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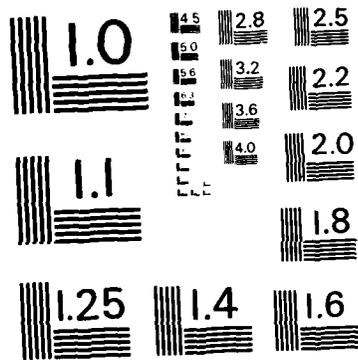
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*Computer Science  
Training in the  
Department of Defense:*

*The Silent Problem*

*Robert L. Hedges*

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**COMPUTER SCIENCE TRAINING IN THE  
DEPARTMENT OF DEFENSE:  
The Silent Problem**

by

**Colonel Robert L. Hedges, USAF  
Senior Research Fellow**

**National Security Essay Series 83-1**

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## FOREWORD

In recent years, as computers have rapidly become part of our everyday lives, the Department of Defense (DOD) has grown increasingly dependent upon this technology. Our latest National Security Essay explores one aspect of this phenomenon as it affects DOD's management of this vital resource—the computer science training and education of DOD officers and civilians.

The author, Colonel Robert L. Hedges, USAF, illuminates the problem of adequate and appropriate computer science training and education by describing current deficiencies, what is being done to correct them, and what more needs to be done. He proposes a new, overall approach to training and education based upon what he identifies as the six main components of computer systems: design, acquisition, implementation, programming, operations, and maintenance. ~~Flowing from this analysis, Colonel Hedges also suggests changes in acquisition procedures and new standards for programming, operations, and maintenance.~~ *are also suggested.*

These recommendations affect not only training and education programs, but have implications for officials responsible for planning DOD computer policy. In our own educational programs at the National Defense University, we are increasing the preparation of future DOD leaders to face the computer age. We are thus pleased to offer this essay as a stimulating addition to the commentary on an emerging national security issue.



**JOHN S. PUSTAY**  
Lieutenant General, USAF  
President, National Defense  
University

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## ABOUT THE AUTHOR

Colonel Robert L. Hedges, US Air Force, wrote this essay while assigned as a Senior Research Fellow in the Research Directorate, National Defense University. He received his bachelor's degree in mathematics from the University of Minnesota and his master's and doctor's degrees in computing sciences from Texas A&M University. Colonel Hedges is also a graduate of the Industrial College of the Armed Forces, NDU. He is currently assigned as the Commander and Program Manager of the Air Force Automated Systems Project Office at Gunter Air Force Station, Alabama.

Before joining the University, Colonel Hedges served as the Commander of the 3390th Technical Training Group (Computer Systems), Keesler Air Force Base, Mississippi. He has served in numerous staff positions including Headquarters, Strategic Air Command as Chief of the Missile and Space Systems Branch, Directorate of Communications-Electronics; and at Headquarters, United States Air Force as Chief of the Networks Management Branch, Directorate of Telecommunications, and Command and Control Resources, Assistant Chief of Staff for Communications and Computer Resources.

## PREFACE

The rapid growth in the use of computers, coupled with their increasingly complex applications, has caused serious concern about the efficient and effective management of this resource. Without doubt, the Federal government—especially the Department of Defense (DOD)—now finds itself in a dilemma. We can't operate without them, we can't go back to our old manual methods of operation, and we can't seem to apply new computer technologies successfully to our own satisfaction and that of Congress, the General Accounting Office, and other external critics.

In response to this growing concern, there have been many different studies conducted over the last 10 years, some by congressional direction, and others at the direction of the President and DOD. However, most of these studies seemed to focus on computer resource management difficulties in DOD. In undertaking this essay, I have tried to take an in-depth look at the way DOD trains and educates its people—officers and civilians—to manage these critical resources.

The findings are sobering: I conclude that DOD is not adequately preparing resource managers. But the situation is not hopeless; the training and education construct I recommend could provide the framework for developing and sustaining the necessary levels of technical and managerial expertise required.

Obviously, the decisionmakers and defense planners of DOD must have the necessary expertise at their disposal to manage computer resources as effectively as possible. Computers are now critical elements in the operation of modern defense systems. My proposal attempts to provide an

improved curriculum model which DOD could use to educate its people in essential computer science skills.

Robert L. Hedges

# 1. INTRODUCTION: WHAT'S THE PROBLEM?

One of the Department of Defense's newest areas of career growth—computer science or automated data processing (ADP)—is falling quickly from grace. Why? Is it an adolescent awkwardness that will pass? Or have tougher but well-intended computer system acquisition restrictions permanently crippled it? Are computer system failures responsible? Or are the practitioners themselves too narrowly focused, too concerned with black boxes and technical witchcraft, to restore order and momentum? Although computers have become a way of life in the Department of Defense, senior decisionmakers show less confidence in their computer science specialists than they do in other technical specialists. Maybe our training and education programs have not produced the "technicians" or "technocrats" who are really experts.

The central issue of this study will be to determine if the Department of Defense (DOD) is providing the caliber of training and education needed to design, acquire, implement, program, operate, maintain, and manage computer systems. This issue is addressed in reports by the General Accounting Office and the House Committee on Government Operations which constantly highlight the myriad problems associated with ADP management. These reports range from particular computer system deficiencies to general concerns of Congress over DOD's inability to manage these large and growing assets. A link between a perceived inability of the DOD to manage computer resources and the training and education provided to career computer science personnel will be developed in this study. Obviously, DOD must provide adequate training to personnel it assigns to such a technical field.

However, a review of the training and education currently provided within DOD suggests inadequacy. It is the aim of this study to reveal where that inadequacy lies and to suggest how to make the education more effective.

## **TRAINING AND EDUCATION ISSUES**

In addition to the reports already mentioned, two other recent studies show a relationship between training and education and the ability to manage computer resources. A study severely critical of ADP training is the Personnel Team Report of the President's Federal Data Processing Reorganization Project. The study (one of the 11 volumes of the final Presidential report) contains this statement of the problem:

Neither training nor career development programs are organized or administered to achieve the most effective development of personnel or utilization of data processing technology.<sup>1</sup>

Most agencies and departments can say they run both career development programs and training programs; however, the study suggests that no one is responsible for the general area of ADP. The study also found that training in the areas of management and technical skills is critical:

Most data processing managers are promoted from technically related computer jobs. When they are promoted, management training is not consistently provided to help them make the transition from technical to managerial functions. . . . There is a lack of comprehensive planning and training tends to focus on skill needs of present jobs without concern for future skills. . . . There is an urgent need for in-house capability and the expertise to prepare specifications and monitor ADP related contracts.<sup>2</sup>

The Report concludes (a) "while there are training resources and facilities available, they are insufficient in number and not properly utilized," (b) "there is no government-wide focus for data processing training . . . ," and (c) "historically, no pres-

sure had been placed on data processing management to develop its people resources." The study team recommended that a Federal Computer Training and Career Development Institute be established within an existing agency, such as the National Bureau of Standards or DOD.

The President's ADP Reorganization Project was never implemented. Instead, its reports were provided to the various governmental departments for whatever use they wished to make of them. Also as a result of the Presidential reorganization review, a second study, *Combat Effective Training Management Study*, was conducted in DOD. Even though this study centered upon combat training, some of its findings paralleled those of the ADP reorganization study. The study was critical of DOD training management, but one of the conclusions was organizational:

There is no organization within the DOD or the services which can perform all five of the classical functions of management for the training system as a whole. There is no single spokesman who can state the services' position on training management issues.<sup>3</sup>

Not only does the Department of Defense face ADP training deficiencies, but the management structure may not be able to solve these deficiencies. The DOD study points out that

There are many training operations problems which are not solvable within the individual services with their current management organization. They may be too complex for the services to solve, they may cross service lines and require the combined efforts of two or more services to solve, or they may be caused by external influences outside the ability of the service to control.<sup>4</sup>

The services have worked together on interservice initiatives. The Interservice Training Review Organization reviews service career specialties and consolidates training programs for cost effectiveness. However, this interservice organization does not have active Office of the Secretary of Defense participation through either membership or specific policy guidance.

Most consolidations are accomplished by one service assuming training responsibility for certain career specialties that are used by all services. Without the sponsorship provided by specific policy guidance, neither training efficiency nor cost effectiveness is achieved.

## TECHNOLOGY AND PERSONNEL

The problems identified in management and training become more important with DOD's increasing reliance on computers. Computer science has found its way into almost every functional area in DOD—logistics, maintenance, personnel, finance, intelligence, operations, communications, and research and development. Soon administration will join the others with systems to facilitate the bulk movement of correspondence, manuals, and numerous other records and documents. All users of computers within DOD are expressing a need for communications to move data and information from computer to computer or terminal to terminal through a host computer system, yet DOD's training and educating of ADP personnel in all the technical ramifications of the field is woefully inadequate. As the summary report of the President's Reorganization Project states:

The Federal government is, in general, mismanaging its information technology resources and has not developed a plan for exploiting the opportunities of the future with respect to investment, service delivery, protection of citizens, or national security. . . . This condition is manifested by such major symptoms as . . . military expertise which is operationally vulnerable as a consequence of obsolescent equipment and systems and underdeveloped technical personnel.<sup>5</sup>

Essentially, the military is heavily dependent on computers, and with the expansion of technology, this dependency will increase.

Applications across a wide spectrum of missions and functions will continue to expand as shown in a recent,

independent computer industry study of defense ADP.<sup>6</sup> Various technical, personnel, and economic forecasts were made for the next 10 years, and even though this study excluded classified, administrative, and small, expendable munitions ADP applications, some valid predictors are proposed. For example, the increased use of microcomputers will be an integral (or "embedded") part of every major weapon system with the number of embedded components rising from 10,000 in 1980 to 250,000 in 1990. The study then concluded that all new ADP applications, existing computer system replacements, and expansions will use microcomputer technology as basic hardware.

From 1980 to 1990, hardware and software costs will increase from \$4.1 billion to approximately \$38 billion. Of interest is that software (or programming) represents \$32.1 billion, or close to 85 percent of the estimated 1990 expenditure. The rapid increase in software costs is attributed to new programs and associated increased personnel required for program maintenance.

With the increased demand for computer science specialists, DOD can expect continued problems with both retention and recruitment—despite new and proposed pay raises. A 1980 *Business Week* special report cited the private sector as being short 50,000 programmers.<sup>7</sup> The same article predicted that the demand for programmers could reach 1.5 million by 1990—three times the existing number of programmers. A recent survey released by the US Department of Labor estimates that the demand for ADP specialists will increase 84 percent by 1990—119 percent and 102 percent for computer system analysts and programmers, respectively.<sup>8</sup>

With the expansion of computer science technology and the demand for more specialists, the issue of training and education becomes important in both quantitative and qualitative ways. Because DOD must maintain current computer systems while integrating new technologies into advanced systems, it faces serious problems in developing and adapting training

and education programs to meet these coming needs. How to solve these problems is the subject of this study.

Although the previously cited studies don't give one a comfortable feeling about the computer science field and training in general, none of the previous efforts specifically examined the content of the training and education that DOD provides. If DOD has difficulties in computer system design, acquisition, implementation, programing, operation, and maintenance, we must look at the training and education provided to these specialists. If these specialists have not been provided adequate or appropriate training and education to perform as the "experts" that many consider them to be or require them to be, serious consideration must be given to restructuring our education and training programs in this area. As documented by numerous studies, analyses, and reports over the last 10 years, the Department of Defense needs education and training programs for computer professionals which are

- comprehensive
- flexible
- future-oriented
- timely, and
- continuous.

The remainder of this study will examine officer and DOD civilian training and education programs. Chapter 2 reviews and analyzes current DOD computer science career programs. Chapter 3 reviews private sector training initiatives and those proposed in DOD programs. And chapter 4 provides conclusions and recommendations.

## 2. CURRENT TRAINING AND EDUCATION: WHERE IS THE DEPARTMENT OF DEFENSE NOW?

Civilian education and training programs are virtually non-existent in DOD, which is typical of the situation across the Federal government. For this reason, and because the Office of Personnel Management has just issued new standards for computer specialists which will be used in planning new education and training programs, our examination of current programs will concentrate on those provided for military officers, with only cursory attention paid to civilian programs.

After reviewing officer training and education programs within the Army, the Navy, the Marines, and the Air Force, it will be obvious that computer science differs within each of the four services. Once these differences have been recognized, the key question can be asked—do the various training and education programs meet the prescribed goals of the services? Once that question is answered, a second question must be asked—are these programs adequate?

Each service manages its own computer science resources—its equipment, people, and money. The Air Force has a separate directorate for data automation, while the other services have merged computers and communications into single directorates. Combine this different organizational approach with the fact that computer science has been divided basically into two pieces: one piece, covering general purpose computers (such as in personnel and logistics), the second being the application of computers in the embedded world. The embedded world can range from using general purpose

computers in specialized systems, such as command and control and intelligence, to making computers an integral part of a weapon system.

Let us now review computer science career specialties within each service along with their training and education programs followed by a brief look at civilian training to determine whether Defense's ADP training provides what is expected.

A comparison of the various programs will be made to aid in the analysis needed to answer the adequacy question. "Adequacy" is used in the sense of DOD computer science specialists being able to design, acquire, implement, operate, program, and maintain those computer assets that are being reviewed so critically by DOD decisionmakers as well as by Congress.

### **ARMY: COMPUTER SCIENCE AS A SECOND SPECIALTY**

Within the Army the ADSM (Automated Data Systems Management) Officer (specialty code 53) is the computer science expert. The ADSM specialty code is further broken down into SC53A, Applications Software Analysis and Design, and SC53B, Automated Information Systems Management. Two Army publications provide a link between what the specialists are expected to do and what their training and education should allow them to do. One publication, Army Regulation 611-101, *Commissioned Officer Specialty Classification System*, states

The ADSM [career field] encompasses positions involving the planning, organizing, directing, coordinating, controlling, and budgeting of automated data systems to serve the needs of functional users.

Applications Software Analysis and Design Special Qualifications: In-depth knowledge of systems software, application design techniques, information design technology, and automated data systems resource management as

evidenced by possession of a baccalaureate and/or graduate degree in computer science, automatic data processing, or a closely related academic discipline, and/or equivalent training and practical experience. Working knowledge of computer hardware, data communications and high level programming language (normally ANSI COBOL).<sup>1</sup>

The other, Army Pamphlet 600-3, *Officer Professional Development and Utilization*, cites the following:

Automated Information Systems Management Special Qualifications: Knowledge of computer hardware, systems software, application design techniques, data communications, and automated data systems resource management as evidenced by completion of the ADSM Course (USAADMINCEN) and/or equivalent training and practical experience.<sup>2</sup>

In order to review the training provided to ADSM officer specialists, we must see how the Army looks at computer science as a career specialty. The Army has a separate computer specialty code, but no provision for a fulltime career. Officers nominally enter the ADSM field 8 years into their career—when they have completed qualifications on their initial or accession specialty, such as armor or infantry. For example, a young officer on his or her way to a career in computer science might logically begin by attending a training program at Fort Benjamin Harrison, Indiana, the Army's Institute of Administration. However, because computer science is a nonaccession specialty—a specialty you can't begin your career in—no officers go through their entire career in ADSM. Furthermore, the dual specialization philosophy means that ADSM personnel will spend the rest of their career in and out of two specialties—50 percent in each as an optimum. This "in and out" philosophy means that the ADSM officer absolutely cannot keep up with a technical career field like computer science.

## Training and Education

Now that we have seen what the ADSM officer is supposed to do and know, let's see how the training and education process matches or links with the *do* and *know*. The program of instruction for the Automatic Data Processing Officer Course, August 1979, which is still current in 1982, is the source for the following review.

*The Course.* A 13-week, 520-hour, Automatic Data Processing Officer Course is the basis for entering officers into the ADSM career field. Of the 520 hours, 478 are for academic instruction.

The academic program is divided into the following areas and hours:

	<b>Subjects</b>	<b>Hours</b>
1.	Special Subjects: To provide the students with a basic orientation to the course and a general knowledge of selected special subjects.	12
2.	Software: To provide students with knowledge of the techniques of computer programming for electronic digital computers. Emphasis is placed on third generation ANS COBOL and the IBM Disk Operating System.	214
3.	Hardware: To provide the student with a general knowledge of the peripheral devices used with an IBM 3600 Computer System.	10

4.	Systems Analysis and Design: To provide the student with a working knowledge of the techniques of systems analysis and design used in the initial employment of an ADP system or in modifying an existing automatic system.	99
5.	Management: To provide the student with a working knowledge of the principles and procedures involved in acquisition, installation, maintenance, and management of automatic data processing systems and related equipment.	98
6.	Quantitative Analysis: To provide the student with a working knowledge of the various Quantitative Analysis (Operations Research) techniques available for solving complex problems and constructing working models.	45
	TOTAL	<u>478</u>

*The Link.* Are there links between what a specialist is to *do* and what a specialist is to *know*? Yes, and no. Yes, in that all major topics in the specialty description apparently are covered. No, if you're concerned about either computer system hardware components that include more than just peripheral devices or analysis and design that are more than software and forms.

#### **NAVY: COMPUTER SCIENCE ISN'T A "DRY" SPECIALTY**

Navy career progression is traditionally "wet," a term commonly used to describe the unrestricted line (URL) career path—the fighting or warfare specialty Navy. The "dry," or restricted line (RL), career path includes various support and

technical specialties. However, the "dry" Navy doesn't include computer science as a separate specialty. Instead, Navy officers can pick up computer science as an URL subspecialty through either job experience (much like an on-the-job training program) or through graduate education. Before they can work on a computer science subspecialty, officers must be fully qualified in their warfare specialty. But once officers gain that second skill, they can expect to spend every other assignment in their subspecialty—much as in the Army.

In the Navy's computer science subspecialty, which it calls computer technology on its subspecialty fact sheet, are two specialty codes—XX91 for computer science and XX95 for computer systems technology. The first two positions in the specialty code designator are reserved for warfare specialty identification. Both computer specialty codes (91 and 95) are to "provide the Navy with *technical and managerial expertise essential to the successful design, implementation and effective utilization of computer based systems* in military operations"<sup>3</sup> (italics added).

### **Training and Education**

The Navy sponsors two advanced degree programs for the computer science subspecialty. One through completion of the Naval Postgraduate School at Monterey, California, and the other by completing a management, business, or engineering master's degree program at a civilian university. In order to qualify for a subspecialty from a civilian university, the following courses must be included in the degree program:

1. Computer high order languages; e.g., COBOL, FORTRAN.
2. Computer systems design and characteristics; e.g., scientific, business, or general purpose installations.
3. Data bases and data base management.
4. Problem-solving techniques using computers.
5. Financial management and techniques.
6. Cost/benefit analysis.

The postgraduate program at Monterey provides two computer technology curricula: Computer Systems (Curricula 367 for specialty code 95) and Computer Science (Curricula 368 for specialty code 91). The Naval Postgraduate School catalog lists them thus:

*Computer Systems*

Graduate core courses:

- Probability and statistics
- Operation research
- Financial management
- Economics
- Economic evaluation of computer systems
- Computer devices and systems
- Software development
- Operating systems
- Systems analysis and design
- Computer management
- Organization and management

Optional area of study (or approved alternate):

- Computer center and network operation (3 courses)
- Tactical systems (3 courses)
- Information and teleprocessing systems and networks (3 courses)

Thesis or project required (8 quarter hours)

*Computer Science*

Graduate core courses:

- Applied probability and statistics
- Discrete mathematics
- Automata, formula languages and computability
- Structural programming languages
- Data structures
- Compiler design
- Operating systems
- Computer architecture
- Artificial intelligence
- Operations research
- Numerical analysis
- System design and analysis
- Management and electronic electives

One of the following option areas must be selected:

Tactical computer systems (6 courses)

Computer software (5 courses)

Military data processing (4 courses)

Thesis or project required (16 quarter hours)<sup>4</sup>

*The Link.* Both curricula are comprehensive, with the Computer System program concentrating more in the software (programming) and management areas. Conversely, the Computer Science program concentrates on integrating both software and hardware into computer systems. The training and education provided at Monterey is very sound. Based on the Navy's utilization after program completion, the training could be considered overkill—part-time use of the extensive training isn't providing an adequate return on the investment.

## **MARINE CORPS: COMPUTER SCIENCE AS A SPECIALTY**

Unlike the Navy, the Marine Corps has a career path (unrestricted) for officer computer science specialists. In fact, the Marines have three separate specialty codes: 4002 (Data Systems Officer), 4006 (Data Systems Operations Officer), and 4010 (Data Systems Software Officer). The latter two specialties are for Limited Duty Officer and Warrant Officer authorization. Since the Data Systems Officer (4002) encompasses the entire field of computer science, we will review it in this section. The other two specialties (4006 and 4010) relate to day-to-day data processing center operations and programming.

As described in the Marine Corps' *Military Occupational Specialties Manual*, the Data Systems Officer (4002)

manages the activities of a data systems activity which encompasses systems for recording, collecting, controlling, verifying, interpreting, and presenting data used in planning and directing automated Marine Corps data systems. . . . Assists the commander in determining

policy for installing and operating automatic data processing systems. . . . Coordinates and consults with manufacturers' representatives and governmental agencies on design and development of data processing systems. Establishes criteria for training personnel in data processing procedures, programming techniques, equipment setup and operations, and system analysis and design.<sup>5</sup>

In contrast to the other services, Marine Corps officers completing an advanced degree earn a different specialty code. The first two digits of the code specify the special education program and the last two the primary area of specialization—in this case computer science. Both the Data Systems Specialist (specialty code 9646) and the Management, Data Systems Officer (specialty code 9648) come under the special education program. Specialty descriptions and duties and tasks are minor expansions of the Data Systems Officer.

### **Training and Education**

Like the Army's, the Marine Corps initial training program for the Data Systems Officer runs 13 weeks. The Marine Corps program is 461 hours long with 368 academic subject hours.

*The Course.* The Data Systems Staff Officer Course consists of the following basic program:

	<b>Subjects</b>	<b>Hours</b>
1.	Computer System Fundamentals	21.5
2.	Job Control Language	30
3.	Operating System Utilities	56
4.	COBOL Programming Language	94
5.	MARK IV (data and file management)	26
6.	Systems Analysis and Design	40
7.	The Data Processing Organization	73.5
8.	Self-Paced Electives:	25
	a. Assembly language coding	

	b. COBOL (extension)	
	c. Data control techniques (extension of job control language)	
	d. FORTRAN	
9.	Administrative	93
	TOTAL	<u>461<sup>6</sup></u>

*The Link.* As in the Army training program, the Marine Corps program provides a link between the *do* and *know*. Like the Army though, over two-thirds of the Marine Corps training program concentrates on the software or programing aspects of computer science. Additionally, the Marine Corps program has no training in the hardware area.

The Army and Marine Corps have certain similarities, but the Air Force takes an approach which differs in both the use of their computer science specialists and in the number of different specializations within the career field.

#### **AIR FORCE: COMPUTER SCIENCE SPECIALTY PROLIFERATION**

The Air Force is certainly not last when it comes to the number of different computer science specialty codes available. Six different specialty codes evolve from two entry-level training courses in computer operations and programing. One of the six specialty codes has five separate specialties—or subspecialties—indicated by suffixes.

The following specialty codes currently comprise the computer science career field in the Air Force:

*Computer System Program Director (0960)*—Serves as the ADP Program Single Manager of a major computer activity or as a senior executive within that activity as designated by the ADP Program Single Manager.

*Computer Systems, Plans and Program Officer* (5164)—Develops long- and short-range planning documentation for computer resources, formulates programs for acquisition of manpower and funds, develops and interprets policy, and provides general staff support for activities concerned with computer systems development and operations.

*Computer Systems Manager* (5176)—Implements ADP projects and programs and projects including direction of activities concerned with computer systems analysis; software design, development, testing, maintenance, and documentation; operation of large-scale computer facilities; modification and design of computer hardware. This specialty will be used for supervisory positions in computer operations or computer software development.

*Computer Systems Staff Officer* (5116)—Manages computer systems programs, including development of policy, planning, program formulation, funding, acquisition of ADP resources, and general staff support for activities concerned with management of the overall ADP program. This specialty will not be used for those positions that involve the direct supervision of computer operations and computer software development.<sup>7</sup>

When it comes to training and education, the Air Force is the first service to provide entry-level and intermediate career programs. The entry-level program includes the 5135 (two separate programs—one, 5135, for those with academic background in computer science and the other, 5131, for those without) and the 5155 specialties. The Air Force Regulation 36-1(C8), *Officer Classification Regulation* describes these as follows:

*Computer Systems Development Officer* (5135)—Performs computer software development functions; develops and implements systems and procedures to ensure maximum exploitation of computer software toward organizational needs; plans, designs, develops, maintains, and administers computer data bases for functional computer users; designs and prepares access mechanisms and security packages and procedures to

ensure data base integrity; analyzes requirements for and assigns, develops, programs, documents, tests, implements, modifies, and maintains computer software.

Suffixes:

- A. Basic Software (nonfunctional)
- B. Applications Software (functional)
- C. Data Base Administration
- D. Computer Mathematics, Techniques
- E. Computer Performance Evaluations

*Computer Operations Officer (5155)*—Responsible for the operation of computer systems in direct support of tenant units, base and headquarters management functions, and mission-related information processing requirements.

### Training and Education

I will first review the 5131 and 5135 (Computer Systems Development Officer) courses—which are similar in both length and content to the Army and Marine Corps courses—and then the 5155 (Computer Operations Officer) and the 5116 (Computer Systems Staff Officer) courses.

*The Courses.* The 13-week basic entry Computer System Development Officer course (5131B) is designed for those individuals having little or no academic background in computer science. Academically, the program is divided into the following major blocks:

<b>Subjects</b>	<b>Hours</b>
Principles of Computer Systems	40
Problem-Solving and Structured Programing	40
High Order Language (COBOL)	80
Applied Systems Analysis and Design	64
Software Design and Program Maintenance	72
Representative Assembly Language Programing	56
Data Base Systems Design	48
Project Management and Design	40
System Implementation and Maintenance	68
Administrative	12
	<hr/>
TOTAL	520 <sup>8</sup>

The program for individuals with an academic background in computer science (5135) runs about 5 weeks, and includes the following:

<b>Subjects</b>	<b>Hours</b>
Computer Systems Concepts	30
Analysis and Techniques	47
Computer System Design Concepts and Techniques	48
Functional Requirement/System Design	77
Administrative	11
	TOTAL 213 <sup>9</sup>

A graduate of either the 5131 or 5135 course enters the computer science career field with a specialty code B suffix meaning: Application Software subspecialist—in other words, a programmer. The short-course graduate is considered a fully qualified programmer because of either previous academic education or programming or systems analyst experience. In contrast, the long-course graduate is considered an entry level programmer and not fully qualified until completing 18 months of field experience. Other subspecialties or suffixes (A, C, D, and E) are picked up by working in jobs that require these specializations without any previous training. Unfortunately, a brand new unqualified B suffix trained person could be sent into one of these positions.

Computer Operations Officer (5155) entry-level training is provided in a 6-week course (33 academic days). Subject areas and contact hours are as follows:

<b>Subjects</b>	<b>Hours</b>
Introduction to Computer and Data Processing	54.5
Computer Systems	61
Management Responsibilities	60
Management Systems	73.5
Administrative	15
	TOTAL 264 <sup>10</sup>

Even though the other services may assign an officer into a Data Processing Center job, the Air Force is the only service to provide a separate specialty for Data Processing Center management and supervision. Furthermore, the Air Force is also the only service to provide an intermediate-level computer science career course.

Attendance at the Computer Systems Staff Officer (5116) course—intermediate-level training—is normally reserved for captains through lieutenant colonels who have worked in one of the career specialties (5135, 5155, 5164, or 5176). Course content includes three major topics and requires 5 weeks (26 days) of training time.

<b>Subjects</b>	<b>Hours</b>
Computer Systems Functions and Hierarchy	67
Computer Systems Development and Acquisition	74
Computer Systems Case Study	67
<b>TOTAL</b>	<b>208<sup>11</sup></b>

The Air Force considered adding senior- (executive-) level training to its collection of courses, but this consideration has temporarily been abandoned pending a thorough review of current training and education programs.

*The Link.* Linkage between the *know* and *do* also exists in the Air Force programs. The Air Force is the only service to provide multidisciplines within computer science.

The need to provide separate computer operations training appears to be questionable, especially since both operator and programing experience eventually lead to common intermediate-level specialty codes. Conversely, the other services are training primarily in operations and programing management, rather than in operator or programing skills. The Air Force should consider deleting the operations special code and adding the operations training to their programing (5131 and 5135) courses.

## **CIVILIAN TRAINING: A EULOGY TO THE COMPUTER SCIENCE SPECIALIST**

The President's Federal Data Processing Reorganization Project was especially critical of the management and training programs designed for civilian personnel in the Federal Government. Even though the study recommendations were not mandated for implementation, several changes have been made to minimize deficiencies in the civilian computer science career field. For example, the US Office of Personnel Management (OPM) has updated classification standards in the computer specialist series.<sup>12</sup> In the same release, OPM also eliminated one career field designation (the digital computer systems administrative series) and replaced it with the updated classification. Changes are also evident in DOD.

Within DOD, a new directive has been issued on career management for computer science specialists. Two of the objectives of the new directive are to

- meet current and future DOD-wide need for ADP personnel and to provide capable replacements for key ADP positions on a planned, systematic basis and
- support the ADP training budget planning process.<sup>13</sup>

The first objective is to meet the quantitative problem of competing for a resource that is in high demand. The second objective is to meet the qualitative problem of training and educating these specialists in all aspects of computer science.

To meet the training and education needs of civilian computer science specialists, the new DOD directive provides a master training plan and a list of existing training courses where the training plan requirements can be met. The training plan provides a list of 28 subject areas that is similar to the academic content of the training programs provided by the services. In addition, the training plan is divided into the civilian

subspecialties of computer science (programmer, systems analyst, equipment analyst, and computer specialist) and the degree of training needed in each of the 28 subject areas. Furthermore, the training required for entry- (GS 5-GS 8), intermediate- (GS 9-GS 12), and senior- (GS 13-GS 15) level personnel is annotated at either the introductory or comprehensive training levels.

The introductory and comprehensive training is to come from courses listed in the new DOD manual. These courses are tied to the 28 subject areas and provide a listing of where the training can be received. Of interest to this study is the fact that no service entry-level training program is recommended. Only the Air Force intermediate-level course is included under the subject area for ADP Rules, Regulation and Budgeting. Therefore, there is little attempt to use the existing service programs to meet the DOD civilian training requirements.

Without full use of the existing service training programs, the civilian program continues to operate under a "short-course syndrome." Furthermore, since attendance is not mandatory the funding for these courses can be expected to be a low-priority item.

An extract from a 1977 Marine Corps memorandum (CCIR 1540) to the Assistant Secretary of the Navy for Financial Management aptly summarizes the funding and training problems still facing the services:

Civilian personnel ADP career development is the responsibility of each ADP activity. . . . Civilian training is limited primarily by the unavailability of training funds and extra costs associated with . . . civilian assignments to schools.

## **THE TRAINING PROBLEM**

A definite problem appears after reviewing the various computer science codes and the training and education

provided to develop these specialists. The problem is that the training and education programs are designed to develop programming specialists. If specialists must be competent in all areas of computer science then adequate training in design, acquisition, implementation, operation, and maintenance must be added to programming. Computer science must be considered in terms of six areas of expertise.

Programming is only one of these six areas of computer science. Is the programming training and education that the services provide part of the problem? Yes! It is the most important part of the problem if computer science specialists are to be considered and used as experts in all six areas.

Before digging into the comparison and analysis of the specific service training programs, a basic definition of "computer system" is provided. If a computer system were to be nothing more than the *integration* of the correct *hardware* devices and the correct *software* to meet the function or functions to be performed, we could divide computer science into three instead of six pieces: integration, hardware, and software.

If we look at the software or programming part, it is subdivided into two major subsets: first, those programs necessary to make all the hardware devices work together—*system programs*; and second, those programs needed to solve specific problems—*application programs*. Hardware devices comprise the physical components of computer systems—central processing units, channels, input/output control units, and its peripherals or terminals. Selection of the correct and integratable hardware and software completes the computer system. With this in mind, the comparison and analysis of the respective training and education programs can be better understood.

Table 2-1 summarizes the service programs by major topics and hours of coverage. Like topics have been grouped under more generalized headings. For the Air Force, the programmer specialty code—5135—has been used for compari-

son. The Navy has been excluded since its program is at the graduate level and we are comparing entry-level programs.

**TABLE 2-1**  
**Summary of Service**  
**Computer Science Training Programs by Topic and Hours**

Topic	Hours		
	Army	Marine Corps	Air Force
Orientation	12	21.5	40
System Support and High Order Language (COBOL)	214	180	240
Low Order Language (Assembly)	0	0	56
Data Base Systems	0	28	48
Hardware Devices (peripheral)	10		0
Systems Analysis and Design	144	40	136
Data Processing Organization	98	78.5	0
Electives	0	15	0
Administrative	42	93	12
TOTAL	520	461	520

NOTE: Administrative time includes such items processing and testing. The times vary by service since some of these times are included within the topic hours.

**SOURCES:**

Army: Automatic Data Processing Officer Course, August 1979.

Marine Corps: Program of Instruction, IBM System 360(OS) Data Systems Officer Course, US Marine Corps Education Center, US Marine Corps Development and Education Command, Quantico, Virginia, FY 1978.

Air Force: Plan of Instruction (Technical Training), *Computer System Development Officer*, Keesler Technical Training Center, 14 June 1980.

With the exception of minimal hardware coverage by the Army, and low order language coverage by the Air Force, all three courses are programming oriented. Not only that, they are high order language (COBOL) oriented at a basic, or

beginner's, level. Because of this, the Department of Defense isn't training with the goal of putting out qualified programmers. Generally, only entry-level programmers (or coders) are being trained. This means that each service must provide extensive on-the-job training and experience at receiving posts, bases, or camps to bring these slightly trained officers up to a qualified level. The Air Force, for example, gives their officers an entry-level specialty code after training and does not consider them fully qualified until they obtain 18 months of field experience.

Obviously, the services are only training and educating their personnel on part of the software or programming piece of the integration, hardware, and software pie, which is really only part of the six-piece computer system. And even though design, acquisition, implementation, programming, operations, and maintenance are covered in every course, the coverage is strictly from a programming point of view—from basic program design through program maintenance. Furthermore, the very process of identifying education and training requirements within existing procedures and fiscal constraints argues against expecting any substantive improvement in the breadth and depth of education and training for ADP professionals in DOD. Current procedures emphasize training for specific systems or well-documented requirements and are vulnerable to travel funding cuts and lack of time, space, and instructors at existing facilities. There is no support for broad based, future-oriented education programs within the bureaucracy.

### **Summary**

The DOD is in reality training and educating computer science specialists as programmers at the novice or entry level. Utilization of these officer specialists can range from heavy programming responsibilities (as in the Air Force) to more generalized management responsibilities assumed in the other services. These restrictive programs should keep us from assuming that we're surrounded by technical experts in a complex field. If our training and education programs are

inadequate, how have we gotten to where we are today in the world of computers? The Department of Defense, and certainly the entire Federal government is inundated with computers. As both technology and computer system uses and techniques expanded, the training and education programs stagnated: in fact, many of the programs were reduced in length to save money. Two problems continue to plague the computer science field: neither training nor the specialists have kept pace with the technology evolution.

Keeping pace with the technology evolution is a key point when coupled with austere training budgets. Generally mature applications of computer systems (like personnel and finance) are relatively stable when compared to the changing requirements for complex command and control systems. The inability of the Department of Defense to meet the complexity challenge can be seen in computer system acquisitions that haven't survived because of cost and time overruns. Problems can't always be placed at the doorstep of changing requirements, lengthy approval times for acquisition, and so on.

A more basic and fundamental problem is building a construct for a training and education program that will provide the type of individuals that can meet the complexity challenge. I will cover this construct in detail in chapter 4, but, before that, a brief review of what the private sector is doing in training and education is warranted. Along with this review I will summarize current and future Department of Defense initiatives in computer training programs.

### 3. **TRAINING AND EDUCATION INITIATIVES: WHAT'S BEING DONE?**

A quantitative problem accompanies the increasing demand for computer science specialists. Moreover, the need to keep up—or catch up—with a fluid technology creates a qualitative problem. Neither problem will go away if left alone. They can be ignored or responded to in a fix-when-confronted or the-pain-is-unbearable fashion.

An example of what's being done in both the private and public (Department of Defense) sectors to solve both the quantitative and qualitative problems confronting computer science training and education will show that both sectors need to do more.

#### **PRIVATE SECTOR INITIATIVES**

The private sector can continue to solve the quantitative problem—the shortage of computer science specialists—by attracting public sector and industry employees, and new academic graduates. This attraction results from the potential for increased salaries as well as from the desire to get away from old equipment and processes. But hiring from someone else doesn't solve the overall quantitative problem because there are not enough computer science specialists to go around. How does training and education enter this problem solving process in the private sector?

Computer science professional papers, journals, and magazines are citing more and more examples of companies

and corporations looking inward to solve their quantitative problems. Certainly from the DOD point of view, initiatives such as in-house training programs are increasing—not only programs to train inexperienced personnel, but funded programs to enhance the potential of the already employed computer science specialists.

To this end, in-house training programs can be conducted by using either existing computer science specialists as instructors or contracting out the training to one of the many computer vendors. Increased training means increased investments that must be included in the budget.<sup>1</sup> The level of investment, therefore, reflects the level of interest senior management places in solving the quantitative problem. One might ask whether anyone is interested enough to solve the quantitative and qualitative problems by starting his own schoolhouse. Wang Laboratories, Inc.—one of the fastest growing minicomputer companies—has done just that by creating its own Institute of Graduate Studies which opened in September 1981.<sup>2</sup>

Why would a computer vendor take on such a large investment venture? The answer is *need*—the need to fill the void in the practical world of application of computers vice the theoretical emphasis stressed at traditional academic institutes. According to Dean Ugo O. Gagliardi, "Traditional university programs ignore the issue of how you get large bodies of people organized to develop software products. . . . We will pay faculty industry-competitive salaries. People you want to hire to teach state-of-the-art techniques are already working in industry."<sup>3</sup> The Wang program, geared to develop software engineers, will concentrate on system software (operating system programs) before expanding into the application program design area. The institute will offer both part-time (two half-days per week for two years) and full-time (12 months) graduate programs, and will seek academic accreditation. Since enrollment is open, the program should grow rapidly. Other computer vendors and computer-bound companies could take advantage of this program over other in-house initiatives. However, programs like this only help qualitatively for

those personnel having an undergraduate degree—it won't help if your objective is to train or cross-train into the computer science field at the entry level. This paradox brings up an interesting question: What about our traditional universities and colleges filling in the quantitative void and the need for qualitative improvements?

Many universities and colleges suffer the effects of the quantitative problem because they too are losing qualified faculty to the private sector—better paying jobs, better equipment and facilities with which to conduct research, and increased advancement opportunities. Sound familiar? According to an article in the November 1980 *Datamation*, the demand for computer science Ph.D. graduates is eight times more than the approximately 200 now receiving degrees.<sup>4</sup> This demand has produced a ripple effect. Not only are our universities and colleges not producing enough computer science Ph.D.s, but the loss of faculty to industry further impedes Ph.D. production. This exodus also restricts the number of master and undergraduate computer science degree graduates. An article in *Data Management* estimates that the universities and colleges are providing only one-sixth the number of undergraduate qualified computer science specialists needed.<sup>5</sup>

The two articles point out the reality of the quantitative problem. The demand for computer science specialists will increase in an environment of decreasing ability to meet that demand from the academic world. But what about the qualitative problem—the ability to prepare new computer science specialists?

The academic world has joined professional organizations in an attempt to improve the qualifications of computer science specialists as they enter the field.<sup>6</sup> This training and education collaboration, now several years old, has inspired model curriculum projects like the one developed by the Data Processing Management Association. The goal of this project is to develop a nationally recognized and accepted model curriculum for undergraduate Computer Information Systems

education for the 1980s, and is based on the following core areas:

- Introduction to Computer-Based Systems
- Applications Program Development I & II
- Structured Systems Analysis
- Data Base Program Development
- Applied Software Project Development<sup>7</sup>

If the private sector appears not able to completely solve the quantitative and qualitative problems, how can the public sector—specifically DOD—expect to? As most managers will agree, the first step in solving a problem—or in this case two problems—is to recognize that a problem exists. Having established the existence of the problem, let us now see what initiatives are being taken by DOD.

### **DEPARTMENT OF DEFENSE INITIATIVES**

A *Datamation* article stated that initiatives are certainly needed: "A governmental task force looking into the issue of computer personnel shortage claims that this shortage may actually impede technological advance in this country. It is predicted that by 1985 over half of the total US work force will use computing technology daily—and that we face an imminent defense crisis because we will be unable to attract scarce computer science resources to defense problems."<sup>8</sup> Again, the quantitative problem exists.

The easiest way to solve any shortage of computer science specialists in DOD might appear to be to increase the training quotas to the service schools. Let's make two assumptions: first, DOD will need more computer specialists in the future; second, the retention of these specialists will not improve because of private sector demands.

Turning the crank faster on service schools may not be as simple as it sound. Increased training loads will reach a certain maximum based on physical limitations. Classroom

space, equipment availability, and housing are but a few of the constraints. Even going to three shifts per day may not handle excessive student loads. A more important factor will be finding qualified instructors which was a problem when the Army recently increased the number of its Signal Corps (communications) specialty codes. And, if we produce more computer specialists using inadequate training programs, we give a false sense of security to senior managers without really addressing the underlying qualitative issues.

### **Army Computer Science Changes**

The new specialty code (25B) is for the Teleprocessing Operations Officer—a merger of communications and computer science.<sup>9</sup> A new training program that consists of two computer science phases has been implemented. The first phase, conducted during initial training, includes four 2-week blocks: the first, an overview of the new specialty, an introduction to the programming language known as "Ada," and an introduction to applied tactical data systems; the second, data base management systems; the third, computer networks and distributed processing; and the fourth, computer performance and measurement. The last three blocks of the new program are at the graduate school level, and that is where the qualitative problem occurred. Because the Army didn't have the qualified instructors, they had to contract out the last three blocks to an academic institution.

The second phase of the program is conducted by the Electrical Engineering Department of the Air Force Institute of Technology (AFIT) at Wright-Patterson Air Force Base, Ohio. The Teleprocessing Operations Officer enters this phase after he has had field experience. The student attends AFIT for two quarters—approximately 6 months—and takes seven courses: Digital Computer Design, Operating Systems and File Structures, Software Systems Acquisition, Computer Data Base Systems, Mini/Micro Computer Laboratory, Computer Systems Architecture, and Software Engineering. After the Army builds a base of qualified personnel to draw upon, it will

eventually provide its own computer science specialists to AFIT as faculty members.

The merger of the computer and communications disciplines at the Department of the Army level has caused qualitative improvements in the communications side, but what about the Automated Data Systems Management (ADSM) specialist on the computer side? Even though internal Army studies recommended that the ADSM specialty code be an accession (full-time career) rather than a nonaccession specialty, nothing has been done.<sup>10</sup> The Army should give serious consideration to making the ADSM a career accession specialty and merging that training with the new Teleprocessing Operation specialty which puts the automator and communications training together. The Army also recommends the program for civilians—a giant step forward unless a temporary duty funding problem should slow this advance.

### **Air Force Qualitative Review**

The Air Force has recently completed a review of the training and education programs supporting their computer science career specialists. Even though major changes were proposed, the Air Force made no changes because the computer science community in general has had to accept staying within current course lengths and instructor authorizations. Any immediate changes must be made within the existing training support capabilities. Neither training instructor authorizations nor course lengths can be changed without going through an occupational measurement survey of the computer science community. The data gathering portion of this survey has just been completed with 2,867 forms out of a possible 2,900 returned. However, nearly a year will pass before the data are fully analyzed.

What will such a survey show that the computer science community doesn't already know? The survey will definitely help if the respondents call for more and better training and specify in which areas. And if the survey indicates that the majority feel satisfied, then necessary changes will be more

difficult to make, especially since major course revisions are needed immediately. Even if the data clearly support the need for a comprehensive and continuous education program, the sheer scope (in terms of resources) of such a project would almost certainly insure its demise in the budgeting process.

Short-term changes are being made to the various courses reviewed in chapter 2, adding more emphasis to the design, development, implementation, and maintenance of application programs (5131B course). The staff level course 5111, for instance, adds project management to the main topics of acquisition and planning and programming, but the operations course 5151 continues with only minor upgrades. Emphasis falls on major command computer science specialists to continue local job training to include such items as attending short courses and contract training. But there are very few other service initiatives on the horizon.

#### **Other Service Initiatives**

With the exception of those made by the Army and the Air Force, no major qualitative initiatives appear on the horizon. The Marine Corps will modify its existing program when it fields equipment, and the Navy sails on—wet that is. As Army Colonel William L. Sanders commented, "There are three ways to make a career in the Navy: under the water, on the water, and in the air. I really wonder about an officer who wanted to make a career in computers."<sup>11</sup>

#### **SUMMARY**

We generally recognize that quantitative and qualitative problems exist in the computer science field. However, initiatives and innovations to cope with these needs differ between the private and public sectors.

Programs similar to the Wang, Inc. initiative will be common if the academic world cannot meet the demand for qualified graduate level computer science specialists. The Department of Defense must recognize that programs of this nature may have to be used if in-house institutions cannot handle the increased load (such as AFIT and the Naval Postgraduate School). To solve the quantitative problem with less experienced officer and civilian accessions, DOD must be prepared to crank up the training quotas. To solve the qualitative problem, they must recognize that current training programs need improvement and future courses will need to be longer—especially if faced with making non-related majors into computer science specialists.

In an academic sense, DOD must be prepared to offer a new "major" in computer science to new undergraduate officers and civilians entering military service. Due to increased course content, this training process will certainly take more time. However, since many pilots and communicators enter DOD without technical undergraduate degrees, DOD has had to send these officers through a computer training course. The Department of Defense must first recognize the major quantitative and qualitative problems facing the nation's defense managers, and then take decisive steps to solve them.

#### 4.

## CONCLUSIONS AND RECOMMENDATIONS: WHAT NEEDS TO BE DONE?

Training programmers and then requiring them to be responsible for designing, acquiring, implementing, programming, operating, and maintaining new or enhanced computer systems is absurd.

Since the first commercially available computer appeared in 1954, much more than the training and education programs has changed. Hardware and software technology and techniques have grown exponentially in comparison to the moderate growth of training and education programs.

Is the DOD asking too much of its computer science specialists based on their initial training? Yes. Recall the six pieces of computer science. Programming is but one piece, and DOD is currently training for part of that piece—training for application programmers only. Complete exposure would require training coverage in system as well as application programming.

Programming, or the software problem, is a rapidly growing area of computer science. Programming and programmers are causing costs to escalate. The Department of Defense needs to concentrate more on programming techniques and practices not only to improve productivity, but also to apply new and better processing capabilities. Many new applications of computer systems are so complex that software engineers are needed to solve both public and private sector computer problems.

Minor computer science course changes are evident; however, the needed significant improvements are not yet on

the horizon. The most significant change I have observed has been the effort in the Army to begin training and educating communicators as computer specialists. The Army has realized that the communications world is not only going digital, but also that communicating devices themselves are based on computers. Although the computer world is sorely in need of communications expertise, training and education in this subject is not being added to either the Army or other service computer science specialist courses. Because all services are relying too heavily on work experience to compensate for inadequate training and education, they are overworking their computer science specialists.

"Work experience" seems to be a term used to justify resistance to change. Work experience provides the conduit through which initially trained personnel can reach their level of productivity, but improvements by work experience in areas for which specialists have not had initial training are not guaranteed. This system is based on the assumption that fully qualified people are out in the working environment to continue this learning process, but this is not the case. The Department of Defense is not providing training to match initial assignments. Current training and education programs are simply inadequate.

## CONCLUSIONS

Contrary to one common criticism, the Department of Defense is not saturated with computer science specialists who are too technically oriented. Close objective study suggests these conclusions:

1. Computer science training and education deficiencies have been recognized in other studies, including those directed by the President and DOD.
2. The content of current training and education programs for officer and civilian computer science specialists is deficient in all six areas of computer science.

3. Only one service, the Air Force, has a full-time career path for computer specialists; the Marines however, do have an unrestricted career path for officer computer specialists. In the Army, an individual can have computer science as a specialty after qualifying in a first specialty, and finally, an individual in the Navy can be a computer specialist part-time at the graduate level.

4. Because the demand for computer science specialists in the 1980s will exceed the supply, a grow-your-own construct is needed in DOD to meet the shortage.

### RECOMMENDATIONS

In order to overcome these limitations, DOD needs to take the following management actions:

1. Implement a revised training and education construct. This construct should include, at a minimum, the following major areas of study on computer systems:

- a. Design
- b. Acquisition
- c. Implementation
- d. Programing
- e. Operations
- f. Maintenance

2. Provide the proposed training at these levels:

- a. Initial service entry
- b. Intermediate (mid-career)
- c. Executive or senior
- d. Continuous (refresher or special topics)

3. Provide officers and civilians (cross-training into the career field or just entering government service) with the initial-entry training. Position assignment can determine other training phases (intermediate- or senior-level).

4. Implement computer science specialties in the Army and the Navy as accession or unrestricted line specialties, respectively.

5. Centralize (at DOD and service levels) all planning, programming, budgeting, for computer science training processes irrespective of whether computers are being used in either embedded or general purpose applications.

6. Assist the services in implementing the proposed training construct while determining the applicability of a joint or multi-agency education and training facility.

### **Proposed Training and Education Construct**

The recommended construct is based on the six-part computer system that has previously been discussed. To develop this construct, I will expand each major area of concentration though this expansion is not intended to be a complete course outline. It is simply a starting point.

*Design.* The construct's initial phase should serve as the orientation and then as the detailed look at hardware, software, and then integration. In addition, the orientation will include the basics, ranging from what computers are and how they evolved, to computer system logical hardware and software components. Hardware coverage would include, in the technical language of the field, basic architectures (conventional, mini, and micro) through specialized configurations supporting various single- and multi-application designs. In this phase, software exposure would be at the level of system (operating system) programs and user application programs. No actual programming would be required. Coverage should include various system programming configurations and operating techniques (such as multiprogramming, multiprocessing, data base management, and distributed processing). Computer system design and integration would encompass the principles of selecting the correct hardware and the correct

software for various applications and the control processes necessary to insure that the hardware and software match up at implementation. This final part of the initial phase would also include hardware and software standards and military specifications, data communications (local and remote requirements), human factors engineering, and communications network architectures, protocols, privacy, and security.

*Acquisition and Implementation.* Until major changes occur in the way the Federal government acquires computer systems (new ones, upgrading, or replacement), the training must cover Executive and Legislative Branch guidance. This coverage means reviewing not only applicable DOD directives and instructions, but also Government Services Administration and Office of Management and Budget policies and procedures. Additionally, it should include the Brooks Bill (PL 89-306) and the new Paperwork Reduction Act of 1980 (PL 96-511). Those familiar with the computer system acquisition process realize that this part of the course will take a long time, especially when the entire acquisition process is analyzed comparatively with the respective service's implementing documents. We must emphasize user and computer science specialist participation in problem or requirement definition. They need to understand the importance of functional analysis and the need for realistic system specifications that can be articulated in the approval process. The approval process is the time when it seems that everyone gets to take at least one shot at any computer acquisition. Because other agencies are involved in the acquisition process, General Accounting Office and House Government Operations Committee reports should be incorporated into this phase.

This phase of the construct should have two parts. First, there should be training in program or project management for the implementation of new or replacement (or upgraded) computer systems. This part would include the contract (acquisition) management as well as the installation of computer system hardware and software specified in design. The second part should be directed at software development—either a new application, or the conversion and/or expansion of an

existing program. Either part requires competencies in project management such as organization and control procedures.

*Programing.* The programing phase of the construct provides the expansion of those software (system programs and application programs) items covered in the design phase overview.

Application programing exposure can be at the level of designing, developing, documenting, and implementing a class practicum. Prior to any class exercises, standard high order languages, programing standards, documentation requirements, and systems analysis and design (structured design and programing) would be covered. Additionally, the concepts of software engineering and software production would be introduced—from both the research and development and the current application viewpoints.

This phase, and the following one, are partially included in most of the service programs now in use.

*Operations.* The basis for this phase of the construct is already covered in the existing service programs. If this phase were the last portion covered in the training and education world, it would be the ideal time to include representative case studies—the good versus the bad.

*Maintenance.* Maintenance can take on two separate meanings in the computer science world; that is, one meaning is that of program maintenance and the other is equipment or hardware maintenance. The latter meaning is intended here; the former meaning is to be covered in the programing phase.

Since most computer systems are maintained by a contractor, the potential exists for conflict or mobility problems: will contractor personnel actually be there when needed and are there sufficiently trained military personnel to take over? Add to this problem the availability of spare parts (and their replenishment) and test equipment and some more serious problems could exist. Although many computer facilities are fixed, if they are installed in overseas areas they are susceptible to the above problems. This phase should therefore

concentrate on the existing maintenance and logistical support requirements which are needed to support normal (peace-time) computer systems from mobilization (increased surge and processing) to conflict (loss and replacement).

Computers are much like people—you don't realize how much you depend on them until they're gone. We're probably in a better position today to replace people in a conflict scenario than we are computers. But the problem at hand is still related to people—having enough of them and having them adequately trained and educated to design, acquire, implement, program, operate, and maintain our DOD computer systems.

### SUMMARY

A new training and education construct is needed, but how long should it be? A conservative estimate would be 26 weeks for the initial course—twice as long as now being conducted by the services. What about the intermediate course? Again, about 26 weeks could be looked at for an initial estimate. Why are they the same length? Primarily due to the fact that depth of coverage is different. The initial course would spend a majority of the 26 weeks in the design and programming phases. The other phases would be covered to the depth necessary to make each specialist aware of the entire career field from both a technical and professional point of view.

The intermediate course would skim over the design and programming phases, concentrate on current significant policy changes being considered, and prepare the specialists for staff and management positions. In this regard, the course would concentrate on the other phases of the training and education construct. The executive-level course would be a subset of the intermediate-level course. By design, it would be much shorter (2 to 5 weeks) and intensive in nature. The Air Force is giving a similar program (1 week) to senior officers

entering the communications-electronics career field. In this example, a 30-week intermediate-level course is the basis for the concentrated short course.

Implementing the new construct won't solve the real and perceived problems immediately. However, anything worthwhile takes time. Be prepared to look for 5- and 10-year results.

In the long run the Department of Defense must accept the fact that it ignores the ADP education and training problem at its and the nation's peril. Once the validity of the need is accepted, the futility of training for specific skills in an evolving technology combined with an inflexible bureaucracy will force us to address the need to establish a comprehensive, continuous, and flexible program outside the existing system.

## ENDNOTES

### CHAPTER 1

1. US, Office of Management and Budget, *Personnel Team Report*, Federal Data Processing Reorganization Project, September 1978, p. 26.
2. *Ibid.*, p. 28.
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