A PROCESS TO EVALUATE TRAINING MEDIA ALTERNATIVES

Dr. Erik S. Hougland
Dr. Dennis S. Duke
Naval Training Systems Center
Orlando, Florida

ABSTRACT

This paper describes a process used to evaluate various types of media used in a training organization. The process uses as its basis a training device selection model that incorporates concepts of training effectiveness, technical efficiency and cost into an algorithm in order to determine the most effective training device(s) to be utilized in a training situation. This algorithm uses weighted scores as a basis for determining an optimal rank ordering in the three categories of training effectiveness, technical efficiency and cost. The final determination of which media are the most effective in training students is made by the analysis team utilizing data provided by the model. This paper provides a description of how the process was used by the analysis team in evaluating the training situation at the Marine Corps Security Force Battalion.

BACKGROUND

One of the missions of the Naval Training Systems Center (NAVTRASYSCEN) is to examine various training organizations and undertake a Training Situation Analysis (TSA) to assess the current training situation existing at a certain location. The TSA recommends alternatives which may improve the effectiveness and/or efficiency of the training being provided. The TSA is a management document which describes the training situation in quantifiable terms. It provides a snapshot of the training situation much like an accounting audit provides a snapshot of the financial situation of an organization. Decision makers at the training organization use the TSA as legitimate justification in requesting funds needed for improvements in the training program. The quantifiable analysis offered by the TSA provides a cogent rationale for the distribution of training resources. The TSA is a valuable document in support of training media development programs.

The personnel at the NAVTRASYSCEN are acutely aware of the need for quantifiable data needed by training organizations to justify additional funds. This keen awareness of the importance of producing reliable data in quantifiable terms prompted the analysis team tasked with undertaking a TSA for the U.S. Marine Corps (USMC) Security Force Battalion to embark on an in-depth review of the literature in order to determine the most effective way to quantifiably measure the training requirements. One of the primary concerns of the team was to find a media selection model capable of examining state-of-the-art simulation media while concurrently analyzing the training requirements of the battalion.

Initially the team tried to use the Automated Simulator Test and Assessment Routine (ASTAR) model.[2] ASTAR, which was developed in 1984 by the American Institute for Research, is an analytic program designed to forecast the effectiveness of training systems. ASTAR provided a multidimensional perspective of system effectiveness. It is intended to be used when given a trainee population with specific capabilities and limitations and a stated set of training and performance objectives, the analyst wants to "... determine how will the entire training system promote the acquisition of the skills and knowledge required for proficiency, both on the training device and in the operational situation." ASTAR is designed to be conducted at three levels of analysis ranging from Level 1 which is the "Training System" overview level, to level 3 which is a very deep analysis requiring 35 different ratings on each training or operational sub-task. The analysis team elected to employ the ASTAR level 2 analysis which entailed 13 rating judgments for each training task.

Although the eight areas of an ASTAR analysis (1. Performance Deficit, 2. Learning Difficulty, 3. Quality of Training Acquisition, 4. Residual Deficit, 5. Residual Learning Difficulty, 6. Physical Similarity, 7. Functional Similarity, and 8. Quality of Training - Transfer) seemed adequate for evaluating the training tasks - media alternatives for the Security Force Battalion, it was found that the analytical effort was extremely time consuming for both the analysis team and subject matter experts (SME) at the Security Force Battalion. The amount of time required to answer 100 questions (scales) on 215 tasks for each of 15 to

20 alternate training media was not available. For this reason, the use of ASTAR was abandoned.

The analysis team also looked at other models designed for use in media selection. The Training Effectiveness and Cost Effectiveness Prediction (TECEP) model[1] was examined and rejected for use on this project. This was due to the complexity of the model itself and the type of media with which it concentrates - primarily the media used in the classroom such as programmed texts, instructional television, etc. This was not applicable for analyzing the training situation at the Security Force Battalion. Several other models were examined before it was decided to customize an approach.

In retrospect, the Automated Instructional Media Selection Model (AIMS)[5] may have been sufficient for the analysis effort, however it was not available to the NAVTRASYSCEN analysis team at the time the work was to be done.

Finally, it was determined that it was necessary to design a customized training device alternatives model for use in this TSA. This paper highlights the process used by the analysis team in trying to determine the most effective and efficient way to train the Security Force Battalion. As a result of the analysis, a customized model was developed to satisfy the requirements. This paper provides a description of the customized model and illustrates how the model is an integral part of the training system analysis.

THE PROCESS -- INSTRUCTIONAL SYSTEMS DESIGN APPLICATIONS

The TSA analysis team approached the task in a manner similar to that advocated by Heeringa, Baum, Holman and Peio.[4] The Heeringa research team surveyed the procedures that the Army, Navy, and Air Force used in developing the requirements for training devices. As reported by Hays and Singer[3] these authors found that "...although the details of the procedures differed across services, there are seven functional objectives common to all services and to training system development in general." This paper illustrates how the process used by the analysis team complements the functional objectives proposed by Heeringa and others. The paper also highlights how, as a result of the process, a customized algorithm was developed for undertaking the training alternative evaluation.

The seven functional objectives identified by Heeringa[4] are:

1. An adequate task and skill analysis
2. A media analysis and selection
3. A specification of training performance to be achieved on the training medium,
4. A description of the operational training concept for using the training medium,
5. A plan for the integration of a training medium into the existing or planned training system,
6. A determination of both the instructional and simulation features required of the training medium, and
7. An audit trail detailing the procedures followed in the analysis.

This paper will detail the functional objectives presented by Heeringa, et. al. [4], however, in order for the reader to gain a better perspective of the training situation faced by the analysts, the following description of the training program at the USMC Security Force Battalion schools is provided.

The Training Situation -- USMC Security Force Battalion

The USMC Security Force Battalion was created by the Commandant of the Marine Corps as a direct result of the unfortunate incident which occurred in Beirut, Lebanon, on 23 October 1983 in which 241 Americans were killed. It was decided by Headquarters Marine Corps (HQMC) that a separate battalion be formed in order to guard against intrusion of unfriendly forces onto U.S. ships and naval installations. The resultant organization was the USMC Security Force Battalion. This battalion was tasked to provide personnel to security departments at designated naval installations; to support anti- terrorism training at naval installations; to augment fleet/force Inspectors General to oversee employment and use of Naval security forces at Naval installations; and to maintain a Fleet Anti-terrorism Security Team (FAST) for deployment as directed by Commander in Chief, U.S. Atlantic Fleet.

Two installations were established to prepare marines for Security Force Battalion duty. One was on the East Coast, and the other was on the West Coast. The training program initially designed to prepare marines for their assignments can be briefly described by the follow-

ing progression of annexes in the plans of instruction:

The initial two annexes are the basis for the course. They provide all trainees with an introduction and refinement of pistol and shotgun marksmanship skills. Here most of the instruction is "Hands-on," takes place on pistol and shotgun ranges and deals with live fire experiences.

The third annex introduces the trainee to the principles and applications of Security Force Battalion tactics. Here the students learn military tactics as they relate to security force battalion operations. They must demonstrate their proficiency in the basic marksmanship skills learned in the previous step of the progression, plus show their comprehension of military tactics. Application exercises are designed to enable the student to prove that he understands how the marksmanship skills are integrated with military tactics.

The fourth and fifth annexes take the trainee further and introduce him to physical security and anti-terrorism techniques as they relate to security force battalion operations. Here the student is presented with more advanced applications of weapons and tactics and must demonstrate proficiency in numerous simulated scenarios.

The instruction at the battalion is designed to progress from simple level one psychomotor marksmanship skills to more advanced high-level cognitive skills requiring the student to make initial assessments of threat conditions and make quick mental decisions in areas requiring shoot or no-shoot judgments.

Simulation-based training media are applicable at all levels of instruction. The analyst must determine what types of such media would be most effective and why? These are the questions that should be quantitatively answered by the Instructional System Design process and the supporting techniques described in this paper.

INSTRUCTIONAL SYSTEMS DESIGN THE FUNCTIONAL OBJECTIVES

Objective One -- Adequate Task and Skill Analysis

When undertaking a training situation analysis, the first objective, according to Heeringa and others [4], is to insure that a validated task and skill analysis is in place. In the early phases of the TSA the analysis team from the NAVTRASYSCEN assisted the Security Force Battalion in the review of the tasks to be trained and the skills to be developed. However, most of this work was completed by the battalion and approved by HQMC prior to the involvement of the analysis team. Thus, the team treated the existing task and skill analysis as provided data. This was an important assumption since the task and skills analysis and individual training standards (ITS) served as a basis for the development of questionnaires to identify training requirements.

Objective Two -- Media Analysis and Selection

The second objective in Heeringa's [4] scheme is the media analysis and selection. This objective insures that the most appropriate media for training is selected. It was in this objective that the analysis team concentrated upon most heavily. Heeringa maintains that the media analysis can be accomplished in four stages as mentioned below.

1. Initially it is suggested that training tasks be classified into learning task categories. In order to facilitate the ease of training device categorization, the first task of the analysis team was to group the training objectives into areas which could accommodate both training requirements as well as training device categories. The following three areas resulted:

   a. Procedural tasks in which the trainee has to undergo a certain action such as cleaning an M-16 rifle,

   b. Qualification tasks in which the trainee has to be able to attain a pre-established standard such as to qualify on a rifle range by hitting a certain number of targets,

   c. Engagement tasks in which the trainee has to directly interact with his immediate environment, such as going into a combat setting and engaging a simulated enemy.

2. The second suggestion is that media criteria be identified. In order to simplify the training device classification the various media were grouped into three classes based upon their physical composition. These areas consisted of

   a. Training mockups which were simply cutaways such as a side view of an M-16 rifle,

b. Enhanced interactive courseware training simulators such as marksmanship trainers,

c. Full-up training simulation in which the trainee is totally immersed in the training situation such as is the case of a combat village.

3. The third suggestion is that media alternatives be identified. Within each device class there were several types of training devices which are designed to provide the same type of training. Some however are better than others, offering more enhancements or better visual acuity. This third suggestion requires that these alternatives be identified.

4. The last suggestion is that the alternatives be analyzed in terms of the media criteria. It is within this section that the algorithm does the most work. We were faced with the problem that there were many alternatives within the same category. The major question was what was the most effective? Another concern was how can we quantitatively rank order the training device alternatives in terms of training effectiveness, efficiency and cost?

Objective Three -- Specify Training Performance to be Achieved on Media

Heeringa's third functional objective involves the specification of the training performance to be achieved on the training medium.[4] This functional objective served as the heart of the example. It was realized that without these specifications it would not be possible to determine if trainee performance would be improved by the use of a particular training medium. Therefore, in order to satisfy this requirement, a questionnaire was developed with the assistance of training subject matter experts at the battalion. This questionnaire was based on the individual training standards (ITS) prepared by HQMC. These ITS's were derived from the task analysis done by HQMC at the onset of the creation of the battalion.

The Questionnaire -- A Basis for Analysis

The questionnaire illustrated in Figure 1. was developed in order to present seven variables deemed important by the authors as well as the subject matter experts. These variables can be considered to be characteristic of training devices as well as training requirements. Along the left column of the questionnaire are listed all of the ITS's deemed applicable for simulation. Along the top, seven variables which were believed to be descriptive of training requirements as well as media requirements were listed. These variables are listed below.

1. Feedback - The immediacy of response to student action.

2. Student mobility - The student's freedom of motion during a training exercise.

3. Weapon fidelity - The fidelity of a simulated weapon or the use of a real weapon.

4. Target realism - The fidelity of a simulated target, or the use of a real target.

5. Score recording - The keeping and types of records of training performance.

6. Training media portability - The requirement to use a device in more than one location, requiring its transport.

7. Target visual discrimination - The target range requirement for simulator training an ITS.

Objective Four -- Description of the Operational Training Concept

Heeringa's fourth objective is the description of the operational training concept for using the training medium.[4] The operational training concept includes the consideration of the training conditions and the training location. This operational training concept also helps plan for introducing the training medium into the training setting. When the analysis team was investigating the U.S. Marine Corps Security Force Battalion they carefully examined the conditions and location where the training was to take place. For example, instruction in pistol and shotgun techniques normally takes place on the range. However, questions relative to whether or not training in pistol and shotgun techniques could take place on a marksmanship simulator located in a training building were asked. It was from these types of questions that the variables used in the questionnaire were derived. Determinations as to the effectiveness of the training on the simulator versus actual live shooting were made by reviewing studies on various firearms training simulators, acquired by NAVTRASYSCEN as well as training devices currently being used in other services, law enforcement agencies, and the private sector.

COURSE		OBJECTIVE CRITICALITY	QUESTION #1 FEEDBACK	QUESTION #2 STUDENT MOBILITY	QUESTION #3 WEAPON REALISM	QUESTION #4 ENVIRONMENTAL REALISM	QUESTION #5 SCORING	QUESTION #6 DEVICE PORTABILITY	QUESTION #7 TARGET CLARITY
LESSON DESIGNATOR	TIME TO TEACH (MIN)	1=NONE 2=MEDIUM 3=LOW	1=NONE 2=DELAYED 3=IMMEDIATE	1=YES, SAME POSITION 2=NO, LTD MOVEMENT 3=NO, UNLTD	ST TAUGHT TO: 1=CLRM LECTURE 2=COMP GRAPHICS 3=WEAPON MOCKUP 4=STIMULATOR 5=REAL THING	ST RESPOND TO: 1=INSTR LECTURE 2=COMP GRAPHICS 3=STAGED MOCKUP 4=FNT/SIDE VIEW 5=REAL THING	RECORD TRAINER PERFORMANCE: 1=YES, REQUIRED SCORING 2=NO, NOT REQD	RQMT TO MOVE TNG DEVICE: 1=YES, OFTEN 2=YES, SELDOM 3=NO RQMT	TARGET DISTANCE REQUIREMENT: 1=31 METERS 2=30 METERS 3=NO RQMT
BTA-06 T1	480	1	2	3	1	5	1	1	3
BTA-06 E1	60	2	1	3	4	5	1	1	3
BTA-06 E2	60	1	2	3	4	5	1	1	3
BTA-06 E3	30	1	2	3	4	5	1	1	3
BTA-06 E4	20	2	2	3	4	1	2	1	3
BTA-06 E5	20	2	2	3	1	1	2	1	3
BTA-06 E6	20	2	1	3	1	5	2	1	3
BTA-06 E7	20	3	1	3	4	5	1	1	3
BTA-06 E8	20	3	1	1	1	1	2	1	N/A

Figure 1. Training Requirements Questionaire

Objective Five -- Integration of the Medium into the Curriculum

Heeringa's fifth objective involves the integration of the training medium into the existing or planned training curriculum.[4] The TSA is an action plan in itself. It addresses the manner in which the training media will 'fit' into the training curriculum. As part of the analytical effort, various training objectives for a particular training device were developed and reviewed so as to insure compatibility with the existing or proposed instruction. In the case of the Security Force Battalion, the training progression was closely examined.

Figure 2 illustrates the training progression in the Battalion according to learning task categories, i.e. procedural, qualification and engagement:

> The procedural (P) tasks involved basic instruction in a particular area,
>
> The qualification (Q) tasks involved the application and demonstration ability using procedural tasks, and
>
> The engagement (E) tasks involved training to provide demonstration to integrate all skills and knowledge into realistic scenarios.

Figure 2 shows the 'Building Block' nature of the instruction. For example, the introductory Pistol and Shotgun Annexes (Lessons) of the Plan of Instruction utilize a simple to complex progression of skills as illustrated in the figure. The figure also illustrates how the introductory Pistol and Shotgun Annexes serve as procedural and qualification input to the more advanced Tactics Annex which requires these skills in the engagement of opposing forces. The Tactics Annex, in turn, serves as procedural and qualification input to the Physical Security and Anti-Terrorism Annexes which require the highest level of engagement skills. Training simulators of each class and with varying degrees of complexity were considered for recommendation for insertion into the curriculum. Their position in the curriculum was determined via an analysis of the student progression while in training.

Objective Six -- Determine the Required Instructional and Simulation Features of the Medium

The sixth objective involves the determination of the instructional and simulation features of the alternative training media to support the training requirements. The required features were determined by SME's in response to the questionnaires described in OBJECTIVE THREE. The features possessed by the alternative training media in support of the requirements were rated by NAVTRASYSCEN analysts. This was done based on the study of training media currently available in the commercial market. A modified version of the questionnaire, shown in Figure 3, was used for these ratings. The seven variables used to describe training requirements and media features were listed across the top. Down the left column were listed the alternative training media. The use of the same scale for training requirements and media features and capabilities allowed direct comparison when using the model to be described.

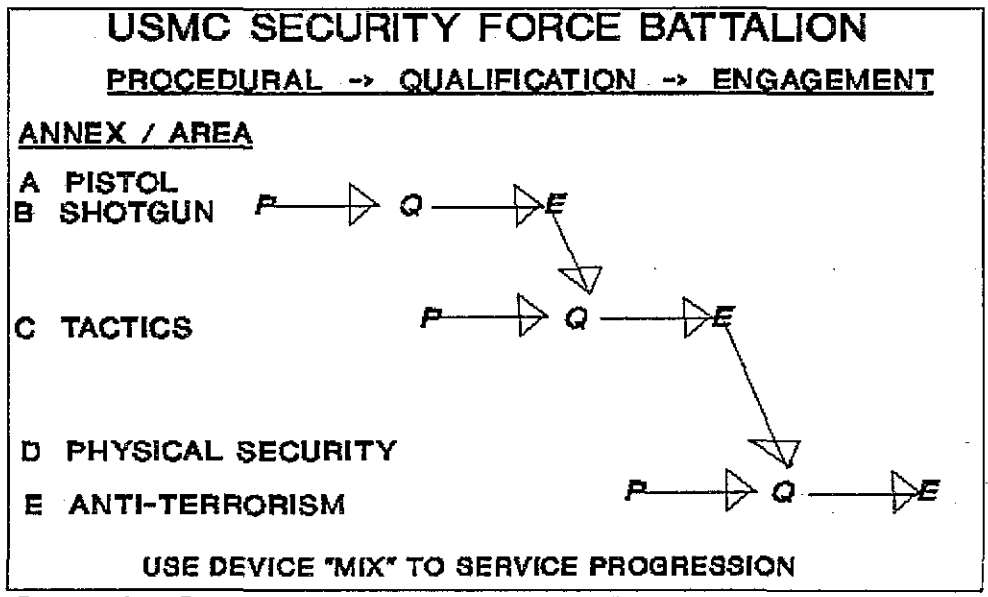

Figure 2. Progression of USMC Security Force Battalion Training

TECHNICAL CAP		OBJECTIVE CRITICALITY	QUESTION #1 FEEDBACK	QUESTION #2 STUDENT MOBILITY	QUESTION #3 WEAPON REALISM	QUESTION #4 ENVIRONMENTAL REALISM	QUESTION #5 SCORING	QUESTION #6 DEVICE PORTABILITY	QUESTION #7 TARGET CLARITY
MEDIUM	TIME TO TEACH (MIN)	1=NONE 2=MEDIUM 3=LOW	1=NONE 2=DELAYED 3=IMMEDIATE	1=YES, SAME POSITION 2=NO, LTD MOVEMENT 3=NO, UNLTD	ST TAUGHT TO: 1=CLRM LECTURE 2=COMP GRAPHICS 3=WEAPON MOCKUP 4=STIMULATOR 5=REAL THING	ST RESPOND TO: 1=INSTR LECTURE 2=COMP GRAPHICS 3=STAGED MOCKUP 4=FNT/SIDE VIEW 5=REAL THING	RECORD TRAINER PERFORMANCE: 1=NO, NOT RQRD 2=YES, REQUIRED SCORING 4=HARDCOPY	RQMT TO MOVE TNG DEVICE: 1=YES, OFTEN 2=YES, SELDOM 3=NO RQMT	TARGET DISTANCE REQUIREMENT: 1=31 METERS 2=30METERS 3=100M+ 4=RQMT
A			3	2	4	3	4	1	2
B			3	3	4	4	4	1	2
C			3	3	4	5	4	2	3
D			3	3	4	5	4	1	3
E			3	3	5	5	2	3	2

Figure 3. Technical Rating Questionnaire.

Objective Seven -- Provide an Audit Trail

The final objective in a training system design, according to Heeringa and others [4] is to provide an audit trail. This is necessary in order to provide decision makers with quantifiable justifications along with supporting rationale so that they can defend their programs (training media) in the funding process.

The use of the algorithm used by the NAVTRASYSCEN analysis team provides an excellent audit trail for anyone wishing information about why a certain training media was recommended over others. Rank orderings and scoring tallies are available for review so that every step in the process can be critically reviewed.

THE MODEL

When an analyst looks at a particular training situation, the number of entities and their mutual relationship increases beyond the ability of the analyst to comprehend. Therefore, he must be able to break the larger system into subsystems, almost as the schematic of a computer consists of blocks and their interrelationships, with each block having a schematic of its own. This "breaking down" of a larger system into subsystems is called a hierarchy. A hierarchy is based on the assumption that each of the separate entities identified as part of a system can be grouped into disjoint sets with the entities of one group influencing the entities of only one other group, the group located above it in the hierarchy, and being influenced by the entities of only one other group. The elements of each group of the hierarchy are assumed to be independent. If there is dependence among them we then study the dependence and independence separately. This hierarchy concept formed the basis of the decision support model used for the USMC Security Force Battalion TSA.

The Analytic Hierarchy Process (AHP), provided a method of ranking training media alternatives.[6, 7] The initial task that had to be accomplished was to define a final goal. The goal was termed, "obtain training media." This goal became the top level of the hierarchical network. Layers of logically related subjects were built the into the hierarchy . This is illustrated by Figure 4 below. The different training annexes, pistol, shotgun, tactics, physical security and anti-terrorism, and priorities within these annexes comprised the second level. The training requirements, the seven variables influencing training which were identified in OBJECTIVE THREE, made up the third level. The fourth or bottom level contained data for each of the alternative training media and training requirement variables.

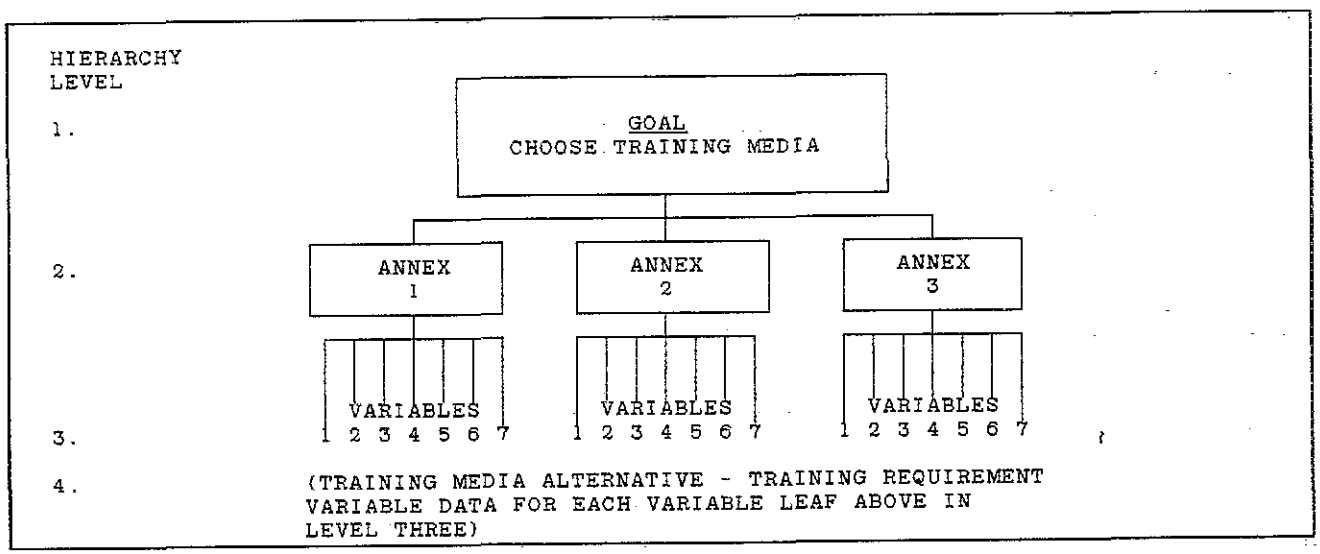

Figure 4. Training Media Alternative Evaluation Hierarchy

The AHP used the data for the training media, obtained from the responses on the questionnaire made by subject matter experts from the Security Force Battalion and technical capability assessments made by the NAVTRASYSCEN analysis team (see Figures 1 and 3) to generate scores upon which the rank ordering of the alternatives is based. The AHP rankings were based upon comparing the importance of pairs of factors in a hierarchy branch to the "Parent Node" immediately above that branch. (PAIRWISE) The comparisons were made by SME's from the Security Force Battalion. This is presented below.

Comparison of Level 1 to Level 2: The different annexes of training, Pistol, Shotgun, Tactics, etc., were compared in a PAIRWISE fashion for their importance to the final goal.

Comparison of Level 2 to Level 3: For each training annex, the Training Requirement Variables were compared in a PAIRWISE fashion for their importance to the training annex above

Comparison of Level 3 to Level 4: Each of the MEDIA ALTERNATIVES were

compared in a PAIRWISE fashion for importance to the Training Requirement above it in the hierarchy.

This scheme constituted the subsystem breakdown of the media alternative evaluation system.

When making individual pairwise comparisons of these types, the analyst may create inconsistent overall judgments. In fact, some level of inconsistency is almost impossible to avoid. The AHP calculates an index of this inconsistency and ranks each comparison for its contribution to the index. These rankings and the analysts knowledge are then used to re-evaluate the judgments and bring the inconsistency index to an acceptable level.

The AHP provided two means of entering Media Alternatives data in level 4 of the hierarchy.

1. Direct comparison of all media for each terminal branch of the hierarchy.

2. The comparison of potential ratings at each terminal branch, followed by the use of actual ratings for each media alternative - training requirement pair.

The data requirements for the former were prohibitive, so the latter, "Ratings," method was used. This "Ratings" method was a feature of a commercial AHP product, EXPERT CHOICE.[7]

For each training objective, NAVTRASYSCEN analysts matched pairs of Security Force Battalion training requirements obtained from SME's working at the schools (see Figure 1), and training media capabilities developed by NAVTRASYSCEN engineering professionals (see Figure 3). For each such pair, consisting of a training media alternative and a training requirement, a score was calculated by the formula:

SCORE =

(MEDIA CAPABILITY) -

(TRAINING VARIABLE REQUIREMENT)

These matchings of media capability and training variable requirements provided scores, either positive or negative, that were then used as the basis for further analysis. The SCORES used to rank the media had the following interpretations:

A score of zero indicated that a medium met the training variable requirement.

A negative score indicated that a medium was not capable of satisfying the requirement.

A positive score indicated that the medium was more than capable of meeting the requirement, possibly because it had capabilities not needed to satisfy the requirement, i.e., a Porsche when a Hyundai was desired. Larger positive scores indicated an inappropriate application of the training media. Such situations were to be avoided.

The following flow chart in Figure 5 defines the process of generating training variable requirement - alternative training media scores from the Security Force Battalion SME's and NAVTRASYSCEN analysts. Training requirements for each specific training objective, purpose, and application were developed by the SME's. The "Variables" used were defined earlier in OBJECTIVE THREE and are used later for the example application.

In developing these scores, it was noted that a difference of "one" standard answer in one variable does not have the same importance as a difference of "one" in another variable or even the same variable. This property, when combined with differing importance of each Training Requirement for different training objectives (e.g. small unit engagement tactics versus individual marksmanship skills) results in a complex decision analysis problem for which the AHP is designed. The structure of the total hierarchy to reflect the use of "RATINGS" inputs is shown in Figure 6.

The "Ratings" layer, 4R, contains the SPECIFIC SCORES, or RATINGS, for each alternative media - training variable requirement pair which are used to calculate the AHP's weighted index of the alternatives.[7] The resultant TOTAL SCORE, or RATINGS INDEX, is used to generate the Rank Ordering of the alternative media.

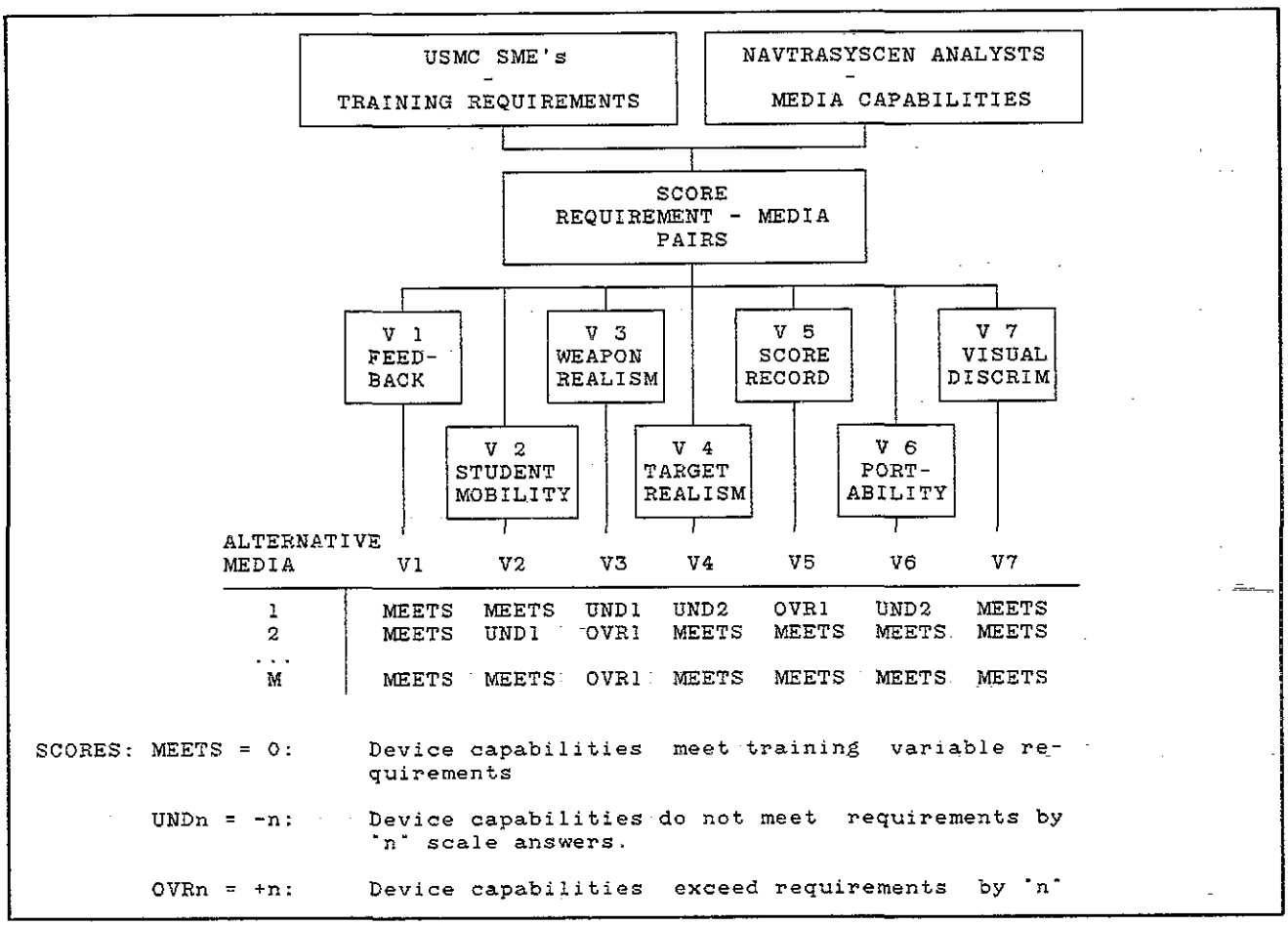

Figure 5. FLOW CHART: Generation of Training Requirement - Media Capability SCORES

THE APPLICATION

Two Hundred fifteen individual lessons with terminal and enabling objectives were rated by SME's at the Security Force Battalion using the form in Figure 1. Additionally, the SME's rated the criticality of each objective to the Security Force Battalion's missions in order to complete the PAIRWISE comparisons.

Assignment of the lessons of each Annex to Procedural, Qualification, or Engagement categories was done by the NAVTRASYSCEN analysis team after studying the programs of instruction for each annex.

In order to not omit any annex and category combination from the list of recommended training media, a separate AHP model was developed for each annex and category combination rated by the SME's. Twelve of a possible 15 combinations were rated, as indicated in Table 1. Seventeen commercially available non-developmental training devices/media and "Live Fire" were rated using the AHP models. The rating of "Objective Criticality" was used as the primary discriminator.

The economic ranking was done for five media to train Annexes A and B (Pistol and Shotgun), and seven to train Annexes C, D, and E (Tactics, Physical Security, and Anti-Terrorism). The criteria for this decision were availability of cost data and an *a priori* determination of suitability for the training purpose.

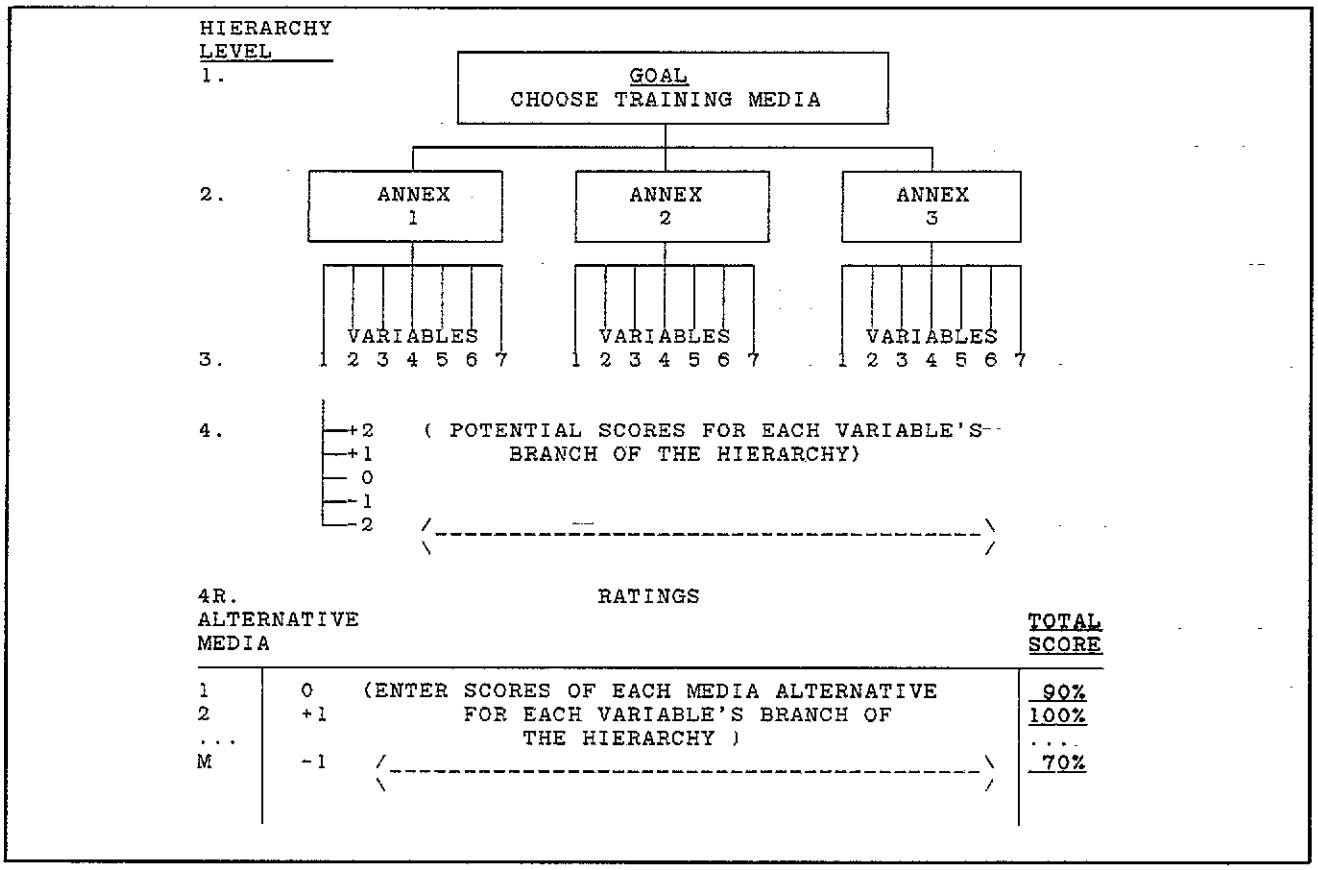

Figure 6. Training Media Alternative Evaluation Hierarchy with RATINGS Levels in Use

Table 1. Lessons Areas Rated by USMC SME's

CATEGORY	ANNEX PISTOL	SHOTGUN	TACTICS	PHYSICAL SECURITY	ANTI-TERRORISM
PROCEDURAL	X	X	X	X	X
QUALIFICATION	X	X	X	X	
ENGAGEMENT	X	X		X	

Tables 2 and 3 show the net training ranking of the media alternatives that received economic analysis. The Life Cycle Costs (LCC) are based upon an analysis of the numbers of devices required to serve anticipated student loads, maintenance requirements, instructor requirements, facilities requirements, and service life.

The ratio of each alternatives LCC to the lowest LCC in the rating group is the basis of the Economic ranking.

The results of the analysis are shown in Tables 2 and 3.

The complete tables from which these extracts were drawn have been presented along with accompanying rationale in the TSA to the USMC Security Force Battalions for their use in formulating training strategies.

Table 2. Training and Economic RANKINGS, Annexes A & B, Pistol and Shotgun

TRAINING RANK	DEVICE	LCC RATIO	ECONOMIC RANK
1	LIVE	12.3	5
2	"A"	1.0	1
3	"B"	6.7	4
4	"C"	4.5	3
5	"D"	3.0	2

Table 3. Training and Economic RANKINGS, Annexes C, D & E, Tactics, Physical Security and Anti-Terrorism

TRAINING RANK	DEVICE	LCC RATIO	ECONOMIC RANK
1	"B"	1.6	2
2	"A"	1.0	1
3	"E"	*(N/A)*	
4	"F"	43.7	6
5	LIVE	12.3	5
6	"G"	6.8	3
7	"H"	7.2	4

SUMMARY

This paper described the methodology by which the NAVTRASYSCEN developed a customized algorithm to address the question of choosing an optimal training media to satisfy training requirements at the USMC Security Force Battalion. The method followed the Instructional Systems Design Process Objectives described earlier.

It is realized that much more research can be done in this area. This was an initial attempt which satisfied our direct need in the TSA for the Security Force Battalion. We are currently employing the model for determining the optimal selection of training devices in other training areas. An extension to the method is being developed which will consider the situation where few, if any, training systems are available for meeting training requirements. Training media characteristics will be compared for eventual use in systems to be developed. We invite your input regarding suggestions for improvements.

BIBLIOGRAPHY

[1] Aagard, J.A. and Braby, R., Learning Guidelines and Algorithms for Types of Training Objectives, TAEG Report No. 23, Naval Training Equipment Center, Training Analysis and Evaluation Group, Orlando, Florida, 1976.

[2] American Institutes for Research, ASTAR User's Manual, July, 1988.

[3] Hays, R.T. and Singer, M.J., Simulation Fidelity in Training System Design, Springer-Verlag, New York, New York, 1989.

[4] Heeringa, L.M., Baum, D.R. and Peio, K.J., An Analysis of Training Device Requirements Documentation Procedures (Army Research Institute Contract Number MDA 903-81-C-0214), Minneapolis, Minnesota, 1982.

[5] Kribs, H.D., Simpson, A.C. and Mark, L.J., Automated Instructional Media Selection (AIMS), NAVTRAEQUIPCEN Report 79-C-0104-1, Orlando, Florida, 1983.

[6] Saaty, T.L, The Analytic Hierarchy Process, McGraw-Hill, New York, New York, 1980.

[7] Saaty, T.L. and Forman, E.H., Expert Choice, Decision Support Software, Pittsburgh, Pennsylvania, 1988.

ABOUT THE AUTHORS

Dr. HOUGLAND is a Systems Engineer in the Advanced Systems Branch at the Naval Training Systems Center. His work includes engineering design approaches for training equipment to meet requirements. He has had experience in the design of air, submarine, and ground forces trainers. He received the Ph.D. degree from Virginia Polytechnic Institute and State University in environmental sciences and engineering.

Dr. DUKE is the Head of the Submarine Plans and Analysis Branch at the Naval Training Systems Center. During the time this work was performed, he was the Project Manager for Marine Corps Training Situation Analyses in the Land Plans and Analysis Branch. He has had previous experience as an analysis manager, an integrated logistics support manager and as an instructor in avionics equipment repair, management theory and instructional systems design. He holds a masters degree in systems design, a masters degree in business administration, and a doctorate in administration.