to support training. A sample of MTP tasks was analyzed to identify enhancements that might increase the extent to which the training of standards and subtasks are supported by SIMNET. The Armor School DOTD continued this effort by applying the criteria to all tasks at the platoon through task force level. The enhancements considered are listed below.

- dismounted personnel (capability to dismount vehicles within SIMNET)
- machine guns
- small arms
- ability to improve positions (e.g., dig positions for defensive missions)
- popped hatch (capability to gain a complete view of a situation by viewing it from the commander's hatch)
- built up areas
- varied terrain
- limited or varied visibility
- varied weather conditions
- secure transmission means
- early warning devices
- realistic appearing aircraft
- cover and concealment
- turret/hull down positions
- mines/obstacles
- hand and arm signals
- jamming effects on radio
- crew level maintenance
- NBC (Nuclear, Biological, Chemical) contaminated areas
- resupply vehicles (with the ability to move over terrain)
- NBC attacks
- hot loop (running communication lines among vehicles to reduce the need for radio communications)
- AVLB (Armored Vehicle Launched Bridge)
- on board smoke (capability of a vehicle to establish a smoke screen without outside help)
- engineer unit
- capability to mark terrain
- FASCAM (family of scatterable mines)
- recognition signals
- realistic prepare to fire checks
- realistic compass use
- night operations
- ability to take actions at halt
- ability to establish all around movement security
- variable fire support parameters
- realistic radio frequencies
- personnel casualty assessment and evacuation

- equipment damage assessment
- realistic radio operations (effects of terrain on transmission quality)
- Air Defense Artillery (ADA) weapons
- First Sergeant's vehicle
- Improved TOW vehicles (ITVs)

Enhancements for each task are divided into two categories. Category A enhancements will result in raising the overall ability of SIMNET to support training on that task. Category B enhancements may improve the ability of SIMNET to support the training of one or more standards but will not, in and of themselves, raise the rating for the entire task.

Estimates of Data Sources Required to Support the Application of Each MTP Standard

MTP standards at the armor platoon level through the battalion task force level were examined by the author to identify data sources required to apply each standard in the SIMNET environment. The five possible data sources were:

- data broadcast over the network that might be automatically collected;
- communications over the tactical radio network;
- direct observation of exercise participants;
- records of a unit's plans for conducting a mission;
- data on the features of the terrain on which a mission is conducted.

Estimates of data source applications took future refinements in networked simulators into consideration. Certain standards that cannot be applied in SIMNET will be supported by future generations through the addition of new types of network data. For example, information about the use of machineguns will be carried over the network as machineguns are added to future networked simulators. The criteria used in deciding which data source or sources apply to each standard are provided below.

Automated. Data on training exercises that are broadcast over the SIMNET network are presented in Table 5. These data consist of firing events, vehicle locations, and other information about the status of vehicles. Any standards that might be applied, in whole or in part, using network data were rated as using "automated" data. Examples of such standards include "trail tank orients main gun opposite to direction of travel" and "the platoon assaults in line formation."

Table 5.

Data on Vehicle Firing Events, Location, and Status Available from Networked Simulators.

Direct Firing Events

- Time of firing event
- ID of firing vehicle and target vehicle
- Type of weapon system and ammunition used
- Location of firing vehicle and target vehicle (or ground impact)
- Range of engagement
- Results of engagement expressed as a hit, kill, or miss
- Identification of firing events that are fratricidal

Vehicle Location and Status

- Time of vehicle location or vehicle status update
- ID of vehicle
- Location of vehicle
- Speed of movement
- Odometer reading
- Number of liters of fuel remaining
- Rounds of ammunition remaining
- Direction of movement
- Turret azimuth
- Operational status of vehicle (fully operational, destroyed, communication loss, or mobility loss)

Indirect Firing Events

- Time of indirect fire missions
- Type of shell employed
- Number of rounds employed
- Location of target (or ground impact)
- Result of engagement

Future networked simulators will provide network data on dismounted personnel, firing events for machineguns and small arms, and additional combined arms elements such as combat engineer vehicles. The addition of dynamic terrain to networked simulators will allow units to mark terrain, emplace minefields/ obstacles, and dig positions. Dynamic terrain will also make it possible to implement NBC contamination and support the training of standards requiring NBC conditions. Standards that might be applied using these additions to network data were rated as using "automated" data.

Communications. If any part of the information needed to apply a standard must be obtained by monitoring radio communications, the standard was rated as using communications data. Many of the standards receiving this rating involve reporting of events to higher headquarters or dissemination of information over the radio net (e.g., "reports crossing of the SP on time"). Others are concerned with assessing whether proper radio procedures are employed (e.g., "subordinate commanders acknowledge the platoon leader's signal or radio message).

Plans. Any standard that requires information about the outcome of the planning process for a mission was rated as using planning data. This information includes all unit control measures. These data are made available by obtaining copies of the unit's orders and graphics and/or by listening to the unit leader deliver the operations order (OPORD). An example of a standard using planning data is "(the unit) follows the prescribed route of march, without deviation."

Observation. The application of certain standards requires direct observation of exercise participants or the results of the actions of these individuals (in cases where the results are not transmitted over the network). Many of these standards involve actions that fall in the category of troop leading procedures. For example, a platoon leader should "conduct a map reconnaissance," "issue overlays," and "check subordinate overlays to ensure they are posted correctly." An example of a standard that involves examining the results of actions would be "all reflective surfaces on vehicle are covered."

Terrain. Any standard requiring information about the terrain on which an exercise is conducted was rated as using terrain data. An example is a standard requiring a platoon to "move continuously on a covered and concealed route." In SIMNET, these data are available from the terrain database used to generate the "out the window" and "birds-eye" views of the battlefield. Although these data are stored in a computer, and accessible by automated methods, they are not broadcast over the network.

Table 6 shows the percentage of Armor Platoon MTP standards using each source of data. Most of the standards use more than one data source, so the percentages total more than 100%. Table 7 shows the various combinations of data sources used in applying Armor Platoon MTP standards and the percentage of standards using each combination of data sources.

It is important to note that the "observations" data source means direct observation of the behavior of individual soldiers. Such observations can be made by a trainer in the SIMNET environment only when soldiers are outside of the simulators. There have been discussions of using videotaping or other means to monitor the behavioral events inside a simulator, but this approach appears to be too costly to implement on a regular basis. Therefore, the memory of exercise participants is the major source of information about what would otherwise be events observed by a trainer. Information about these events will tend to surface during After Action Reviews (AARs) to the extent that they are relevant to key exercise events.

Table 6.

Percentage of Armor Platoon Mission Training Plan Standards Using Each Source of Data

Data Source	%
Observation	67%
Network	37%
Radio Communications	28%
Planning	25%
Terrain	18%

Table 7.

Data Sources Used in Applying Armor Platoon Mission Training Plan Standards

Data Sources	% of Standards Using Data Sources
Observations	35%
Communications + Observations	8%
Network	6%
Network + Communications	6%
Network + Terrain	6%
Observations + Planning	6%
Network + Planning + Terrain	5%
Communications	4%
Communications + Observations + Planning	4%
Network + Planning	3%
Network + Observations	3%
Network + Observations + Terrain	2%
Observations + Terrain	2%
Network + Communications + Observation	1%
Network + Communications + Observation + Terrain	1%
Network + Communications + Planning	1%
Network + Communications + Terrain	1%
Network + Observation + Planning	1%
Network + Observation + Planning + Terrain	1%
Communications + Planning	1%
Observation + Planning + Terrain	1%

Design of Database Tables

Platoon, company team, and battalion task force data are stored in separate tables in the database. The data table descriptions provided below are specific to the armor platoon tables; however, the design of the tables at platoon level is identical to that for the higher echelons with one exception. The letter "P" in the table and field names is replaced with the letter "C" at company team level, and it is replaced with the letter "B" at battalion task force level.

Five tables are included in the database for each echelon. The first three provide information about tasks, subtasks, and standards, respectively. The fourth provides information about enhancements that would raise the ratings of the extent to which specific tasks are supported by SIMNET. The fifth indicates the unit missions and Situational Training Exercises supported by each collective task.

Figure 1 illustrates how the five tables are linked to one another through a common data field (task ID). This link, in the context of a relational database management system, makes it possible for the user to ask questions involving the analysis of data from more than one table.

The description of data tables includes a definition of the data contained within each column (or field). These descriptions also include a specification of the data type within each column and the maximum number of characters or numbers available for each record.

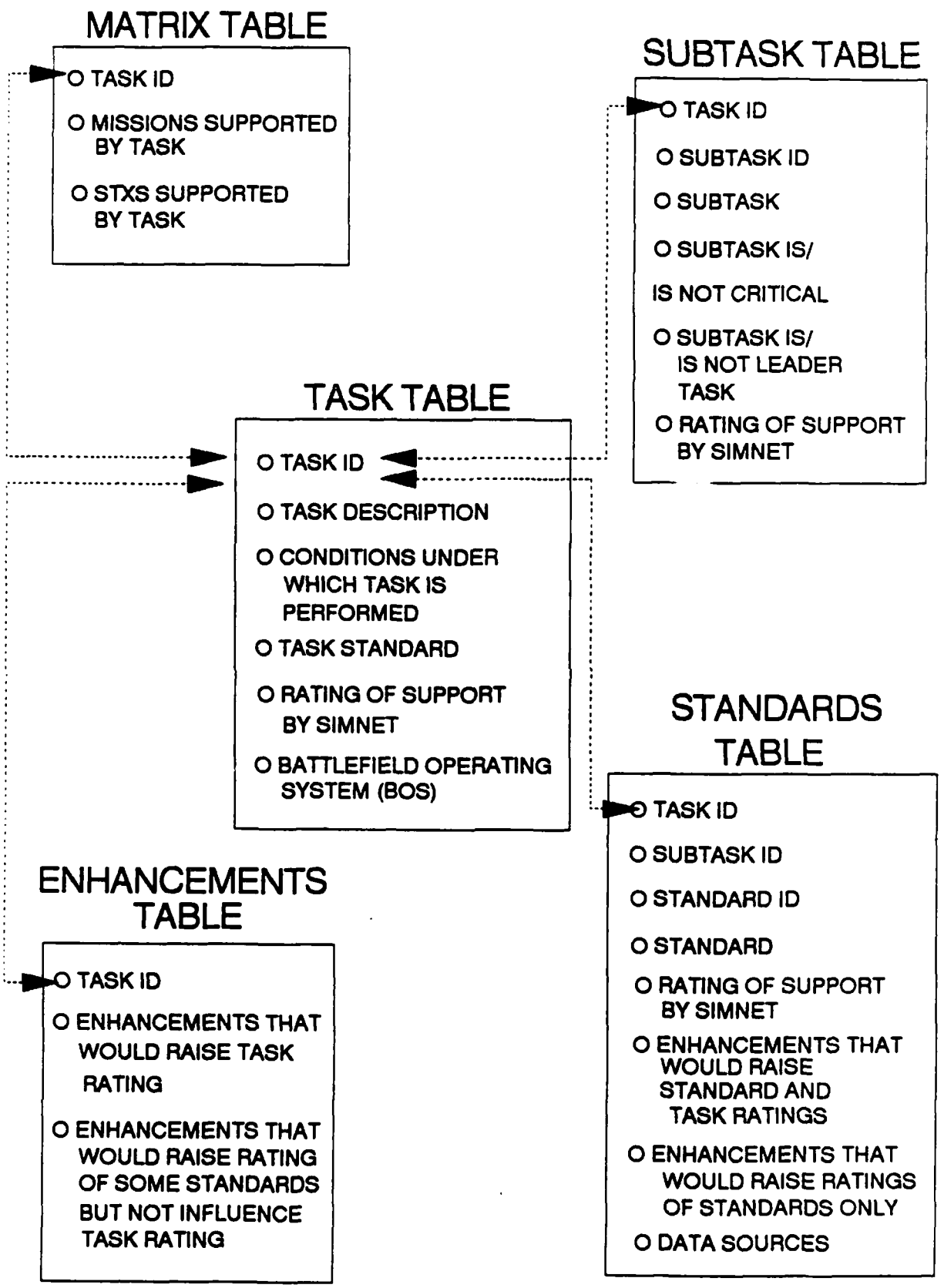

Figure 1. Components of the simulation networking/training requirements relational database.

Task Table

Table 8.

Column Descriptions for Task Table (Table Name= PTASK)

Column No.	Field Name	Data Type	Length
1	tasknum	Small integer	2
2	task	Character	63
3	taskst	Character	500
4	taskcon	Character	750
5	trn	Character	1
6	bos	Character	3

The six columns in this table are defined as follows.

1. Task number (numbered sequentially beginning with "1" according to sequence in MTP document.

2. Task name and number from the MTP.

3. Task standard from the MTP.

4. Description of the conditions under which the task is performed (from the MTP).

5. Rating of extent to which training of the task is supported by SIMNET.

6. Battle Operating System (BOS) appropriate to the task (man= maneuver, css=combat service support, fs=fire support, mob= mobility/countermobility, int=intelligence, command and control=cc).

Subtask Table

Table 9.

Column Descriptions for Subtask Table (Table Name= PSUBS).

Column No.	Field Name	Data Type	Length
1	tasknum	Integer	4
2	subnum	Decimal	5,2
3	subtask	Character	250
4	crit	Character	1
5	lead	Character	1
6	sim	Character	1

The six columns in this table are defined as follows.

1. Task number (numbered sequentially beginning with "1" according to sequence in MTP document.

2. Subtask number (task number followed by decimal point, then number of subtask from MTP document...for example, the number for the fifth subtask of the first task would be 1.05.)

3. Statement of the subtask (from the MTP).

4. Subtask is or is not critical according to the MTP (y/n).

5. Subtask is or is not a leader subtask according to the MTP (y/n).

6. Rating of extent to which training of the subtask is supported by SIMNET.

Standards Table

Table 10.

Column Descriptions for Standards Table (Table Name= PSTANDS)

Column No.	Field Name	Data Type	Length
1	tasknum	Small integer	2
2	subnum	Decimal	5,2
3	stanum	Character	1
4	stand	Character	550
5	simtrn	Character	1
6	enhancea	Character	50
7	enhanceb	Character	50
8	media	Character	5

The eight columns in this table are defined as follows.

1. Task number (numbered sequentially beginning with "1" according to sequence in MTP document.

2. Subtask number (task number followed by decimal point, then number of subtask from MTP document. For example, the number for the fifth subtask of the first task would be 1.05.)

3. The letter designation for each standard (from the MTP).

4. A statement of the standard.

5. Rating of extent to which training of the standard is supported by SIMNET.

6. List of SIMNET enhancements that will improve the rating of the extent to which the standard and subtask are supported.

7. List of SIMNET enhancements that will improve the rating of the extent to which the standard is supported.

8. List of data sources required to apply standard. Possible sources are network (a), radio communications (c), planning (p), observation (o), and terrain (t) data. Letters are listed in alphabetical order (e.g., a standard that requires network and planning data would be recorded as "AP" rather than "PA"). This field contains only an "x" for some company standards to indicate that a unit must perform an action in accordance with another MTP tasks. Such a standard is a placeholder for an entire task.

Enhancements Table

Table 11.

Column Definitions for Enhancements Table (Table Name=PENHANCE)

Column No.	Field Name	Data Type	Length
1	tasknum	Integer	2
2	a	Character	200
3	b	Character	350

The fields in this table are defined as follows.

1. Task number (numbered sequentially beginning with "1" according to sequence in MTP document.

2. List of enhancements that would raise the overall rating of the ability of SIMNET to support training on the task, and identification (in parentheses) of the standards affected by the enhancement.

3. List of enhancements that would raise the rating for standards but not raise the rating of the overall task.

Training Matrix Table

Table 12.

Column Definitions for Training Matrix Table (Table Name=PMATRIX)

Column No.	Field Name	Data Type	Length
1	tasknum	Integer	2
2	mission	Integer	2
3	stx	Character	20
4	comment	Character	450

The fields in this table are defined as follows.

1. Task number (numbered sequentially beginning with "1" according to sequence in MTP document.

2. Indication of missions to which task may contribute as follows: 1=offense; 2=defense; 3=offense and defense.

3. Identification of the situational training exercises (STXs) that are supported by the task.

General Commands for Analyzing the Database with Structured Query Language (SQL)

The purpose of this section is to provide basic guidance on using Structured Query Language (SQL) to analyze the contents of a database. For more extensive guidance on writing SQL commands, the reader is referred to the XDB reference manual (XDB, 1990).

Commands for Creating Lists

The general format for all queries intended to create lists is as shown below.

```
select (list of table columns)
from (list of tables to be used)
where (rule showing link between tables or qualifying rule)
and (qualifying rule)
group by (list of columns in sequence in which data are to
        be organized)
```

The first line of the sample format shows all of the columns or fields to be included, with each field name separated from others by a comma. For example, if you want the names of tasks and subtasks (from the columns by these names) write "select task,subtask." The second line shows the name of the table or tables from which information is to be taken. To select columns from both the ptask and psubs table you would write "from ptask,psubs." You can use an asterisk as a wild card if you want to select all of the columns from a particular table. For example, to select all columns from the ptask table you would write "select* from ptask."

The third line of the SQL command can be used to link two tables or to present a qualifier that will limit the information to be displayed. The use of qualifiers will be described first. Qualifiers normally limit the cases displayed to those having a particular value for a variable. For example, the command "select* from ptask where simtrn="h" would display data for only those tasks with a value of "h" in the simtrn column (i.e., tasks whose training is supported highly by SIMNET). You can use as many qualifiers as you want, with each qualifier being preceded by an "and."

When writing qualifier statements, there are certain conventions that must be followed. First, quotation marks should be used to enclose character data (e.g. where simtrn="h") but not numerical data. Second, you can use the percent symbol (%) as a wild card by using the expression "like" rather than "=." For example, if you wanted to restrict an information display to standards using communications data, you could accomplish this by writing the SQL command "where media like "%c%."

A link is required when an SQL command involves two or more tables. The purpose of the link is to integrate data across tables. For example, if one wanted to generate a list of standards from subtasks that are highly supported by SIMNET, one would have to combine information from the pstands table (statement of standard) and psubs table (ratings of extent to which training of subtask is supported by SIMNET). The purpose of the link is to relate the data in one table to that in another table by identifying data elements common to the two tables. The SQL statement "where psubs.subnum=pstands.subnum" would serve to link these tables, because these two columns contain identical information.

Finally, the SQL commands used to analyze data in the relational database may include a grouping command to help organize information. This command is used if you want information to be displayed in a particular fashion. For example, you might want to generate a list of platoon tasks along with a rating of the extent to which the training of each task is supported by SIMNET. It is likely you would want all of the tasks with the same rating to be grouped together. You could accomplish this by writing "group by simtrn,task." The "group by clause" must include the names of all the columns listed in the "select clause", even if only the first name is truly important to the grouping.

Commands for Performing Tallies

The general format of the SQL commands used to generate data tallies is the same as that used to generate lists. Differences between lists and tallies are in terms of specific information to be included in the SQL commands.

A counting function is indicated by including tally requirements among the list of data columns in the select clause. A counting function is shown by including "count(*)" in the list of target columns. For example, the SQL command "select count(*) from pstands where media like `%c%'" will count the platoon standards using radio communications as a data source.

Qualifiers and links within SQL commands for tallies are written in the same manner as they are for generating lists. Further, group statements are written in the same manner whether generating tallies or lists. However, "group by" clauses are required for all tallies, while these clauses are optional when generating lists.

Using the Database to Estimate Benefits of Simulator Enhancements

The simulation networking/training requirements database makes it possible to examine the value of specific SIMNET enhancements according to two general criteria; the number of tasks influenced, and the value of the tasks influenced. The value of the tasks influenced can be assessed according to one, some, or all of the criteria listed below.

- the number of Situational Training Exercises which include the task
- the number of missions which include the task
- the number of critical subtasks included in the task
- the number of unit subtasks, as opposed to leader subtasks, included in the task
- the extent to which performance of the task can currently be trained in SIMNET
- the extent to which performance of the task will be could be trained with future networked simulators if specific enhancements were made

The last criterion is especially important and warrants further discussion. A training method that addresses only a portion of a training objective is awkward to use, because it forces the trainer to figure out how to use other training methods to compensate for the deficiencies in the first method. The complexity of this decision-making chore becomes apparent when one considers the magnitude of the collective training requirement at each echelon. Therefore, an enhancement that shifts a certain number of tasks to the highly supported category is more valuable than one resulting in the shift of the same number of tasks to the partially supported category.

The exact rating of all tasks, subtasks, and standards after a potential SIMNET enhancement is not contained in the database. Instead, the database identifies those tasks, subtasks, and standards expected to be influenced by the enhancement. This information can provide a good approximation of the relative effects of enhancements being considered, as illustrated in Table 13. Notice that if SIMNET were enhanced with dismounted personnel, nine armor platoon tasks would be moved from the partially supported category to a higher category. Since highly supported is the only category above the partially supported category, at least nine tasks would become highly supported by adding dismounted personnel to future generations of networked simulators.

To gain a more precise estimate of the benefits afforded by a particular enhancement, it is necessary to re-examine those tasks that move up from the "marginally supported" and "not supported" categories. This re-examination is performed in two steps. First, a subset of the standards for these tasks is examined to decide how the ratings of these standards would be influenced. The subset of standards are limited to those categorized in the database as being influenced by the particular enhancement. Therefore, information contained in the database guides the user through the re-examination process in an efficient manner. Second, the extent to which the targeted tasks would be supported by enhancements must be recomputed using the rules previously presented in Tables 3 and 4.

Future Database Development to Support Benefits Estimates

Additional information would be useful in estimating the benefits and costs of specific enhancements. Meliza and Knerr (1991) identified two types of information relevant to examining the benefits of collective training devices that are not included in the current database. First, information about the availability of the resources required to train a task using operational equipment is important in examining the benefits of a proposed collective training device. That is, simulations may be the only way to train certain collective tasks for those units lacking the resources to train on these tasks at home-station. Second, data on the proficiency of units on specific collective tasks is needed to provide further information about the benefits of addressing these tasks.

As previously mentioned in this document, the current relational database describes lower echelon collective and combined arms training requirements from the perspective of armor units. The next generation networked simulator, known as the Close Combat Tactical Trainer (CCTT), is intended to support the training of infantry units to a greater extent that SIMNET does. To attain this goal, it is important to view training requirements from the perspective of infantry units, as described in squad and platoon level MTP documents.

The current database does not address the cost of the enhancements, and it does not address technical risks involved in attempting to implement those enhancements. Linking the cost of a particular SIMNET enhancement to the value gained from the enhancement is a complex task, because the costs of many enhancements are interdependent. For example, three of the SIMNET enhancements addressed by the database (minefields/ obstacles, mark terrain, and improve positions) all require replacing the static terrain in SIMNET with dynamic terrain that can be manipulated by soldiers.

Table 13.

Number of Armor Platoon Tasks Within Each Ratings Group Moving to a Higher Ratings Group If Enhancements Are Made

Enhancement	Training Support by SIMNET: Partial	Marginal	Not	Total
Dismounted Personnel	10	9	13	32
Mines/Obstacles	5	10	4	19
Mark Terrain	2	5	2	9
Machine Guns	4	4	0	8
Hand and Arm Signals	4	1	0	5
Turret/Hull Down Positions	2	3	0	5
Small Arms	0	2	0	2
Improve Positions	1	1	0	2
Varied Weather Conditions	1	0	1	2
Limited or Varied Visibility	1	1	0	2
Air Defense Artillery	0	1	1	2
Realistic Appearing Aircraft	0	1	1	2
Engineer Unit	0	1	1	2
Cover/Concealment	1	1	0	2
NBC Attacks	0	0	2	2
Resupply Vehicles	0	0	2	2
Built Up Areas	0	0	1	1
Varied Terrain	0	1	0	1
Secure Transmission Means	0	1	0	1
Early Warning Devices	0	1	0	1
NBC Contaminated Areas	0	0	1	1
Realistic Radio Operations	1	0	0	1
AVLB	0	0	1	1
FASCAM	0	0	1	1
On Board Smoke	1	0	0	1
Crew Level Maintenance	1	0	0	1
Recognition Signals	1	0	0	1

Sample Queries

A representative sample of SQL statements for use in estimating the benefits of specific SIMNET enhancements are provided below. The queries are appropriate for examining platoon level data. To use them at company or battalion level, replace the name of the platoon table with the appropriate name for the higher level table. For example, the ptask table becomes the ctask and btask table at company and battalion level respectively.

Organizing Training Requirements According to the Extent to which They are Supported by SIMNET. These sample queries organize training requirements according to the extent to which they are supported by the current version of SIMNET, and they organize these requirements according to various estimates of there value (e.g., critical versus non-critical subtasks).

- List MTP tasks as a function of the extent to which their training is currently supported by SIMNET.

```
select trn, task
from ptask
group by trn,task
```

- List MTP standards that are highly supported by SIMNET (rated "h") along with the name of the task in which the standard falls.

```
select task,subnum,stanum,stand
from pstands,ptask
where pstands.tasknum=ptask.tasknum
and simtrn="h"
```

- List tasks by BOS and as a function of the rating of the extent to which their training is supported by SIMNET

```
select task,bos,trn from ptask
group by bos,task,trn
```

- Tally the number of subtasks falling within each category of SIMNET support, by task.

```
select tasknum,simtrn,count(*)
from ptask,psubs
where ptask.tasknum=psubs.tasknum
group by tasknum,simtrn
```

Organizing Training Requirements According to the Effects of SIMNET Enhancements. The queries may be used to examine the effects of possible SIMNET enhancements on the ability to support training at the task, subtask, and standard levels.

- List MTP tasks that would move to a higher rating by SIMNET enhancements.

```
select tasknum,a
from penhance
where a!="none"
```

- List MTP tasks that would move to a higher rating by a specific SIMNET enhancement, such as the addition of "smoke".

```
select task,a
from penhance
where a like "%smoke%"
```

- List MTP standards that would become more trainable in SIMNET if a specific type of enhancement (e.g., smoke) were made to SIMNET.

```
select stanum,stands
from pstands
where aenhance like "%smoke%"
or benhance like "%smoke%"
```

- Count the number of standards that would be influenced by a specific enhancement in SIMNET, such as the addition of "smoke".

```
select count(*)
from pstands
where aenahnce like "%smoke%"
or benhance like "%smoke%"

select psttrn,count(*)
from pstands
where aenhance like "%smoke%"
or benhance like "%smoke%"
group by psttrn
```

- Count the number of tasks for which the rating would be raised by a specific enhancement, such as dismounted personnel.

```
select count(*)
from penhance
where pa like "%dismounted personnel%"
```

- List tasks that would be more trainable in SIMNET if enhancements were made including list of enhancements (group by bos)

```
select task,bos,trn,pa from ptask,penhance
where ptask.tasknum=penhance.tasknum
group by bos,ptask,ptrn,pa
```

Using the Database to Support Performance Measurement

The major goals of using the database for performance measurement are to focus the attention of the user to tasks supported by SIMNET and to explore methods for integrating data from multiple sources. Most of the guidance for using the database to estimate the benefits of SIMNET enhancements applies directly to the goal of identifying tasks, subtasks, and standards to be addressed by a performance measurement system.

Restricting the attention of the user to standards supported by SIMNET provides a different picture of the use of data sources in comparison with that provided in Table 4. Table 11 shows the frequency with which various combinations of data sources are used in applying only those standards that are rated as highly or partially supported by SIMNET, in comparison with Table 4 which considered all standards. Focusing on standards that are supported by SIMNET decreases the relative importance of direct observation of the behavior of soldiers as a data source, while increasing the importance of all other data sources. The effects of considering only those standards supported by SIMNET on the relative frequency of use of the various data sources are as follows:

- the percentage of standards using network data increases from 37% to 53%;
- the percentage of standards using observational data decreases from 66% to 47%;
- the percentage of standards using communications data increases from 28% to 39%;
- the percentage of standards using planning data increases from 25% to 34%; and
- the percentage of standards using terrain data increases from 18% to 22%.

Once the database has been used to restrict the attention of the user, it can be used to analyze appropriate standards. The most obvious application of the database is searching for key words and phrases within the standards of interest. For example, asking the database to list all platoon standards in which the term standard operating procedures or SOP is used, results in a list of 36 standards. This information is important to performance measurement efforts, because it identifies standards in which part of the behavior to be measured is guided by rules specific to a particular unit (e.g., "SOP is followed for communications during radio silence and emission control conditions").

Table 14.

Percentage of Platoon Mission Training Plan Standards, Supported by SIMNET, by Data Source.

Data Source	%
Observation	47%
Network	53%
Radio Communications	39%
Planning	34%

A second way to use the database to examine standards involves using information about data sources. Because the focus of training is at the task and subtask level, one of the most useful applications of the database is to summarize and examine data sources at the task level. In terms of developing a performance measurement system it helps to know, for example, which tasks are heavily dependent upon observational measures.

The use of information about data sources can be combined with word searches. For example, a recent effort to design information displays for platoon level performance analysis included a display that replays vehicle movement (data collected from the simulation network) from a bird's-eye view (Meliza, Bessemer, Burnside, and Shlechter, 1992). One aspect of unit performance to be assessed in this display was whether vehicles moved continuously under situations where temporary cessation of movement could have disastrous effects for a unit. Asking the database to identify all standards using network data containing the words "continuously" or "continuous" resulted in a list of standards where continuous movement is important.

Future Database Development to Support Measurement

In certain cases MTP standards do not provide measures of performance (MOP). For such standards, MOPs need to be developed and included in the database. As part of the UPAS project, software was developed for linking performance standards and MOPs with data displays that can be used in deciding whether a unit met the standard (Meliza, Tan, White, McMeel, and Gross, 1992). This software, called the Unit Performance Measurement System, records the results of the application of MOP for a particular unit in a manner that allows the data to be transferred to the

simulation networking/training requirements database, creating an empirical database that can be used to support training research. Implementing the use of this software for data collection purposes requires developing additional measures of performance and data displays.

Sample Queries

Queries that might be used to identify or count tasks, subtasks, and standards supported by SIMNET were listed under the previous objectives. Additional queries that might be used to support performance measurement are provided below.

Word or Phrase Searches. The representative commands provided below involve word or phrase searches as a function of a number of criteria (e.g., search only those tasks highly or partially supported by SIMNET.

- List MTP standards containing a key word. The command below would cause the system to select the standard number and statement of the standard for every platoon standard containing the word "report."

```
select stanum,stand
from pstands
where stand like "%report%"
```

- List, by task, MTP standards containing a key word. The command below would cause the system to select the statement of the task and standard for all standards containing the word "report."

```
select task,stand
from pstands,ptask
where ptask.tasknum=pstands.tasknum
and stand like "%report%"
```

- List MTP standards highly or partially supported by SIMNET that contain a key word. This command would cause the system to select the standard number and statement of the standard for every platoon standard rated as "h" or "p."

```
select stanum,stand
from pstands
where (simtrn="h" or simtrn="p")
```

- Count the number of MTP standards containing a key word. This command would cause the system to tally the number of platoon standards containing the word "report."

```
select count(*)
from pstands
where stand like "%report%"
```

- Count, by task, the number of MTP standards containing a key word.

```
select task,count(*)
from pstands,ptask
where ptask.tasknum=pstands.tasknum
and stand like "%report%"
group by task
```

Organizing Training Requirements According to Data Sources. The sample queries below are concerned with examining data source requirements as a function of a variety of variables (e.g., whether the standard is from a task that is highly supported by SIMNET).

- List the standards that make use of a particular data source or combination of data sources. The query below would produce a list of standards using network, radio communications, and terrain data.

```
select stand
from pstands
where media="act"
```

- List standards fully or partially supported by SIMNET, as a function of data sources used.

```
select media,stand
from pstands
where (simtrn="h" or simtrn="p")
group by media,stand
```

- Lists standards from tasks fully or partially supported by SIMNET, as a function of data sources used.

```
select media,stand
from ptask,pstands
where ptask.tasknum=pstands.tasknum
and (trn="h" or trn="p")
group by media,stand
```

- Count the number of standards using a particular data source or combination of data sources. The first query would tally the standards using network data in combination with radio communications and terrain data. The second query would tally the standards using network data (alone or in combination with other data sources.

```
select count(*)
from pstands
where media="act"
```

```
select count(*)
from pstands
where media like "%a%"
```

- Count the number of standards using each combination of data sources.

```
select media,count(*)
from pstands
group by media
```

- Count the number of standards supported by SIMNET as a function of data sources used.

```
select media,count(*)
from pstands
where (simtrn="h" or simtrn="p")
group by media
```

Using the Database in Modeling Behavior of Semi-Automated Forces (SAFOR)

Current interest in SAFOR behavior includes describing the expected behavior and deciding how to measure this behavior to insure that expectations have been met (Mullally, Petty, and Smith, 1991). SAFOR measurement techniques are needed to assess the effectiveness of tools being developed to control behavior of the SAFOR. Unlike measuring the performance of actual units, SAFOR measurement involves only three sources of data; network data, terrain data, and tactical communications (simulated communications from friendly units).

SAFOR modeling includes the behavior of enemy and friendly units. Both types of SAFOR have the same job, cuing and reinforcing the actions of the unit to be trained. Descriptions of the expected actions of SAFOR must be extracted from MTP documents through careful analysis of task conditions, task standards, subtasks, and subtask standards. The use of information about data sources immediately helps to reduce the number of standards to be analyzed, because the only standards of interest are those that use network data and/or tactical communications data. Only 532 of the 1,193 armor platoon standards use network and/or communications data. The number of standards to be addressed in the near term can also be reduced further by concentrating only on those standards that are supported by the current SIMNET.

Once the database has been used to reduce the number of standards to be addressed according to the data source criterion, it supports further analysis of SAFOR requirements through the use of word and phrase searches.

Future Development of the Database to Support SAFOR Research

The most useful expansion of the database, in terms of SAFOR research, would involve identification of those performance standards that require a unit to interact with the enemy or with other friendly forces. Due to the relational nature of the database, this information could then be used to automatically provide "roll ups" at the task and subtask levels. This analytical procedure may be used to reduce the number of standards to be evaluated avoid the need to examine all 5,000 standards.

Sample Queries

Most of the queries used to support the application of the database to modeling SAFOR behavior will involve searches for key words and phrases. The most useful word searches will be conducted by examining the descriptions of conditions under which a task is perform (taskcon), task standards, and subtask standards. Two examples of such searches are provided below. The first is used to look descriptions of task conditions containing the word "enemy," and the second is used to select subtask standards that contain the word "enemy."

```
select taskcon
from ptask
where taskcon like "%enemy%"

select stand
from pstands
where stand like "%enemy%"
```

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