Appendix

Appendix A
Training in the U.S. Military

The U.S. military recruits and trains large numbers of young people. Parts of the military training model resemble apprenticeship, except that the "related instruction" (which takes place alongside on-the-job training in private sector apprenticeship) is front-loaded in the military. That is, new recruits receive intensive instruction at the beginning of their tour, followed by on-the-job training coupled with written and practical skills tests.[1]

Aside from the very different missions, there are several basic differences between military and conventional private sector training. One is the scale and scope of training. Private firms often give little training to young entry level workers because they expect them to move on within a year. The military recruits for 3- to 4-year tours of duty, and trains all recruits. Some remain in the military for a 20-to 30-year career. Further, the military model is up or out; if recruits do not pass training and move up, they may be discharged. Military training also is aimed more at specific performance standards, based on job analysis, than most private sector training. Also, military training is evaluated and improved constantly, with the trainees' commanders providing feedback. Instructors are rotated, conducting training for 3 or 4 years at a time and then returning to the field. Thus they maintain and upgrade their duty skills.

Instructional technology also is more prevalent in military training than the civilian sector. The military has a keen interest in training technology for several reasons. The portability and consistency of instructional technology make it very atttactive for the military's large worldwide trainee population and high turnover. The military also frequently introduces new equipment with sophisticated and complex capabilities that are particularly well suited to technology-based training. Finally, the Department of Defense (DoD) can afford the startup costs associated with hardware and software development. Because DoD's training budget is so large (DoD spends approximately $3,500/person annually on training compared with perhaps $100 to several hundred dollars per employee in the private sector), the military's investments in training research have the potential to yield large cost savings if they produce more effective or efficient training methods.

The military services have a multibillion dollar inventory of training material. For example, in 1986, the Naval Training Systems Center processed more than $1.0 billion for research, testing, and development of training systems, and provided logistics support for over $3 billion worth of training material and systems in use throughout the world. Because of its increasing emphasis on training technology, the military training market is one of the few U.S. defense markets that is growing.[2]

Scope of Training[3]

The Department of Defense had almost 5 million personnel in 1989 (see table A-l). The 3.8 million uniformed personnel received the equivalent of 250,000 years of training, with 81 percent going to active forces and the rest to Guard/Reserve personnel (see table A-2).

The figures in table A-2 only cover what DoD calls "individual training and education," or training of individual uniform members in formal courses conducted by organizations whose major mission is training. Training by units—roughly equivalent to on-the-job training—is not reported in the DoD ***Military Manpower Training Report.***

DoD divides individual training programs into six categories:

1. ***Recruit Training:*** given to enlisted personnel with no previous service by the Branch they join. Recruit training is more akin to socialization than to skills building. An individual coming from duty in another Branch may need modified Recruit Training.
2. ***One-Station Unit Training (OSUT):*** initial training given only by Army Combat Arms (e.g., Infantry, Armor, Artillery). OSUT combines Army Recruit Training with advanced individual training.
3. ***Officer Acquisition Training:*** now includes six general programs (Service Academies, Recruit Officers Training Corps, Officer Candidate Schools, Off-

[1]Unless otherwise referenced, the material in this appendix is from Douglas Copeland, personal communications to OTA, October 1989-January 1990; and Greg Kearsley, "Instructional Technology and Worker Learning Needs," report prepared for the Office of Technology Assessment contract No. L3-5615, February 1990.

[2]Steve Hull, "Hot Markets," *Military Forum,* vol. 6, No. 3, November/December 1989, p. 5.

[3]The information presented below is derived from the *1989 Defense Almanac*, the Department of Defense *Military Manpower Training Report* (MMTR) for fiscal year 1990, and the Department of Defense, Office of the Assistant Secretary of Defense Manpower, Installation, and Logistic, *Occupational Conversion Manual.* In some cases, these data will address requirements for fiscal year 1991. This fiscal year 1991 information is part of the MMTR and is required by the U.S. Congress in accordance with 10 U.S.C. 138(d)(2). The MMTR for 1990 was prepared in March 1989. It should be noted that this reflects neither the Presidential Budget presented to the Congress in January of 1990, nor any increased demands due to the 1990 Iraqi invasion of Kuwait (e.g., call up of reserve forces).

Table A-l—Department of Defense Personnel (as of March 1989)

Active duty personnel:	
Army	*764,259*
Navy	581,050
Marine Corps	194,860
Air Force	575,604
Total	2,115,773
Guard and Reserve:	
Army	1,063,437
Navy	241,448
Marine Corps	83,233
Air Force	268,254
Total	1,656,372
Civi/Service:	
Army	430,480
Navy	354,491
Air Force	263,437
Other	96,679
Total	1,145,087
Total DoD	4,917,232

SOURCE: Departmentof Defense, *Defense Almanac, 1989.*

Campus Commissioning, Enlisted Commissioning, and Health Professions Acquisition). There are sub-elements to some of these programs, as well as special programs unique to each service.

4. ***Specialized Skill Training;*** prepares personnel for specific jobs in each service. Initial Specialized Skill Training includes most formal training that follows Recruit Training.The training is for specific jobs listed for: I) Military Occupational Specialty (MOS) for the Army[4] or Marine Corp,2) Navy Enlisted Classification (NEC), or 3) Air Force Specialty Code(AFSC). Following initial training, personnel usually are assigned field duties. Those showing particular aptitude may get Advanced Enlisted Technical/Skill training—usually after they have gained on-the-job experience in their specialty. The advanced training also may qualify trainees for a new occupation code. Personnel may go to several advanced courses during the military career,either for advanced technical areas or management or supervisory positions.

5. ***Flight Training:*** provides basic flight operation skills and knowledge for those seeking to be pilots (aviators} Naval Flight Officers (NFOs), and/or navigators. Often called Undergraduate Pilot Training (UPT), its graduates are awarded their wings and designations and assigned to specific aircraft training squadrons for qualification. For example, a newly designated Air Force pilot who is jet-qualified may be assigned to an F-15 training squadron prior to assignment to an F-15 operational squadron.

Table A-2—Department of Defense Requested Training Loads for Fiscal Years 1990 and 1991[a]

	FY 1990	FY 1991
Active military[b]		
Army	79,667	74,760
Navy	67,224	66,517
Marine Corps	21,656	22,235
Air Force	39,575	37,757
Subtotal	208,122	201,269
Guard and Reserve[c]		
Army National Guard	19,168	18,667
Army Reserve	15,377	15,963
Naval Reserve	3,237	3,259
Marine Corps Reserve	4,179	4,178
Air National Guard	2,941	2,939
Air Force Reserve	1,752	1,774
Subtotal	46,654	46,780
Total	254,776	248,049

[a]DoD defines "Training Load" as the average number of students and trainees participating in formal individual training and education courses during the fiscal year. For a full fiscal year, training loads are the equivalent to the total number of years of training taken by students/trainess.
[b]Each service's training load is the amount of training needed by members of that service. However, some training will be done by other services, in DoD schools, or by outside institutions. The figures above are consistent with the President's Budget for fiscal years 1990-91, submitted in January 1989.
[c]Includes formal school training provided by active military training establishments.

SOURCE: Department of Defense, *Military Manpower Training Report,* fiscal year 1990.

6. *Professional Development Education:* provides education and training to career personnel in preparation for complex duties. It encompasses a range of goals and subjects (e.g., military science, engineering, instructional technology, management, and medical areas). While most professional development is for the officer corps, some programs are for senior enlisted personnel. Some service school programs range from 22 weeks (Armed Forces Staff College) to 4244 weeks (Army, Navy, Marine Corps and Air Command and Staff Colleges).

Load and course data for initial and advanced skill training and pilot training are presented in table A-3. The number of ***initial*** entry-skill training courses shown is large; it also is relatively insensitive to reductions in personnel. DoD would still have to instruct in the entry level skills, but to fewer trainees. Personnel reductions (or increases) would have an impact on course load and thus costs.

In contrast, ***advanced skill training courses are*** given to fewer personnel. Much of the advanced training is in support of specific weapons systems (e.g., F-15 aircraft, M1A1 tank) or weapons platforms (for example, SSBN

[4]Army OSUT satisfies the concept of 'specialized skill training' because it combines the skill training with recruit training in a single program or course (an MOS may be awarded).

Table A-3-Skill, Flight, and Professional Development Training Loads[a] (fiscal year 1990)

Military branch	Initial skill courses (number)	Initial skill load (man-years)	Advanced skill load (man-years)	flight training load (man-years)	Professional development load (man-years)
Army	319				
Active		21,854	*9,503*	1,131	3,641
Reserve		5,855	*656*	114	79
Guard		7,032	*952*	246	86
Navy	172				
Active		23,269	12,563	2,084	2,376
Reserve		1,285	318		123
Marine Corps	342				
Active		5,899	2,276	583	966
Reserve		1,221	93		47
Air Force	*597*				
Active		*13,651*	5,563	2,788	3,632
Reserve		*980*	134	73	49
Guard		*1,446*	408	203	40
Total active		*64,673*	29,905	6,586	10,615
Total Reserve/Guard		*17,819*	2,561	636	424
Total DoD	*1.430*	*82.492*	32.466	7.222	11,039

[a]This table does not include advance individual/team technical training conducted bythe Services. It does include some prior-service trainees and some eross-traineesfrom other skill areas.

SOURCE: Departmentof Defense, *Military Manpower Training Report*, fiscal year 1990.

Ohio class ballistic missile submarine, DD-963 Spruance class destroyer). This advanced skill training includes the equipment associated with the various systems. As an example, some of the equipment on the new U.S.S. ***Arleigh Burke (DDG-51)*** destroyer that requires unique advanced technical training includes: harpoon missile system, Mk-41 Tomahawk launcher system for the Tomahawk antiship cruise missile, SQS-53C hull-mounted SONAR system, **SQQ-9** ASW system, 5"/54 gun system, Phalanx CIWS, and SQR-19 tactical towed-array SONAR system.

Any modification to weapons systems or other equipment will require additional training in operation and/or maintenance. This will in turn affect both the number of courses and student load. Because these might be conducted under contract as factory training or new equipment training (see discussion of providers, below), it is difficult to determine the actual number of these programs or their costs.

Training Delivery Costs

Table A-4 shows funding for ***individual*** military education and training for fiscal year 1990 by type of training. The estimates include military pay and allowances for both trainees and the military and civilian workforce used in the support of initial entry and skill training.

DoD has established the Interservice Training Review Organization (ITRO) to review its training programs. Part of the ITRO mission is to reduce training costs and the duplication of training programs and courses among the services; the mission of the services is central to the evaluation. This program is headed by the commanders of the major training commands.[5]

Training Providers

The DoD and the services use military and civil service personnel as well as civilian contractors to conduct their education and training programs at the military training bases. Each branch conducts its own recruit training program to meet its specific needs and mission. Each service also designs its flight training program to meet the needs of the mission and operational equipment. For example, Navy and Marine trainees designated for the fighter/attack jet training pipeline may be required to complete aircraft carrier take-off and landing qualifications. Some training is provided by other services in DoD Schools, or in some cases by institutions outside DoD. As an example, all explosive ordinance disposal (EOD) personnel are trained in Navy schools. There also is some interservice flight training (the Navy UPT program provides training to the Marine Corps and Coast Guard).

[5]These are: 1) Army Training and Doctrine Command, 2) Chief of Naval Education and Training, 3) Marine Corps Combat Development Command (Marine Air-Ground Education and Training Center), and 4) Air Training Command. ITRO is divided into committees and subcommittees addressing the many areas of military education and training. These include Initial Skill Training, Advanced Technical Training, Flight Training, Training Technology, Contract Training, Training Support, and other areas.

Table A-4-Funding of Individual Training by Service and Type[a] (millions of dollars)

Type	Army	Navy	Marines	Air Force	DoD
Recruit	$ 383.0	$ 531.1	$ 256.4	$ 185.1	$1,355.0
Officer acquisition	128.4	198.4	21.2	152.8	500.8
Special skills	1,532.2	1,784.7	584.9	802.2	4,704.0
Flight	334.6	1,208.7	45.8	902.7	2,501.8
Professional development education	191.8	203.4	53.9	216.7	665.8
Army OSUT	378.3				378.3
Medical	354.9	172.3		222.1	749.3
BOS/direct support	2,191.0	1,039.3	221.6	1,045.2	4,497.1
Management HQs	61.5	27.1	0.4	57.0	146.0
PCS	165.5	142.9	46.4	108.6	463.4
THY	852.8	39.7	17.7	409.4	1,319.6
Reserve/Guard pay	793.1	56.1	66.1	146.8	1,062.1
Total costs	$7,377.2	$5,403.7	$1,314.2	$4,248.6	$18,343.7

[a]Includes military pay and allowances for trainees and for military or civilian trainers andsupport staff, funding fortraining base operation and maintenance, seleeted overhead eosts, and other administrative costs.

ABBREVIATIONS: BOS=base operating support; HQs=headquarters; OSUT=one-station unit training; PCS=permanent change of station ; TDY=temporary duty.

SOURCE: Department of Defense, *Military Manpower Training Report,* fiscal year 1990.

Professional development programs for both officers and enlisted personnel are conducted at military and civilian institutions. Each service maintains Intermediate and Senior Service Schools and Colleges for their officers. In addition, DoD runs joint institutions to prepare military and civilian personnel for special assignments in program and project management, or for very high positions.[6]

Each service also has an office responsible for developing, procuring, and maintaining training systems. The Naval Training Systems Center (NTSC), in Orlando, Florida, for example, defines Navy training requirements, writes contracts, and manages delivery. Most of its development work is contracted out. A similar function is performed by the Army's Project Manager Training Devices (PM TRADE-located in the same building in Orlando). The Marine Corps and Air Force have liaison offices in Orlando. These groups try to coordinate efforts by sharing knowledge and avoiding duplication of efforts. They may work together to develop training systems, or provide them to other branches. For example, about 30 percent of NTSC's procurement budget comes through development and production of Army training devices.[7]

State and local educational agencies sometimes contribute to defense training efforts. For example, recruits at the Naval Training Center (NTC) in Orlando, Florida who need remedial reading or math before taking individual skills training are assigned to the Job Oriented Basic Skills (JOBS) Program, taught by instructors from the Orange County Public Schools System. (The JOBS curriculum was developed and written by Naval personnel.) Orange County does not charge the Navy for this service in recognition of the Navy's large contribution to Orlando's economy. This saved the Navy over $150,000 in instructor salaries between 1984 and 1989.[8]

Individual skills training is sometimes contracted out. A few years ago, for example, a Navy sponsored study concluded that it would be more cost-effective to contract out initial electrical/electronics skills training. A l-year contract (since renewed for 5 years) was awarded to San Diego Community Colleges to provide this service for the Orlando Naval Training Center. An onsite San Diego Dean (retired from the Navy) and an assistant oversee administration and hire instructors, many of whom are also Navy retirees in the Orlando area.[9]

DoD also uses civilian contract instructors for new operational systems coming into the military inventory. This is referred to as Factory Training or New Equipment

[6]Senior DoD and Service Colleges are the National Defense University (NDU—including the National War College and the Industrial College of the Armed Forces), Army War College, Navy War College, Air War College, Defense Intelligence College, Defense System Management College, and the Uniformed Services University of Health Sciences. Intermediate DoD and Service Schools include the Armed Forces Staff College (incorporated into the NDU in 1981), the Army Command and General Staff College, Air Command and Staff College, the College of Naval Command and Staff, the Marine Corps Command and Staff College (the Marine Corps University at Quantico, VA, consolidates Marine professional development programs under one command.) A separate system serves noncommissionedofficers.

[7]Naval Training Systems Center, "Poised for the Future," undated pamphlet.

[8]L.D. Wheatcraft, Naval Training Center, Orlando, Florida, personal communication to OTA, October 1989.

[9]Naval Training Center, Orlando,Florida, personal communication to OTA, October 1989.

Training. Inmost cases this contractor-conducted training is used only until the service is ready to take over the program. There are times, however, when the contractor will conduct the training for the life cycle of the equipment. Contract instructors are expected to follow military training standards.

Defense contractors who develop training programs are required to use the same development documentation and guidelines as the uniformed services. This is based on the "Interservice Procedures For Instructional Systems Development' or ISD. The Marine Corps uses the same system but calls it "System Approach to Training" or SAT ISD/SAT follow the same principles of instructional systems development discussed in chapter 7. This system was implemented service-wide in 1972 and continues to go through modifications.

Basic changes are occurring in the military's training procurement process. Historically, training packages for new military technologies were budgeted, contracted, and managed separately from the equipment itself, and often delivered later. In the case of the B1-B bomber, for example, Boeing delivered the first weapon system trainer 2 years after Rockwell delivered the last aircraft, and aircrews chalked up as many as 600 hours in the plane before getting access to the trainer.[10]

Now, the same program manager is more likely to handle both the military system and the training system, with the training an integral part of the program budget and provided by the military system prime contractor. For example, a Navy contract for a new program for initial jet training includes the T-45 training aircraft, the flight simulators, other training devices, instructors, logistics support, and the training sites. The theory is that the prime contractor will be better able to ensure concurrency with the training system. The change is affecting the military training industry by forcing contractors into joint ventures or requiring systems experts to suddenly also become training experts.[11]

Basic Skills Training

The more technical the requirements of the service mission, the more likely many high school graduates will need remedial training. Each service has programs to remedy educational deficiencies.

Recruits are given the Armed Services Vocational Aptitude Battery test for entry into initial skills training. Those who fail are assigned to remedial training in verbal and math skills (e.g., the Navy JOBS program, the Air Force JORP program, and the Army's JSEP program described inbox 6-E of ch. 6). The curriculum is designed to teach basic skills in the context of the recruit's assigned technical skill. Thus, remedial math instruction for the Navy's quartermaster (navigation) A School might teach the math skills needed to determine the distance, range, and bearing of another vessel based on its radar position.

Trainees who do not pass the remedial training may still go to the first level of initial skills training. If they again fail, they either are discharged or assigned low skill duties. Those in the latter group who perform their duties well and are motivated may be able to reenter initial skills training.

The various services have ongoing research programs to remedy deficiencies in basic education. The Navy Personnel Research and Development Center, the Naval Training Systems Center, the Office of Naval Research, and the Chief of Naval Education and Training have projects to address these problems. The services often contract with civilian organizations or universities to do much of the research and development. For example, the development of JSEP, which was initiated by the Army's continuing education system and monitored by the Army Research Institute, was undertaken by Florida State University and the Hazeltine Corp., now part of Ford Aerospace.

Both DoD and the services also have training programs for newly enlisted personnel in English as a Second Language. The DoD runs such a program at the Defense Language Institute at Lackland Air Force Base. Another program is conducted by the Puerto Rico Army National Guard. This remedial training, including English as a Second Language, is conducted prior to the newly enlisted going to basic training at Fort Jackson.

Training Technology

Current applications of instructional technology in military training are diverse and involve all of the technologies discussed in chapter 7. DoD also has numerous instructional technology research projects; only some of these will move into an operational status. Military training is an enormous enterprise with no centralized coordination. As a result, it is very difficult to provide a comprehensive description of DoD's use of instructional technology. Thus, this section will try to provide snapshots of the kind of activities being conducted.

Two military basic skills projects involve instructional technology: JSEP (see box 6-E in ch. 6) and the Spatial Data Management System (SDMS) project. SDMS was an attempt to demonstrate the use of interactive videodisc (IVD) through basic skills instruction in the context of map reading and navigation. This project was conducted by the Human Resources Research Organization for the

[10]Lawrence C. Grossman, "Prime Time," *Military Forum,* vol. 6, No. 3, November/December 1989.

[11]Ibid.

Army Research Institute in the early 1980s. It did not continue into an operational phase, although it served to demonstrate the potential of IVD for basic skills training.

For initial skills training, the basic model is still lecture/lab, but with numerous training aids in the classroom and laboratory. For example, classroom aids used in torpedo maintenance and repair training at NTC-Orlando include drawings and working cut-away models of torpedoes (full and partial scale), and all the component parts of torpedo propulsion, fueling, and targeting systems. Laboratories range from trouble-shooting benches for propulsion, fueling, and targeting (with actual torpedoes with inert warheads) to a full-scale submarine torpedo loading facility (with all currently used equipment and torpedoes). For firing exercises, a computer-managed system provides post-mission review.[12]

Quartermaster school at NTC-Orlando begins with classroom theory of navigation-learning to read charts, use nautical almanacs (e.g., tide and current tables, light lists), set courses, use dead reckoning, and plot positions. Trainees then move to a classroom with chart tables similar to those aboard ships with radar screens alongside. Videotape provides radar patterns corresponding to the navigation aids on charts plus the associated shorelines and possible other ship traffic.[13]

The Navy also has used teleconferencing for training. In 1989, for example, it initiated an "electronic schoolhouse" project at its fleet combat training center in Dan Neck, VA. The project links the training center with classrooms at navy bases in Norfolk, VA, Charleston, SC, and Mayport, FL, using two-way compressed video delivered via satellite. Each classroom has two cameras, large monitors, microphones, and an audio speaker, and accommodates 30-50 students. Ten courses were taught focusing on soft skills and basic concepts. The preliminary results showed a net savings of $50,000 (a total of 294 students, average 23 per session, a savings of $155,000 in travel and per diem over 5 months, and a cost of $105,000 for the teleconferencing). The students' grades were as good or better as when they traveled to the course, and they were able to train more students per session.

The Army logistics Management College also uses Satellite teleconferencing (one-way video, two-way audio) to teach logistics at over 30 sites. The televised courses have been taken by over 13,000 students.

Computer-based training and interactive video can be used in most military environment-n ships, for example. The Chief of Naval Education and Training (CNET) is monitoring some initiatives for reducing the costs of shore-based training, including mobile pierside trainers, onboard CBT packages, and teletraining. CNET has analyzed a number of existing onboard packages on computer literacy, ship maneuvering, and the Rules of the Road (part of navigation), as well as basic skills (functional and applied). It is examining physical characteristics of hardware and software (i.e., suitability of hardware for onboard spaces), and user characteristics. It found that some sailors were bored by and did not use many training packages. However, the packages did accustom people to computers. This is seen as a major need as more operational systems on ships become computerized.[14]

Military training technology increasingly involves simulators. Simulation is as old as organized warfare. The combat and technical training requirements of World War II, however, marked the beginning of what would become the contemporary simulation and training technology industry.

Simulators are crucial in military training because some tasks are too complex, costly, or dangerous to rehearse or to practice using real equipment. Simulators range from individual weapons simulators (see box A-l), to computer- or videodisc-based simulations of combat situations, to full-scale motion-based simulators, to networked versions of all of these.

The CNET analysis discussed above found that mobile pierside trainers are used more frequently than other CBT packages and contribute to computer literacy. An example is a computer-based simulator-the 20B5 pierside combat system team trainer-that the Navy uses for tactical gaming. It is housed in a trailer equipped with fiberoptic cables for radar and SONAR simulations and communications. The simulation capability arises from the computer programming and auxiliary equipment. For example, a digital general purpose radar indicator driven by the computer simulates combat radar signals. The Navy's current thrust is to introduce the tactical gaming packages dockside and to then move them onboard.[15]

Simulation, usually involving CBT and more recently, interactive videodisc, is also under development for maintenance. For example, in 1987, the Air Force Communications Command fielded 92 interactive video systems for electronics maintenance training on the AN/GRN radar and test equipment. The IVD system delivered on-the-job training for skills that had previously

[12]Naval Training Center, Orlando, Florida, personal communication to OTA, October 1989.

[13]Ibid.

[14]Naval Training Systems Center, personal communication to OTA, October 1989.

[15]Ibid.

Box A-l—The Marksmanship Expert Trainer

The Marksmanship Expert Trainer (MET) is a nonfiring M-16 automatic weapon (actual size and weight) that evaluates the trainee's aim and firing behavior. It simulates recoil and firing noise. When the trainee pulls the trigger, a light pen (instead of bullets) hits a target screen (either 72-inch projection screen or a computer monitor). A breath sensor tells whether the trainee is holding his breath, a trigger sensor determines squeeze/jerk, and an overall sensor evaluates stance. Initial targets are single and fixed; a computer management system shows where each shot went, how many hit the target, how far off the misses were, and the sensor results. More advanced targets pop on and off the screen at random; for each target the management system shows the path the trainee took to aim, how long it took to aim, and how many shots it took to hit the target. The expert systems reduce instructor requirements and sense things a live instructor cannot. The MET also does not require ammunition or a special target range area and thus is less expensive than training on real weapons. It is also safer than real bullets, has low maintenance, eliminates weather delays, and trains more quickly and more accurately.

SOURCE: Naval Training Systems Center, ***Marksmanship Expert Trainer,*** undated **pamphlet.**

been learned only through apprenticeship. The project involved a detailed followup on 160 trainees; however, no comparative evaluation of the IVD system versus apprenticeship only was conducted. The followup study indicated that the system was effective when used but difficult to integrate into the workplace.

Other examples of simulation using CBT or IVD training include:

The Computer Assisted Medical Interactive Video System (CAMIS), **Medical** Heath Sciences Education & T***raining Comman***d, Naval Medical Command: over ***25*** interactive videodisc courses in basic medical skills and medical knowledge areas have been fielded and many more are in development.

GUARD FIST II, Army **National Guard: a simulator employing IVD and computer-generated imagery will be used to provide tactical training in simulated battlefield scenarios. The simulator includes all equipment normally used by the Forward Observer MOS.**

Piloting and Navigation Team Trainers, U.S. Navy: a set of simulators are used to train naval officers on ship navigation and piloting skills. These simulators provide realistic presentations of shipboard equipment and use a variety of hydrographic databases.

OBT-89 ASW ***Trainer,*** **U.S. Navy: a simulator that** provides embedded training for the **AN/SQQ-89** sonar systems installed on surface ships for Anti-Submarine Warfare (ASW). The OBT-89 allows an instructor to program the AN/SQQ-89 for training exereises.

Networking also is increasingly important in military training (see box 7-J, ch. 7). Networking permits many groups to participate in the same training exercises. In addition to equipment, it requires databases for environmental simulation and expert systems for evaluation.

In most Navy ports, networks connect ships in the harbor to signal generators for training exercises. Some ports have master scenario generator/controller systems for battle simulation. Participants use personal computers (PCs) linked by a local area network (LAN) and telecommunications to other groups of participants at other PCs. The defense data network can be used for enhanced naval warfare gaming. An anti-submarine warfare tactical team trainer, with 300 students networked in one building, also is used. Networks involving 22 computers are used in Navy flight trainers to coordinate flight training domes. Simulation exercises can be global in reach: for example, scenarios generated by the Lamps helicopter weapon trainer system can be satellite broadcast to ships at sea and at foreign bases.[16]

As simulation databases have proliferated, the lack of standardization has complicated networking efforts. The B-52 training system, for example, has a database that cannot be used for the B-1 or the C-130. Integration can be a problem even within a single weapons system trainer if different contractors provide individual elements (e.g., the visual image generator and the radar simulator). The services are now working on a standard database that will be interoperable among all simulators, due to be completed in May 1991.[17]

Research on military training technology currently focuses on improved sensor (e.g., radar) simulation, low-cost graphics and image generation, embedded training, part-task training, and team training. In visual scene technology, the cost trade-offs are in the display and the image generator. Display costs for achieving the resolution required for certain training applications have come down significantly. For example, a passive sonar (LOFAR) trainer cost at least $35,000 when a minicomputer had to be used to achieve the high resolution, colors and shading needed for this application. The cost today

[16]Ibid.

[17]W.A. Demers, "All Together Now, " *Military Forum,* **vol. 6, No. 3, November/December 1989.**

can be as little as $5,000 when a 386 PC and video graphics array (VGA) monitor are used. Advances in high definition television (HDTV) will bring further cost reductions for high-resolution simulators. A second consideration is how much of an image a particular simulation actually needs. An F18 operational flight trainer for take-offs and landings uses three computer monitors; air combat maneuvers require a full dome, and battle simulators typically have a five-dome network. The alternative to the domes could be helmet-mounted displays and other features of virtual environments.[18]

Embedded training is attractive to the military for several reasons. First, complex military systems have proliferated to the point that conventional training simply is not adequate-there is too much to learn and remember, especially when duty assignments between training episodes frequently span a year or more. Second, most military training occurs at training centers while military systems are in the field; embedded training puts both in one place. Third, embedded training takes much less space than a classroom or even dedicated training equipment-an especially attractive feature on ships, or in facilities where space is limited. Fourth, embedded training is consistent with efforts to make training technology part of the prime system contractor's responsibility.[19] For all these reasons, current Army policy is that embedded training is to be considered the preferred training alternative for new systems.[20] Still, little is known yet about the design of effective embedded training (see ch. 7).

Performance support systems (PSS) are also getting DoD's attention. A PSS has been developed to help new Army Corps of Engineers employees figure out the complex details of the Army's military construction program. The PSS contains a database, which can be updated, covering each of the hundreds of projects underway throughout the world. An employee assigned to a project could use the PSS to get a list of project tasks, the steps needed to complete each task, and help in accomplishing it. For example, based on situations commonly arising in construction projects, the PSS might point out the need for a high priority letter, display model letters from the database, provide a word processor for editing a model, and print and send the approved letter. It also updates project status, suggests ways to level the workload to avoid crunches, and in other ways helps the employee stay on top of the job.[21]

Part-task trainers address the problem of how to train more people with fewer instructors for less cost. Using portable (often desktop) systems, they are aimed at teaching specific skills that combine in the performance of more complex tasks. Once the specific skills have been mastered in isolation, they can be combined effectively in complex and higher cost group or team simulations. NTSC is incorporating expert systems and interactive videodisc in part-task trainers.

Present military team training often is based on "practice devices" for individual skills used in a team situation. They have few embedded educational features, or evaluation and debriefing capabilities. The goal of current research is to produce effective teams that monitor their own performance, are self-correcting, get task and motivational reinforcement, adapt to unpredictability, and use closed-loop communications. Research on networking also will aid this effort.[22]

Technology Transfer

Because military training is a multibillion dollar enterprise that is increasingly technology-based, technology transfer to the civilian sector has become a major issue. Yet there are few visible examples beyond the use of flight simulators in commercial airlines and the National Aeronautics and Space Administration. Some trainers argue that military training is too specific to military missions (combat and weapons systems) to be applicable in the civilian sector (the so-called "green problem," which refers to the appearance of specific uniforms in training materials). A more basic problem is that the developers of military training technology are simply unaware of potential civilian applications, and potential civilian users are unaware of the military technology. For example, the developer of a military training R&D effort on bulldozer terrain imaging saw its obvious application to civilian earthmoving in construction projects, but failed to imagine its usefulness for open-pit and surface mining. Bridging this awareness gap is going to be extremely difficult.

A third problem is budget-related. If a research project does not have immediate military applications, it is not funded for development or demonstration. Technology transfer does not have a high priority in DoD's budget in general, and training technology is just one of many candidate technologies for transfer. Still transfer efforts are growing. For example, NTSC recently began adapting

[18]Naval Training Systems Center, personal communication to OTA, October 1989.

[19]Ibid.

[20]"Study Plan to Focus Embedded Training Research," *Training Systems and Devices,* vol. 1, No. 4, Fall 1989, p. 6.

[21]Harold Hunter, "The Knowledge Worker Performance Support System, " paper presented at Eighth Conference On Interactive Instruction Delivery, Feb. 21-23, 1990, Orlando, FL.

[22]Naval Training Systems Center, personal communication to OTA, October 1989.

educational software for public schools. It also is exploring medical applications for hand-held sonar trainers.[23]

Often, it is not the training technology per se that transfers, but its concept. Simulators are an example of a military training concept that is now finding a wide range of civilian applications. Thus, tank-driver simulators laid the groundwork for current truck- and auto-driver education units. It was the increasing capacity of PCs and their linkage to IVD that made simulator technology cost-effective for civilian applications that do not have so large a trainee population over which to spread the costs. Similarly, the nuclear submarine simulator led to simulators for nuclear powerplants and eventually for all types of powerplants. Exposure of the general population to motion-based simulators in amusement parks is likely to speed awareness of their potential for civilian training uses.

Yet in these examples, the connection between military and civilian uses was obvious. In most other Federal agencies that are successful at transferring training technology, either a connection is obvious (e.g., firefighting training conducted by several agencies), or the research is targeted directly toward transfer (e.g., the National Institutes of Health, the U.S. Bureau of Mines).

For training technology transfer to become more widespread, DoD would first have give it priority. This is especially important for R&D funding. Second, developers of military training materials would need to make an extra effort to identify potential civilian applications and civilian trainers would need to become more aware of military training systems. Third, both groups would have to hurdle the 'green problem' and realize that adaptation is cheaper than ground-up development.

Skills Transfer

Personnel trained by the military frequently are highly valued in the private sector, either for specific technical skills or for more basic interpersonal and self-discipline skills. The military apprenticeship model can lead to Bureau of Apprenticeship Training (BAT) certification as a journeyman. Even without certification, the military's own recognition of journeyman status is widely accepted by the civilian sector. Moreover, military trainees learn how to test, maintain, and repair the primary equipment ***and*** the testing, maintenance, and repair equipment.

Over the past several decades DoD and the Department of Labor have maintained separate compilations of occupational specialties in the workforce. There are cross data in the identification of these occupational skills that identify DoD officers, enlisted, Civil Service (General Service-GS, and Wage Board), and in the case of the Labor Department, civilian positions. Each occupational area is assigned an identification number based on careful analysis of the job to be performed. In most cases duties, tasks, and job functions are grouped together by service. These specific positions may not be identical, however, due to the equipment, mission, and personnel structure of the individual service.

In most service occupational fields, there are career paths for both officers and enlisted personnel. As an example, the Marine Corp Occupational Field 35, Motor Transport, includes the operations and maintenance functions within the tactical and commercial motor vehicle services. A Marine in this field will participate in a number of formal schools and can progress from Private (E-1) as, for example, a Body Repair Mechanic (MOS 3513), to a Motor Transport Operations Chief with the rank of Master Gunnery Sergeant (E-9). That Marine also may have the opportunity to participate in a formal apprenticeship program that leads to BAT certification.

This field requires skills and knowledge widely needed in the civilian economy. The MOSS include: 3500-Basic Motor Transport Marine, 3513-Body Repair Mechanic, 3521-Organizational Automotive Mechanic, 3522-Intermediate Automotive Mechanic, 3523-Vehicle Recovery Mechanic, 3524-Fuel and Electrical Systems Mechanic, 3525-Crash/Fire/Rescue Vehicle Mechanic, 3529-Motor Transport Maintenance Chief, 3531-Motor Vehicle Operator, 3533 -Tractor/Trailer Operator, 3534-Semitrailer Refueler Operator, 3537-Motor Transport Chief, and 3538-Licensing Examiner.

Other military occupations such as pilot, aircraft maintenance, air traffic controller, powerplant operator, firefighter, cook, medical assistant, or marine navigator also have direct civilian counterparts. While the equipment may not be identical, the skills are readily transferable with little or no additional training. Other skills training such as electrical/electronics provides valuable background for a wide range of civilian occupations.

Finally, some DoD professional development and education concepts may have application to the leadership and management of American industry. Likewise some Government training programs, such as Total Quality Management (TQM—now being used in the military as well), have proven useful in civilian industry.

[23] Ibid.