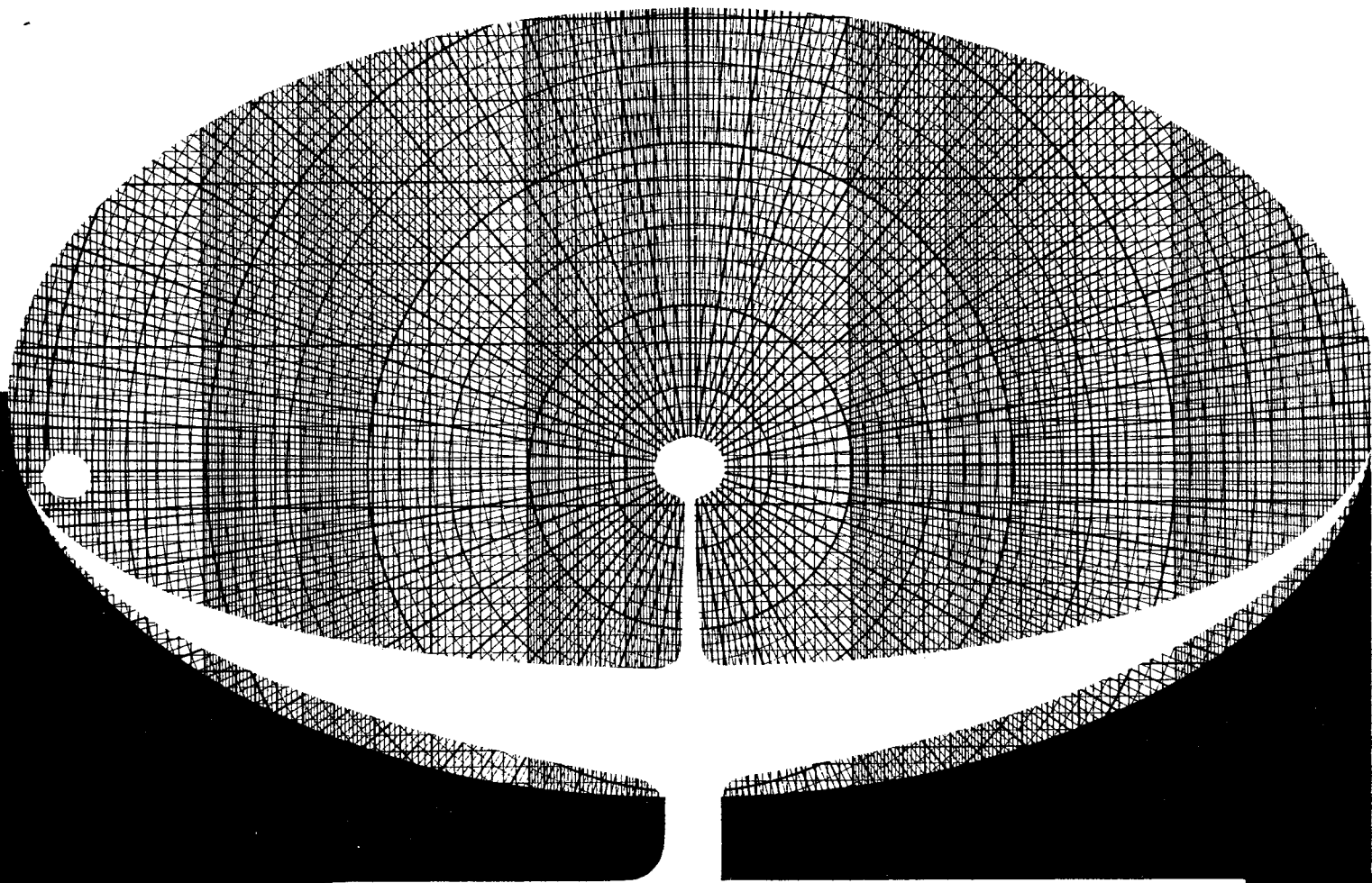

SAGE

ADC COMPUTER PROGRAMMING & SYSTEM TRAINING OFFICE—AND THE SYSTEM DEVELOPMENT CORPORATION

2500 COLORADO AVENUE • SANTA MONICA, CALIFORNIA

AIR DEFENSE COMMAND
COMPUTER PROGRAMMING AND SYSTEM TRAINING OFFICE
UNITED STATES AIR FORCE
P.O. BOX 1406, SANTA MONICA, CALIFORNIA

REPLY TO
ATTN OF: AD8CH

24 April 1961

FOREWORD

1. This brochure has been prepared by the Air Defense Command Computer Programming and System Training Office (APASTO) and the System Development Corporation to provide information for personnel assigned to the SAGE Air Defense Mission System. It is designed to augment a block of instruction in Phase II of the Battle Staff Course to provide an understanding of how computer programs are designed, produced, installed, and maintained.

2. Comments, criticisms, suggestions, etc., on the contents of this brochure are invited and may be submitted direct to this organization.

SAMUEL C. GALBREATH
Colonel, USAF
Chief

CONTENTS

DEFINITIONS

PROGRAM MODELS: Changes in operational requirements, equipment, weapons, etc., require a continual updating of SAGE computer programs. Periodically, a "new" or revised model is produced as required, to take advantage of new weapons systems and satisfy operational air defense needs to meet the changing threat.

STATIC ADAPTATION: Data applied to a SAGE computer program that comprises the physical environment unique to a Sector or Division. Examples are: Sector boundaries, location of all radars, airbases, gap fillers, coverage patterns of radars, height finders, radio sites, etc. (ADCM 55-32.)

TACTICAL ADAPTATION: Data applied to a SAGE computer program that comprises the characteristics, tactics, and techniques used by the computer to solve the air defense problem and assist in selection and application of appropriate weapons. Examples are: Interceptor climb data, cruise data, speed bands, tactics based on various armaments, etc. (ADCM 55-32.)

TURNOVER DATE: The date on which SDC turns over a program model to the SAGE Sector or Division Commander.

SYSTEM TESTING: WE-ADES testing, conducted between turnover date and operational date. Required at all new Sectors and at operational Sectors when new equipment has been added to the system.

AIR FORCE TRAINING DATE: The date on which equipment is available to the SAGE Commander for model familiarization training. A portion of this training will be accomplished in conjunction with WE-ADES testing when this testing is necessary. During model familiarization training, air defense is being conducted with the previous model program.

OPERATIONAL DATE: The date on which the SAGE Commander assumes active air defense with the new program model.

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COMPUTER PROGRAMMING FOR THE AIR DEFENSE MISSION SYSTEM

1.0 INTRODUCTION

The Semiautomatic Ground Environment (SAGE) System, as the major centralized control system for air defense, is being implemented rapidly. Within a few years the major portions of the continental United States and a segment of Canada will be using SAGE. The use of SAGE will provide for vast improvement in defense capability. It will also require that using personnel learn about new technical devices, new technical and operational languages, and new procedures. The preceding parts of the SAGE Battle Staff Course have provided an introduction to the over-all SAGE complex, the SAGE Direction Center and Combat Center, the computers, FSQ-7 and FSQ-8, and the language and symbology used by the system. This part of the course is designed to provide personnel assigned to the SAGE system with the following:

1. General information about what the major agencies, both military and civilian, do in providing and improving the SAGE system.

2. Fundamental knowledge of the advanced planning required in order to develop, design, produce, test, and maintain computer programs for SAGE.

3. Detailed information on steps which the System Development Corporation must take in producing SAGE computer programs for air defense.

4. Information about tools available to field commanders for use in training.

5. Procedures to be followed in making changes to SAGE computer programs.

2.0 HISTORY

In December 1950, Bell Telephone Laboratories accepted the task of assisting the Air Force in bringing the continental air defense system to the best operating condition consistent with design capabilities. Their conclusions and recommendations did improve manual air defense, but in the final analysis, this could not fulfill ADC requirements for a vastly improved ground environment. Also, in 1950 the Air Defense System Engineering

Committee (ADSEC), a group formed by the Scientific Advisory Board at the request of the Air Staff to study the over-all problems of air defense, in addition to agreeing to Bell Telephone Laboratories' recommendations, combined air-defense data-handling work at the MIT Digital Computer Laboratory with radar-data-transmission equipment from Air Force Cambridge Research Center. Results were favorable, which led to "Project Charles" and the establishing of Lincoln Laboratory in August 1951. "Project Charles" recommended testing of a computer in the ground environment by use of the Whirlwind I computer then in being at MIT. These tests, by Lincoln Laboratory, working under the management of MIT led to the establishment of the Cape Cod System in mid 1952. The Cape Cod System established at Cambridge Research Center was the proving ground to test the feasibility of using many radars to gather surveillance data and of feeding the data to a central computer for processing. The initial Cape Cod tests proved that such a system was feasible and the concept of the system was accepted by the USAF in April 1953. Two prototype Q-7 computers and associated equipment were ordered from International Business Machines for delivery in 1955, one to Lincoln Laboratory, Lexington, Massachusetts, for system evaluation testing, development of operational procedures and for limited operator training; the other to Kingston, New York, for technical evaluation and for training of contractor maintenance personnel.

During 1952-1953, experimental studies affecting the performance of man-machine systems were being conducted in the RAND Corporation's System Research Laboratory. The laboratory work led to the development of the Manual System Training Program and later the SAGE System Training Program, both now in use by ADC. Early in the development of the SAGE system, RAND Corporation was selected to provide computer programs for the SAGE system after the first three Sectors and the first Combat Center were operational. In expanding to attain this capability, RAND people worked closely with Lincoln Laboratory people at Lexington during the time that the programs for the first Sectors were being prepared (July 1955 to October 1957).

As the numbers of people involved in this work increased, a decision was made to form an organization separate from RAND Corporation. Thus, what had been the System Development Division of RAND became the System Development Corporation, an independent, non-profit corporation now located in Santa Monica, California. The corporation was officially formed on 1 December 1957. Since then it has grown to a total strength of over 3100 employees. Over 2000 of this number are involved in working on the USAF contract to provide SAGE computer programs and system training programs for air defense.

As the project of simultaneous design, production, installation, testing, and operation of the SAGE system progressed, it was realized that the task was larger than originally contemplated. The job of system design

and improvement of the original system, etc., required additional effort. Improved coordination was required between AMC, ARDC, ADC, and several major contractors.

On 3 June 1957, Hq USAF directed the formation of the Air Defense System Management Office, later to be known as the Air Defense System Integration Division (ADSID). It was composed of military and civilian personnel assigned to the three major commands involved. This agency was supported by a technical contractor, Mitre Corporation, which was originally formed 21 July 1958. Mitre has taken over the great majority of the tasks originally performed by Lincoln Laboratory. Recent events have replaced ADSID with a new agency, still supported by Mitre.

On 1 May 1960 a unique agency was established at the L. G. Hanscom Field, Bedford, Massachusetts, complex; unique insofar as mission, command participation, and inter-agency relationships are concerned. Comprised of four distinct organizations, each is responsible for the mission of its parent command with respect to the design, development, production test, installation, and operational effectiveness of command and control systems. These organizations are CCDD--Air Force Command and Control Development Division (ARDC) (supported by Mitre), ESC--Electronic System Center (AMC), Air Training Command Project Office (ATC), and CCDSO (ADC)--Command Control Defense Systems Office (ADC). Working together on a coordinating basis, they are responsible for management of the total effort required to provide Air Force command and control systems in accordance with approved plans, programs, and operational objectives. Each of these organizations has an office whose prime interest is the (416L) Continental Aircraft Control and Warning System.

Within CCDSO (ADC), the Directorate of Current Systems provides ADC representation in the daily coordination that must take place between the using command and the Electronic System Center project offices. This Directorate provides operational guidance to CCDD/ESC staffs in connection with all air defense projects relating to SAGE. They are also concerned with the compatibility of SAGE and manual portions of air defense operations. They provide a continual service for the field forces of ADC to insure that the unsatisfactory aspects of operating systems are rectified by appropriate agencies within the L. G. Hanscom complex. The Directorate of Current Systems provides responsible ADC staff offices with information on new developments affecting Civil Engineering and Materiel aspects of existing and planned aerospace defense systems during their implementation and modification phases.

3.0 PRESENT DUTIES OF MAJOR ORGANIZATIONS INVOLVED WITH SAGE COMPUTER PROGRAMMING (See Chart I)

1. NORAD/ADC

   a. Establish Operational Requirements.

   b. Prepare Operational Employment Plan.

   c. Determine Computer Program Model Content.

   d. Determine Ancillary Equipment Requirements.

   e. Provide funding for operation of the system.

2. CCDD/Mitre

   a. Accomplish System Design.

   b. Conduct experimental tests.

   c. Provide managerial guidance to agencies involved in accomplishing tasks required to provide a complete, functioning air defense mission system.

3. APASTO (ADC)/SDC

   a. Prepare Operational Specifications for each computer program model.

   b. Accomplish computer program development, design, production, testing, installation, and maintenance.

   c. Prepare changes to computer program models.

   d. Design and produce air-defense problems for system training. (For more details on APASTO (ADC) see ADCR 24-13.)

4. CAC&W (416L) Div. ESC/Western Electric ADES

   a. Monitors contracts for equipment, etc.

   b. Establishes schedules for implementation.

   c. Conducts system tests.

   d. Performs inspections and certifies system performance for acceptance.

There must be close coordination and cooperation between all of these agencies in obtaining an effective SAGE system for NORAD/ADC operational use.

SAGE RELATED RESPONSIBILITIES OF AIR FORCE AND CONTRACTOR AGENCIES

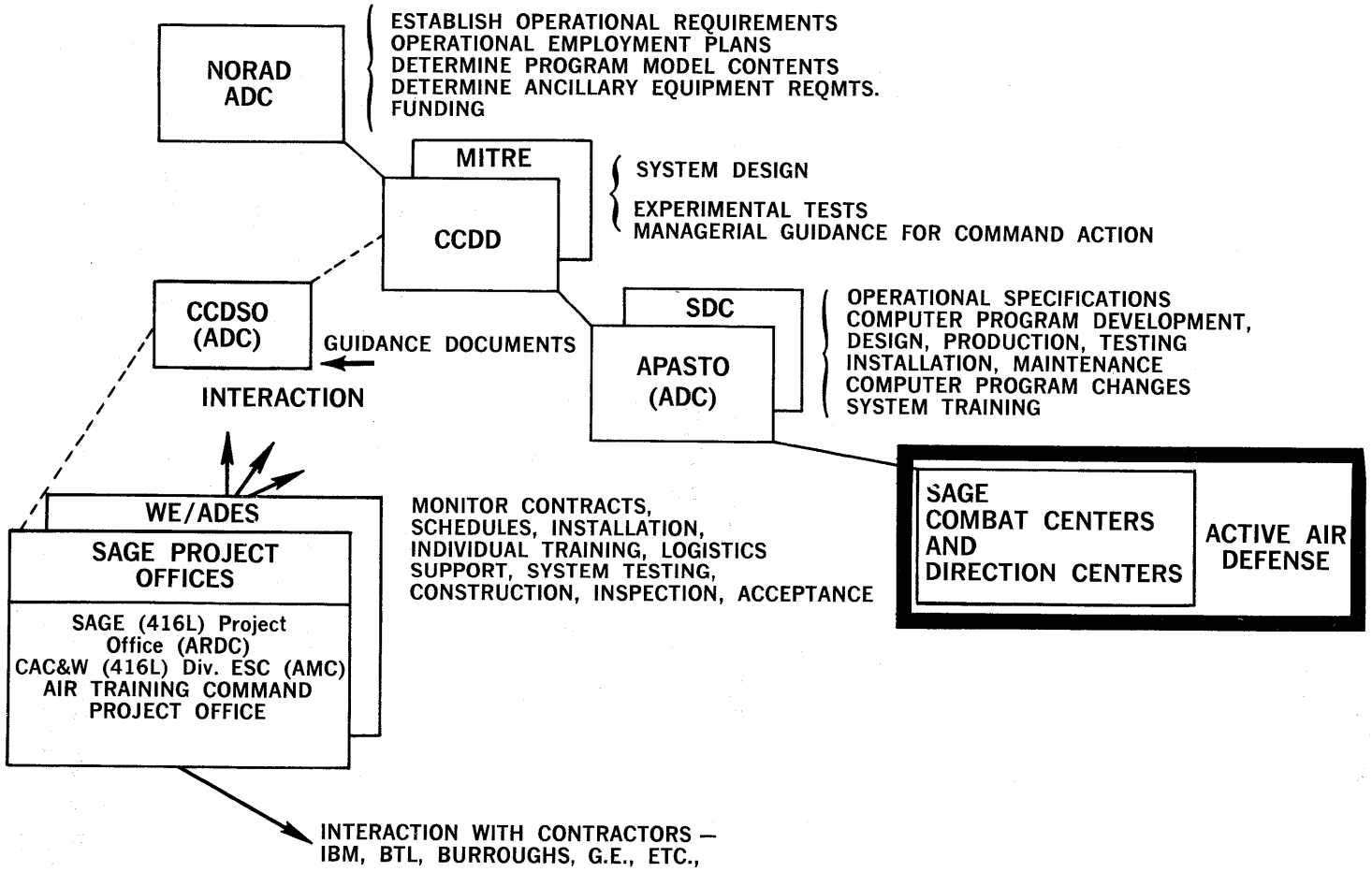

Chart 1

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PLANNING FOR COMPUTER PROGRAMS

The effort to produce a SAGE computer program can be divided into 12 clearly defined steps:

Step 1 is the production of an Operational Employment Plan (OEP) which outlines how each major weapon or electronic environment system will be employed by NORAD/ADC. The leader in publication of this document is ADC. Participation includes representatives of ARDC, AMC, CCDSO (ADC), Mitre, APASTO (ADC), SDC, and contractors involved.

Step 2 is the production of computer program guidance documents under leadership of CCDSO (ADC) and Dept 11 Mitre. ADC and APASTO/SDC participate in preparation.

Step 3 is the formulation of Operational Specifications. This is an APASTO/SDC responsibility. These documents provide detail concerning operational and data processing procedures to be incorporated into an active computer program. For a typical program, the number of operational specifications may run as high as 8 large volumes for a Q-7 program. The writing of mathematical calculations to carry out the operational objectives is a major task. The actual writing is done by SDC based upon daily guidance from the ADC Computer Programming and System Training Office (APASTO). Final approval authority is vested in the APASTO.

Step 4 is the design of the program. The flow of information within the computer, between computers, etc., is designed bit by bit, step by step by SDC.

Step 5 is coding or reduction of flow information to codes that are recorded on tapes or cards and put into the computer as instructions. (Model 8 contains more than 95,000 instructions.)

Step 6 is component testing. Each sub-program is tested, printouts are made, checks are made against specifications, and errors are corrected.

Step 7 is assembling and testing groups of sub-programs.

Step 8 is assembling and testing an entire program package.

Step 9 involves adapting the completed program to the specific Sector or Division area in which it will operate.

Step 10 is installation and testing of the adapted program in computers at operational sites.

Step 11 is operator training.

Step 12 is program maintenance and retrofit while in use at an operational site. This is a continuing process.

An active DCA program which SDC sends to an operational site averages 4 reels of magnetic tape and approximately 100,000 cards. When all associated documentation is provided, it is estimated to amount to 446,000 pages weighing about 3200 pounds. The steps outlined must be accomplished for each major change to a computer program. These revised computer programs are called models. Models are necessary in order to incorporate new systems, modifications of already-existing systems, and changes in desired tactics and techniques to meet the changing threat. The frequency of model introduction is dictated largely by occurrences outside the control of the computer programming agency. It is desirable to keep the number of models to a minimum in order to reduce costs and re-training requirements. Since initial operation of the SAGE system, new computer program models have been introduced on the average of one each 6-9 months. Several computer program models are in various stages of production or planning at any given time. All of this activity takes considerable manpower effort and time. Generally stated, production of a given model can take from 12-28 months. Developmental activities may extend this time period. Chart 2 outlines typical lead-times for a computer program model. The long lead-times involves are not operationally desirable. Considerable effort is being expended by SDC in attempts to develop improved programming techniques which will reduce this time.

After outlining the usual steps in developing a computer program for air defense operation, one major point deserves emphasis. The agency responsible for air defense, NORAD/ADC, makes the final decision on the content of computer program models. In arriving at such a decision consideration must include operational desirability, schedules for introduction of equipment, funding requirements, space available in the computer, lead-time for computer programming, etc. There are always more requirements and less resources than desired so that the decision is a hard one to make. It usually involves compromises similar to those made concerning aircraft modifications with which many people are more familiar. It is NORAD/ADC policy to request field operational recommendations in arriving at model content decisions.

LEAD TIME FOR PROGRAM MODELS
(MAJOR INNOVATIONS)

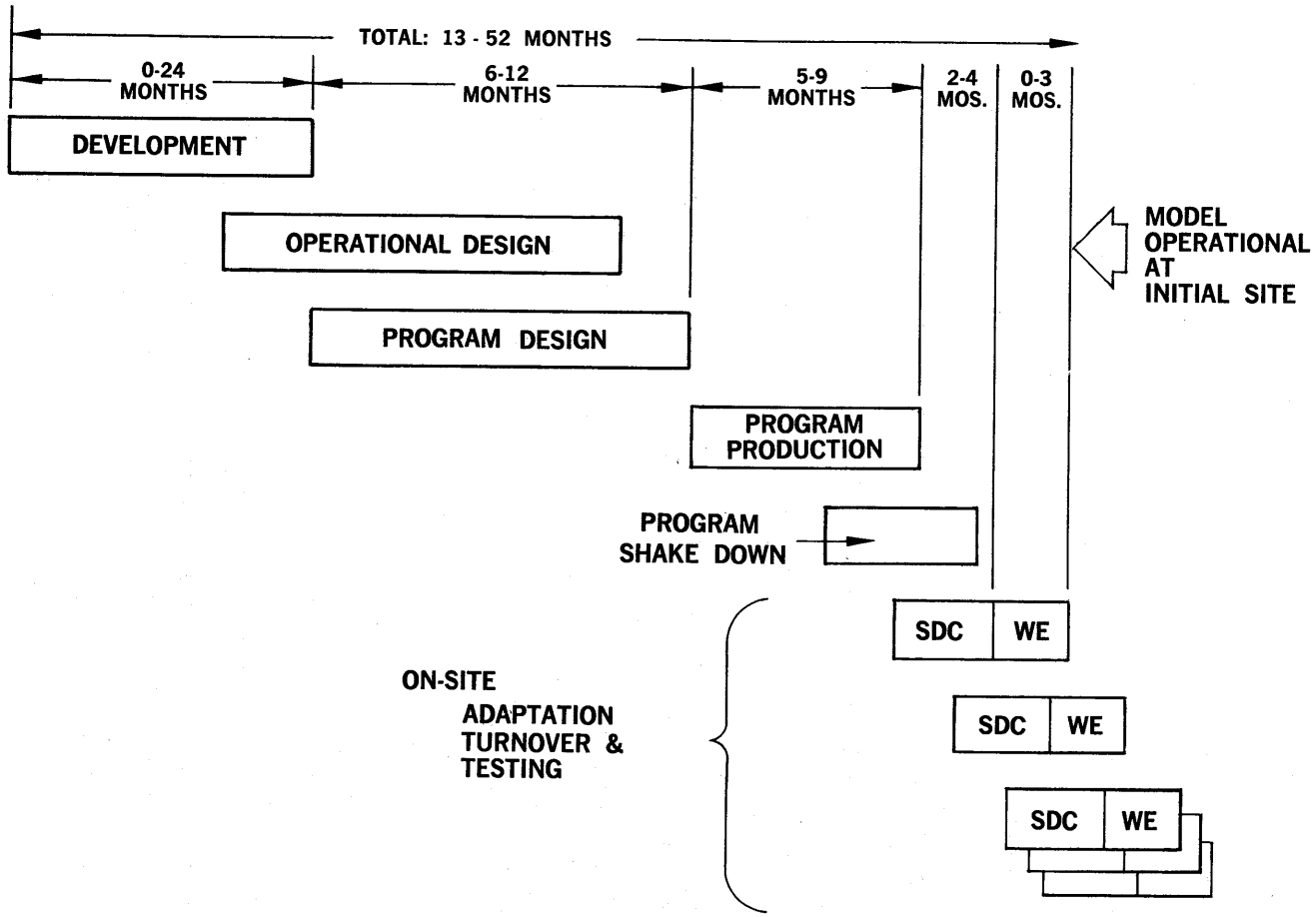

Chart 2

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SAGE COMPUTER PROGRAMMING

1.0 INTRODUCTION

The SAGE AN/FSQ-7 and AN/FSQ-8 computer programs are developed, designed, produced, tested, installed, and maintained by the System Development Corporation of Santa Monica, California. SDC employs a large professional staff composed of computer programmers, behavioral scientists, engineers of many specialities, operations and systems analysts, as well as specialists in the fields of pure and applied mathematics, aerodynamics, air-defense operations, geography, meteorology, and statistics. SDC's responsibilities with regard to SAGE are carried out by four departments. Two of these departments are concerned with SAGE Computer Programming. All four report to the office of the General Manager of the Air Defense Division (ADD).

2.0 THE PROGRAM AS A PRODUCT

The SAGE programs are produced on a System Model basis. Each System Model has operational features and program logics that mark it as a distinct operational and logical entity.

The System Model consists of the following programs: Combat Center Active (CCA), Direction Center Active (DCA), Compatible Duplex Systems (DCS), Operational Data Analysis Programs (ODAP), and SAGE System Training Program (SSTP).

Each System Model, as sent to a SAGE Direction or Combat Center, consists of several physical products, programs on magnetic tapes, and decks of IBM cards, as well as the supporting documentation. These documents are described in a separate section of this booklet.

3.0 GENERAL PROGRAMMING PHILOSOPHY

SDC's general programming philosophy is that of evolutionary change, with each new feature using as much of the logic of the previous model as possible, rather than coding a brand new program "from scratch" when a program improvement is required. Using this approach, new features cost appreciably less and are less difficult to trouble detect.

However, there are instances in which, even though we follow this philosophy as much as possible, a large amount of recoding must be done to accommodate new operational features. For this reason, it is advantageous to remember that a comparison of the over-all size of successive DCA program models bears little relationship to the numbers of newly-coded or recoded instructions required to produce the programs.

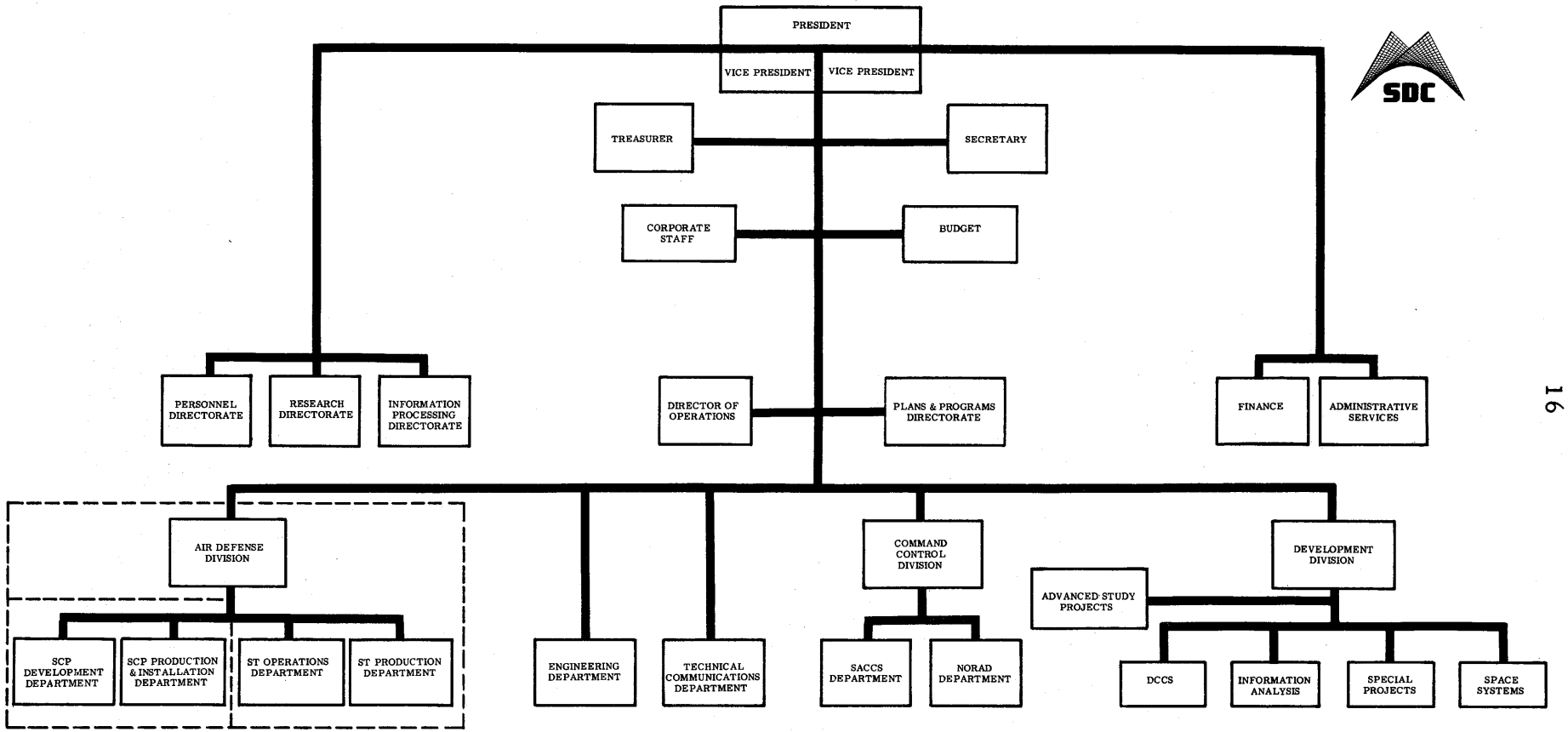
PRESIDENT
VICE PRESIDENT
VICE PRESIDENT
SDC
TREASURER
SECRETARY
CORPORATE STAFF
BUDGET
PERSONNEL DIRECTORATE
RESEARCH DIRECTORATE
INFORMATION PROCESSING DIRECTORATE
DIRECTOR OF OPERATIONS
PLANS & PROGRAMS DIRECTORATE
FINANCE
ADMINISTRATIVE SERVICES
AIR DEFENSE DIVISION
SCP DEVELOPMENT DEPARTMENT
SCP PRODUCTION & INSTALLATION DEPARTMENT
ST OPERATIONS DEPARTMENT
ST PRODUCTION DEPARTMENT
ENGINEERING DEPARTMENT
TECHNICAL COMMUNICATIONS DEPARTMENT
COMMAND CONTROL DIVISION
SACCS DEPARTMENT
NORAD DEPARTMENT
ADVANCED STUDY PROJECTS
DEVELOPMENT DIVISION
DCCS
INFORMATION ANALYSIS
SPECIAL PROJECTS
SPACE SYSTEMS

Chart 3

4.0 ORGANIZATION OF THE SAGE COMPUTER PROGRAMMING EFFORT

The General Manager of the Air Defense Division (ADD) and the Manager of Air Defense Operations assisted by a SAGE Computer Programming Staff, has two SAGE Computer Program (SCP) departments reporting to him. These are: SCP Development Department and SCP Production and Installation Department.

5.0 SAGE COMPUTER PROGRAMMING STAFF

To assist the Air Defense Division Operations Manager, the SCP Staff participates in planning, budgeting, coordinating, scheduling, reporting, and organizing SCP activities.

The SCP Staff Headquarters leads ADD planning for new models of SAGE computer programs. The personnel work with ADC headquarters, APASTO (ADC), CCDSO (ADC), Mitre, SCP Development Department, SCP Production and Installation Department, and ADD System Training Departments, providing advice and assistance to determine the operational requirements for various future time periods and potential models. In this process, operational employment plans, integration plans, and program guidance documents are reviewed within SDC to establish a basis for costing potential new models. Advanced planning personnel assess the availability of manpower and computer time to design, produce, install, and maintain these potential models. The establishment of an agreed upon plan for models thus contains a primary input for budgeting, via the Control Procedures Staff.

After the decision to implement the model has been made, the focal point for coordination and communication resides with SCP Products and Schedules Group. They serve to represent SDC to outside organizations and coordinate the work internally. The Model Coordinator writes a model operational plan that describes the operational capability, the program design changes, the new air defense equipment and its schedule, and the schedule for the computer program model and the planning for phaseover to the new model. In addition, the Model Coordinator identifies responsibilities and establishes a schedule for tasks in the various ADD organizations. He documents this in a model implementation plan. As the work progresses, both the model operational plan and the model implementation plan are reissued to reflect changes and/or further details. The Model Coordinator also provides status reports on the model.

The SCP Products and Schedules Group assists in establishing internal and external ADD schedules and coordinates these schedules with ADC and outside agencies. The group documents the official SDC schedules and commitments in a Technical Memorandum, TM-335. All equipment coordination necessary between the ADD and external agencies is carried

out by the Products and Schedules Group who supply the various departments with this equipment information.

The SCP Production Staff is responsible for developing, recommending and implementing, as directed, the necessary management procedures for improved reporting and control of SCP work in the Air Defense Division. These procedures are directed toward improvement in production control, budgeting and costing practices, and management communications. With respect to SCP work, periodic reports on technical status of products, organizational manpower capability, budget performance and planning considerations are coordinated for Management.

6.0 SCP DEVELOPMENT DEPARTMENT

The SCP Development Department is responsible for the functional design and prototype programming of SAGE Computer Program models, including the development effort which supports these tasks. The design function is divided into three parts: system design, operational design and program design. In order to accomplish this task, several functions must be performed: coordination with ADC, CCDSO, other military agencies, and with Mitre, IBM, W. E. STOD (SDC), and other SAGE contractors; system analysis and designing, generating specifications and experimental programs, developmental and design program testing under simulated and live conditions.

6.1 ORGANIZATION OF SCP DEVELOPMENT DEPARTMENT

The Development Department is divided into three branches plus a Lexington detachment. These branches are: Operational Design Branch, Program Design Branch, and System Requirement Branch. The Lexington detachment--known as the Lexington Development Group, located at Lexington, Massachusetts--provides SDC's support to Mitre and ESS activities. This includes modification and maintenance of DCA program models for use as test vehicles in ESS.

6.2 DEVELOPMENT AND DESIGN OF THE SAGE COMPUTER PROGRAM

The design function which will be exercised in the performance of the Development Department's responsibilities consists of three parts: system design, operational design and program design. A description of these separate functions is given here in some detail.

1. System Design. The system design task is primarily to determine what the Air Defense Command's system requirements are for a new model, verify their feasibility, and translate them into data processing terms. It requires the use and development of tools for the evaluation of subsystem features. Necessary consideration is given to environmental and equipment configurations,

and new techniques of data processing for air defense are developed and explored. The objective is to insure that the most effective operational capability is implemented.

The system design function may be thought of as comprising four phases, as follows:

a. Operational analysis. An analysis team, working with inputs of varying specificity and scope, establishes in gross terms what the system requirements are.

b. Detailing of requirements. The system requirements are subjected to further analyses and a description of them is proposed in greater detail. These first two phases form the two steps of what is sometimes called the system analysis function.

c. Conceptual solutions. The system requirements are thoroughly studied and broad concepts are formulated for their possible solution.

d. Concept verification. The concepts based on previous analyses are evaluated with the objective of determining their feasibility, including gross cost analysis, and their desirability.

This analytical and evaluative function is served by a number of tools which the system designer employs separately or in combination in order to accomplish his particular tasks. Chief among these system design tools are the following:

a. Mathematical modeling. The system or function is described in terms of precise mathematical formulation, that is, a representation is made of it in mathematical terms. This is the prelude to all formal analyses by simulation or analytical means.

b. Simulation modeling. Simulation consists essentially of creating a computerized model of the system functions. Since it is impossible or too expensive to employ the actual system itself, models are created simulating or representing the basic system in order to permit the evaluation of system components and changes to components, or of a whole new concept or system.

c. Mathematical analysis. Formal mathematical techniques are applied to the mathematical model. In practice this technique is limited to small well defined systems.

The products of the system design activity may be such things as the precise description of system requirements, a mathematical or simulation model, an analytical solution to a particular system problem, or the description of an experimental or developmental computer program technique, any of which may be delivered to activities pursuing the other functions of the total design process.

2. Operational Design. The operational design task is to provide the logical detailed description of operational functions in the SAGE Direction Centers and Combat Centers. These descriptions are written for each SAGE computer program model; they cover such functional areas as tracking, weapons assignment, height, and identification, and are known as operational specifications. The operational design reflected in these specifications is based on an interpretation of existing and changing system requirements, evaluation of and improvement to current design, new concepts for improving system capabilities, equipment changes, and deletions of operational features which are no longer needed or which must make room for more important features.

Operational design comprises four phases of activity leading to the preparation of the operational specifications. It also embraces the maintenance of the specifications for the current operational program models through the insertion of changes covering the approved changes made to the models themselves.

The operational design process is iterative in nature, in the sense that ideas are generated, documented and discussed many times for the same functions before being concurred upon and embodied in the approved production version of the operational specifications. The design itself is characterized by the high degree of interdependence which exists among its elements.

The FSQ-7 computer and the computer program are the heart of the SAGE network and almost every change to this system will affect more than one area of the program and hence of the operational design. For example; a change in system requirements for radar data inputs may require

a change in weapons assignment and direction, tracking, identification, information transfer, console design, or others of the 25 functional areas which the design activity embraces. A detailed study must be made of the impact of the change upon affected areas, design changes must be formulated and reviewed, and the associated documentation must be published.

For each configuration in the system, coordination is required for the complex of 25 functional areas. Design specialists are assigned the responsibility of maintaining technical cognizance and liaison with other SDC units and APASTO (ADC) as appropriate and for producing the operational design for the appropriate functional area in which they represent each configuration. By this means, accurate and expeditious handling of all data and communications relative to the operational design effort for a given SAGE program function is assured.

The phases of the operational design process are as follows:

a. Requirements phase. Study of the effect of the change in requirements on the whole system is undertaken.

b. Preliminary design. Planning inputs are prepared individually by each affected functional specialist followed by a review for compatibility in a system environment.

c. Pre-concurrence. Initial specifications are prepared and reviewed by a limited number of internal agencies concerned with preliminary design. Problem areas are identified and resolved wherever possible, and switch and display requirements are specified. The initial specifications are corrected and re-issued for the concurrence meeting.

d. Concurrence. A formal meeting is held with all concerned agencies, both military and civilian, to concur on the proposed specifications for overall model content and schedules. The principal objective is to firmly set the model for subsequent use. Changes agreed upon at the concurrence meeting are made in the specifications, which are re-issued as approved production specifications for program design, production, testing, and installation.

PROGRAM PLANNING

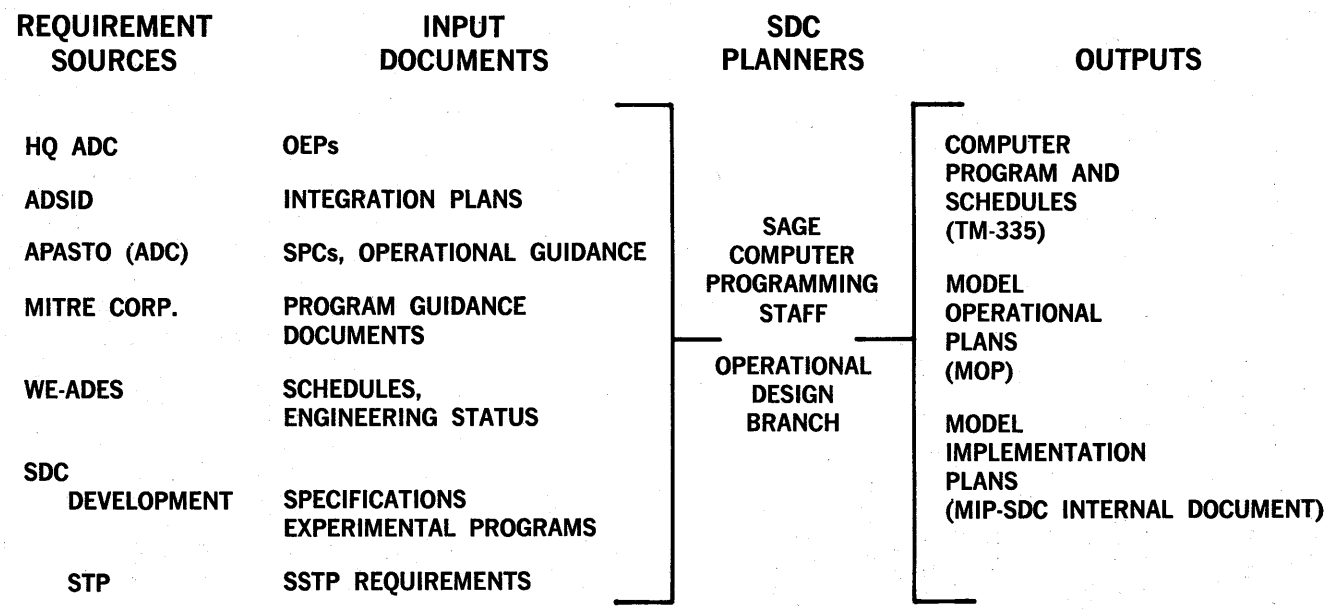

Chart 4

e. Post-design. An active evaluation of the operational design of the computer program is maintained throughout its life cycle in order to determine if operational improvements can be achieved from proposed SAGE program changes.

f. Documentation. The chief products of the operational design activity are the following:

(1) Operational Specifications, already referred to, defines the operational design. These are used for the preparation of the prototype computer program and also for associated documentation which accompanies it into the field.

(2) Model Change Training Guide, defines the changes occurring from one model to the next in terms of their training implications. This document is designed to serve as an aid for the training personnel in their training of SAGE operators at Direction Centers and Combat Centers to realize the operational capability of the model.

(3) Specific design studies, are produced as necessary.

(4) SAGE Positional Handbooks, depict operational procedures, techniques, functions, responsibilities, and relationships for each operator position at SAGE DCs and CCs. They also contain typical display illustrations and detailed emergency procedures.

(5) SAGE System Description, describes the CC and DC programs and facilities, giving a general description of DC and CC operations in relation to the computer program.

3. Program Design. In the program design process, the Development Department produces the prototype computer programs for the SAGE system. Program design differs from operational design in that it represents a further division of the design function; that is, it consists of translation of the operational specifications, which have been generated by the operational design process, into machine instructions for the computer. The individual programmer is usually assigned to write logical pieces or subprograms of the overall program, to design

OPERATIONAL DESIGN

FACTORS	SKILLS	PROBLEMS
INTERRELATION OF FUNCTIONS	MATHEMATICS	UNCERTAIN PLANS
MODEL TO MODEL COMPATIBILITY	PROGRAMMING	COMPUTER LIMITATIONS
EQUIPMENT COMPATIBILITY	ENGINEERING	SDC CAPABILITY
DISPLAY DESIGN	HUMAN ENGINEERING	
ADC OPERATIONS	TECHNICAL WRITING	

Chart 5

the inputs, outputs, and methods of operation and to write the detailed instructions.

Design of the program system involves such things as determining the broad logical subdivisions, the allocation of drum and core storage and the design of control and timing subprograms. As in operational design, there is a high degree of inter-relationship among the elements of the design task; and each activity is closely dependent. Similarly, the task is iterative in nature, requiring the repeated performance of the separate phases of the process.

The complete program design function can be divided into five phases of which the principal two are program costing and design. The coding is largely determined by these and is followed by design testing. The last phase is the documentation effort. The details of the design phase are as follows:

a. Program Costing. This determines the new features contained in the operational specifications, the costs of each in terms of machine storage for each program to see if the program will fit the machine and to estimate the feasibility in terms of available manpower. At this time, schedules are initiated.

b. Program Design. Both gross and minute design are accomplished in this phase. Each feature is assigned to a coordinator who is responsible for designing it in detail and determining how it will merge into the system. Addititional tasks include refinement of storage allocation, design of internal communications, determination of subprograms, and design of program logic. Schedules are now established for initial key punching, coding, computer testing, and other operations.

c. Coding. Detailed instructions are prepared and translated into machine language. Like the other phases, this is iterative. The programmer may go through many reiterations in order to refine the subprogram, seeking the appropriate length, running time and agreement with the design. Error correction reports from the field are monitored so that the previous design errors can be duly noted and corrected.

PROGRAM DESIGN

INPUTS	TASKS	OUTPUTS
OPERATIONAL SPECIFICATIONS	SYSTEM DESIGN	PROTOTYPE AND TEST MODELS
COMPUTER DESIGN	SUB-PROGRAM DESIGN	PHYSICAL PROGRAM
PREVIOUS MODEL	CODING	TRANSFER FUNCTIONS
SPECIFICATIONS	PARAMETER TESTING	ADAPTATION REQUIREMENTS
PROGRAM	ASSEMBLY TESTING	MODEL INVENTORY
UTILITY SYSTEM		

Chart 6

d. Testing. Because of the variety of ways in which errors can occur in the coding process, a great deal of effort must go into testing the programs to determine that they operate according to specifications. Parameter testing consists of testing the subprograms individually, using a range of inputs and comparing the outputs with calculations made by hand. The tests are iterative; they are continued until the subprogram runs successfully. Assembly testing is real-time testing of groups of subprograms to verify their successful interaction. The tests progress in degree of complexity of inputs and usually require successive "debugging" before the program is declared acceptable for release to the Production and Installation Department. The aim is to produce the best prototype program consistent with schedules.

e. Documentation. At the culmination of the design phase, the design activity prepares the associated documentation and the program tapes and card decks that constitute the physical computer program.

7.0 SCP PRODUCTION AND INSTALLATION DEPARTMENT

The SCP Production and Installation Department is responsible for producing, retrofitting, testing, adapting, installing, and maintaining the SAGE computer program models that are turned over to them by the Development Department. In addition, the Department supports SAGE System Tests conducted by the Mitre Corporation at Montgomery Air Defense Sector.

7.1 ORGANIZATION OF THE PRODUCTION AND INSTALLATION DEPARTMENT

The Department is organized into two branches--the Production and Test Branch and the Field Installation Branch--plus a Support Group that is responsible for operating the AN/FSQ-7 facility at Santa Monica.

7.2 PRODUCTION AND INSTALLATION OF THE SAGE COMPUTER PROGRAM

When the development and design phase of the program model has been completed, it is turned over to the F&I Department by the Development Department. It then enters the production and installation phase that is comprised of six separate tasks; i.e., producing, program system testing, adapting, installing, maintaining and retrofitting the program model. A description of these separate tasks follows in some detail:

1. Production. The P&I Department conducts intensive assembly testing of the SAGE Computer Program with simulated inputs of increasing complexity in order to compare the operation of the computer program model with the operational specifications. As the testing proceeds, errors are detected, corrected, and documented. These tests are conducted on the AN/FSQ-7 computer located at Santa Monica.

   Why is simulated testing used in Program Production? When the P&I Department receives the model, it has errors that are rather basic and do not call for sophisticated testing in order to uncover them. To create live air situations to find these errors would be costly and unnecessary. Controlled situations, that would be almost impossible to recreate live on a frequently recurring basis, are needed. Numerous recordings are required that would cause equipment incompatibilities. There would be a duplication of test efforts at sites. Thus, major problems can be overcome most economically and effectively by testing with simulated inputs.

2. Program System Testing. While the use of simulated inputs uncovers most of the major problems, it does not uncover them all nor does it discover the more subtle errors. Testing with simulated inputs has its shortcomings: there is an infinite number of air situations and they cannot all be simulated; timing is difficult in some areas; philosophy of new ideas may prove to be valid during development but realistically undesirable; equipment compatibility and reliability may affect the system adversely; and incompatibility in telling between Sectors may arise.

   After the assembly testing and retrofitting efforts are complete, the model is then sent to the SAGE computer facility at Richards-Gebaur AFB (commonly referred to as Kansas City, where more simulated and live environment testing occurs. The live environment testing is required by ADC, generally to insure a high level of quality for the computer program and, more specifically, to verify that the computer program will operate successfully under live conditions. The procedures used in the Kansas City testing, similar to those employed at Santa Monica, employ ADC Operators. (See ADCR 24-22) Tests based upon the operational design, as documented in operational specifications, are described, documented, and used to verify that the program performs as specified. In addition, an opportunity is provided to verify the positional handbooks in a similar manner. Data reduction

programs are utilized to provide inputs for analyses conducted at Kansas City.

3. Adaptation. The model produced at Santa Monica is designed in such a manner that the program can be readily utilized to perform active air defense at any Sector by inserting local adaptation parameters. An example of these adaptation parameters would be local geography, air base locations, squadron information, etc.

4. Installation. After the completion of the Program System Testing phase performed at Kansas City, the model is shipped to the various Sectors for installation. The adaptation parameters are merged with the program and tested to assure that the adaptation parameters are not in excess of allotted space.

   Up to this point, the model has been subjected to various types of testing by other organizations involved in the generation of the Model (Operation Design, Program Design, and Program Production and Test). However, the Sector Adaptation Parameters have not been previously tested and may contain errors and inconsistencies. As a result, a large percentage of the preliminary field installation testing is designed with this thought in mind.

   The on-site team also performs variations of tests that the model was subjected to prior to this time. This guarantees that the model performs reliably before it is turned over to the Air Force for crew training purposes. Any errors discovered at this time are immediately repaired and documented. This information is sent to all other Sectors and to Santa Monica. Personnel at Kansas City and Santa Monica are available to help solve any difficult problems that cannot be solved by the on-site personnel.

5. Maintenance of the Model. The model is maintained as follows:

   a. Detection of Errors. When errors are found, they are corrected, tested, and documented. These documents are immediately sent to all sites to eliminate needless duplication of effort.

   b. Correction of Errors. All program errors relevant to the site are corrected and installed at the site.

Any errors that the site cannot correct, are forwarded to the SDC home office where additional work is performed.

c. Installation of SAGE Programming Changes (SPC). SPCs are installed and tested based on equipment and program schedules. The schedules reflect the capability of the on-site team as well as all other SDC and non-SDC SAGE contractors.

6. Retrofitting. During the life span of the model, changes to the operational requirements are required. These alterations to the operational design arise from changes made to air defense equipment, modifications to operational concepts, and feedback from actual operations in the SAGE Air Defense System.

Headquarters, Air Defense Command established a procedure for the submission and processing of proposed changes to the computer program (ADCM 55-32). A summary of these procedures is presented in the following section of this booklet. Once the development and design phase of a computer program has been completed, any change is considered a retrofit. When ADC approval changes (SPCRs) are received by SDC for implementation, they are interpreted in detail and classified according to implementation feasibility. Within SDC, the P&I Department is responsible for the bookkeeping, coordinating, documenting, and reporting the status of the requested changes. Following APASTO (ADC) approval of the design specifications for the change and SAGE Program Change Committee approval of implementation schedules, the change becomes an SPC and is implemented into the program design. A thorough examination of the approved change and its relationship to other parts of the program model is required. Each change requires coding, testing (both at Santa Monica and Kansas City), and additional program design documentation over and above the changes necessary in the Operational Specifications, SAGE Positional Handbooks, System Description, Model Operational Plan, and Model Change Training Guide. Retrofitting is performed in both production and operational models.

8.0 RESPONSIBILITY TO THE ON-SITE REQUESTS OF THE MILITARY STAFF

Many activities are carried on by the on-site personnel at the request of the military staff. Some examples of the types of assistance requested are given below:

1. Experimental Programming. These requests are difficult for an on-site team to comply with. A central facility is provided by SDC to act on these requests. The channel for these requests is the same as specified for design change suggestions in Chapter 3, ADCM 55-32.

2. Emergency Change. Emergency change request methods have been provided (ADCM 55-32). Changes on an emergency basis are at the request of the Sector Commander. Requests of this type are responded to by the on-site team on a priority 1 basis with no regard for impact on the present work schedule. Both the military and the SDC teams report the request through the specified channels. If the on-site team is not capable of making the requested change, it is passed to SDC Santa Monica for action and the Sector Commander is notified of this fact. In either case, SDC will respond as rapidly as possible. SDC will inform ADC of the action being taken in response to the Sector Commander's request.

3. Orientation to the Program System. Program orientation is provided by the on-site team by means of individual discussions with operational personnel. Formal group discussions are conducted by senior programmers for larger groups of individuals.

4. Defense Alert Situation. The on-site team is available to provide support to the battle staff so that the probability of a system failure during emergency conditions due to a program malfunction will be minimized. Specific arrangements for this emergency effort are made between the Sector Commander and the Sector Programming Leader.

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SAGE PROGRAM CHANGES AND PROCEDURES

1.0 INTRODUCTION

Air-defense operational requirements do not remain static. If the opposite were true, there would be no need for new computer programs, equipment, or retrofits to operational programs. Once adapted for a particular Sector, the program theoretically could be used indefinitely, replacing only worn magnetic tapes and punched cards. Therefore, predicated upon ADC operational requirements, changes to SAGE Computer Programs and equipment are, and will continue to be, a continuing necessity.

This section summarizes the procedures as published in ADC Manual 55-32. These procedures are to be followed in processing SAGE Program Changes, error corrections, adaptation changes, and emergency program changes. The prime objective of this section is to provide an understanding of the coordinated effort required of both the military user and the contractual support agencies to process SAGE Program Changes in the air-defense mission system. These procedures are designed to insure effective coordination necessary to implement ADC-approved SAGE Program Changes.

2.0 DEFINITIONS

2.1 SAGE PROGRAM CHANGE (SPC)

A required and approved modification to the computer program, processed on a short lead time basis to provide an improvement to the operational system. Depending upon the magnitude of costs (i.e., computer programming design, production, test, installation and necessary equipment changes required to effect the modification), SAGE Program Changes may be retrofitted to existing operational program models or incorporated into the model under production.

2.2 ADC SAGE PROGRAM REVIEW COMMITTEE (SPRC)

A committee consisting of representatives of designated ADC staff sections, chartered by the Commander, ADC, to review and approve or disapprove recommended computer program and related equipment changes, and to establish operational desirability precedence for approved changes. This committee operates in accordance with ADC HOI 55-2.

2.3 DIVISION SAGE PROGRAM REVIEW COMMITTEE

A committee consisting of representatives of designated air division deputates, chartered by the air division commander, to review and approve or disapprove recommendations for computer program and related equipment changes originating within the division. Approved change recommendations will be submitted to the ADC SAGE Program Review Committee.

2.4 SAGE PROGRAM CHANGE COMMITTEE (SPCC)

A committee, chaired by the ADC Computer Programming and System Training Office (APASTO), consisting of representatives from invited contractors. The contractors include System Development Corporation (SDC), Western Electric Air Defense Engineering Service (WE-ADES), IBM, and others necessary for technical assistance. The function of this committee is to effect contractor familiarity with all aspects of the change specifications, to provide sufficient information to the SPRC to the effect that the operational requirement has been satisfied as to method and design, and to effect timely implementation of the change upon ADC approval.

2.5 COMMAND AND CONTROL DEVELOPMENT DIVISION (CCDD)

An Air Research and Development Command organization assigned responsibility for determining technically realistic command and control systems, feasible within the state of the art, cost, integration, and compatibility.

2.6 ELECTRONIC SYSTEMS CENTER (ESC)

An Air Materiel Command organization established to provide for the acquisition and delivery of communications and electronics systems, and for the management of activities pertinent to procurement, production, installation, maintenance, and supply during the development, testing, and acquisition phases of C&E programs.

2.7 COMMAND CONTROL DEFENSE SYSTEMS OFFICE (CCDSO)

An Air Defense Command organization that provides operational guidance to CCDD/ESC staffs in connection with all air defense projects relating to the Continental Aircraft Control and Warning System (416L).

2.8 MANAGEMENT REVIEW COMMITTEE - CAC&W PROJECT OFFICE

A committee comprised of representatives of the major Air Force Commands concerned with SAGE. It is charged with the responsibility for reviewing all contemplated equipment changes.

3.0 SAGE PROGRAM CHANGE PROCEDURES

1. Change suggestions may be initiated by any echelon of the Air Defense Command, other military agencies and/or civilian contractors associated with the SAGE system. Change suggestions are submitted to Headquarters, ADC, through military channels in accordance with Chapter 3, ADCM 55-32,and should contain as much detail as possible, to include: (1) a statement of the problem; (2) justification for the proposed change; (3) the proposed solution, if known, including program, equipment, and procedural changes; (4) the originator's statement of desired priority.

2. The SAGE Program Review Committee at ADC determines whether further action should be taken. If so, a request will be forwarded to APASTO (ADC) and to CCDSO (ADC), indicating conditional concurrence and the committee's operational desirability precedence.

3. APASTO (ADC) and the SAGE Program Change Committee compile the necessary information relative to computer programs and prepare a detailed recommendation for submission to the SAGE Program Review Committee at ADC. Included are: (1) a detailed specification of the computer program change; (2) effects on equipment, if any; (3) effects on the computer program; (4) estimated computer program availability date, etc.

4. CCDSO (ADC) reacts to changes affecting equipment, manpower and training. In coordination with appropriate agencies, they determine compatibility with the present system design or future system design plans. If the change is impractical, this determination is submitted to ADC for reconsideration of the change request. If the change is determined practical and feasible, and after coordination with the appropriate equipment contractors, the SAGE Div. (416L) ESC provides to CCDSO (ADC) information to consist of the following: (1) estimated equipment cost in dollars; (2) non-technical description of equipment; (3) effect on logistic support; (4) length of operational interruption, i.e., equipment down-time; (5) recommendations and remarks. This information is reviewed by the SAGE Management Review Committee (MRC).

5. Upon receipt of all computer program and equipment cost information and recommendations, the SAGE Program Review Committee at ADC makes an evaluation and

FLOW CHART — SAGE PROGRAM CHANGES

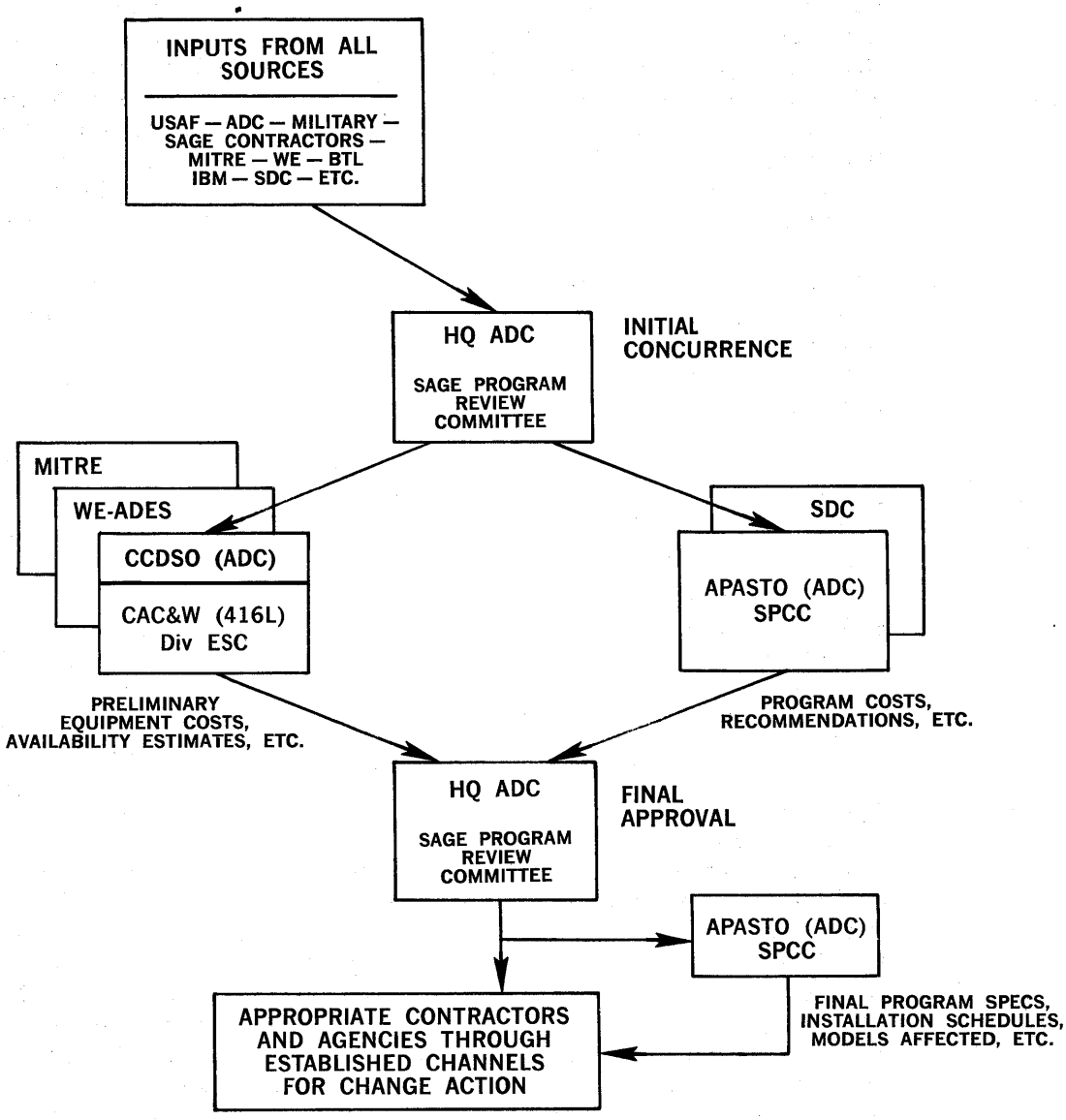

Chart 7

determines the final disposition of the change request, apprising appropriate agencies of their decision. If implementation has been directed, the appropriate contractors will be informed through APASTO (ADC) and CCDSO (ADC), as applicable, to initiate the computer program and Engineering Change Proposal scheduling action necessary to implement the change.

6. As a final step, APASTO (ADC) publishes an official SAGE Program Change (SPC) document which is distributed to all agencies including operational sectors and divisions. This document consists of a cover letter attached to the contractor's document. Combined, they contain: (1) detailed specification of the approved program change; (2) non-technical description of any related equipment changes; (3) program installation schedules compatible with known equipment availability dates; (4) program models affected, etc. Further action is taken by APASTO (ADC) to effect necessary documentation changes, i.e., SAGE Positional Handbooks, Operational Specifications, SAGE System Description, and Model Change Training Guide.

7. In the event the SPCC determines that certain program change requests (SPCR's) require expeditious implementation and are within the capability of on-site programming teams, SDC will, upon concurrence by APASTO (ADC), issue directives for on-site implementation.

8. In determining when to incorporate an SPC, considerations are given to the time required to produce programs, equipment availability, testing requirements, and installation (retrofit time). This may prompt a decision to avoid retrofit for reasons of economy, practicability, or short life expectancy of the operational computer program, training implications, and other predicted activities of a sector.

4.0 OTHER CHANGES

4.1 ERROR CORRECTIONS

Errors are defined as a variation between the operational specification and the computer program. These discrepancies are brought to the attention of the SDC on-site programmers for resolution, as previously described in this booklet. If an immediate correction is undesirable for any reason, SDC will consult with APASTO (ADC) for a determination. In the event changes to the operational specifications are required, an

SPCR will be submitted in accordance with prescribed procedures. (See Chapters 2 and 3, ADCM 55-32.)

4.2 ADAPTATION CHANGES

Changes in adaptation data are authorized under the provisions of Chapter 7, ADCM 55-32. The manual authorizes certain on-site adaptation changes, examples of which are Return-to-Base points; IFR scramble headings; location of picket ships and airborne early warning aircraft; fixed geography, such as cities, landmarks, FAA check-points, warning zones; etc. Reports of adaptation changes are forwarded to APASTO (ADC) with information copy to ADC. Upon review, determination is made of unique-to-site console-label changes. A direct channel to IBM is provided the 4620th ADW to expedite the procurement and direct delivery of the required labels. Division and Sector commanders are authorized to fabricate temporary labels (reference Chapter 3, ADCM 55-32).

4.3 EQUIPMENT-ONLY CHANGES

Requests for changes in equipment only should be submitted in accordance with procedures described in Chapter 4, ADCM 55-32.

4.4 EMERGENCY CHANGES

An emergency change is defined as a required change, modification, or correction to the operational computer program without which effective air defense is impossible. This category of change is authorized under Chapter 5, ADCM 55-32 and is permissible for correction within the capability of the on-site SDC field programming teams.

SAGE DOCUMENTATION

1.0 INTRODUCTION

Thorough documentation of computer programming efforts is a must. Exacting data are required in the specifications that describe the operations of the computer program and from which programs are coded. Detailed descriptions of operator functions, procedures, and responsibilities are required for each operating position in SAGE Combat Centers and Direction Centers. Training information is required for each new program model, describing new procedures with which SAGE operators must become familiar in order to work with the new model.

2.0 PURPOSE

The objective of this section is to summarize the contents and purpose of the principal SAGE Computer Program documents. The SDC documents described below are provided with official ADC sanction in accordance with ADC Regulation 5-5. The SAGE Positional Handbooks, ADC Manuals in the 55 series, are produced and published by SDC under supervision of APASTO (ADC).

3.0 DOCUMENTATION

3.1 MODEL OPERATIONAL PLAN--AN SDC TM (ADC)

1. Contents. The Model Operational Plan (MOP) contains final documentation of new model contents as concurred in by all agencies concerned and as approved by Hq ADC.

2. Purpose. The MOP is issued as a technical planning document. It provides information to all agencies as to ADC requirements planned for inclusion in the new program model.

3.2 OPERATIONAL SPECIFICATIONS--CC AND DC--AN SDC TM (ADC)

1. Contents. These documents specify operational procedures, tactics, techniques, computer program design, programming methods, technical program structure, and mathematical details.

2. Purpose. They provide information as to specific contents of the program model. (Information is translated into computer instructions in the production phase.)

3.3 SAGE POSITIONAL HANDBOOKS--ADCM 55 SERIES

1. Contents. The Handbooks detail operational procedures, techniques, functions, responsibilities, and relationships of operators at SAGE Direction Centers and Combat Centers. They depict typical displays, purpose, and use facilities.

2. Purpose. Handbooks provide personnel assigned to operating positions with detailed procedures and standardized methods in accomplishing their assigned tasks for a particular program model.

3.4 SAGE SYSTEM DESCRIPTION--CLASSIFIED ADCM 55-28 AND 29

1. Contents. The SAGE System Descriptions describe the Combat Center and Direction Center program, operation, and facilities.

2. Purpose. These documents provide a general description of Combat Center and Direction Center operations as related to the computer program model.

3.5 MODEL CHANGE TRAINING GUIDE--SDC TM (ADC)

1. Contents. The Training Guide is a detailed description of changes compared with the previous computer program model, and of recommended methods for on-site operator retraining. Supplements are published as retrofit changes to programs are made.

2. Purpose. This document is used by SAGE site military training units and SDC SAGE Training and Programming Units as a guide in preparing model change training curriculum; it is also used by ATC to update operator training courses.

SYSTEM TRAINING

1.0 INTRODUCTION

SDC had previously developed and installed the System Training Program in the Manual Air Defense System. Through experience gained in the use of this program, ADC determined that a similar program could be used in the SAGE system to meet the requirements for operational system training. SDC was asked to develop such a program for SAGE. The SAGE System Training Program (SSTP) was installed at the first SAGE Sector in advance of the Sector operational date and is being extended to the entire SAGE environment.

There are three primary types of training available to a Commander in the SAGE System. These are:

1. Live training
2. Training and Battle Simulation (TBS) facilities
3. The SAGE System Training Program (SSTP)

All three types of training available must be employed to develop the assigned personnel into the qualified operations team desired.

2.0 THE CONTRACT BETWEEN THE AIR DEFENSE COMMAND (ADC) AND SDC (CHART 8)

The training portion of this contract specifies that the System Development Corporation is to provide, for the SAGE system, necessary personnel, materials, equipment facilities, services, liaison, and travel to develop and implement the SAGE System Training Program (SSTP) for the entire SAGE system.

3.0 SAGE SYSTEM TRAINING PROGRAM (SSTP) TRAINING MATERIALS

In order to produce the training materials for training exercises, the following steps must be taken:

1. Adaptation Data Collection: These data reflect the environment of the Sector--radar location and coverage, communications facilities, air traffic, Sector geography, and a wide variety of items that form the physical background of the Sector.

2. Design and Feedback Conference: On the basis of the data collected and known training objectives, experienced problem formulators and training specialists from SDC and on-site Air Force personnel design the problems to be produced to meet the needs of the Sector.

3. Production of Training Materials: The requirements specified for training materials are converted to instructions for the 7090 computer, which computes and produces the Problem Input Tape and other machine-produced aids. Hand-produced aids are designed and prepared simultaneously.

4. Delivery and Check Out: After production of the problem materials, they are field-checked to ensure that they are correct and in fact are compatible with the Direction Center Active (DCA) Program.

4.0 THE SAGE SYSTEM TRAINING UNIT (STU)

A permanently assigned System Training Unit (STU) is furnished each SAGE Sector and Division by SDC. The unit is comprised of the following:

1. Senior Training Leader
2. Associate Training Leader
3. Training Analyst
4. Training Technician
5. Secretary

These personnel are specialists in System Training, are well versed in air defense, and have an extensive training background. They are assigned to provide the Commander and Staff with professional advice and assistance in the training of operations personnel.

Air Defense Command Regulation 50-3, dated 4 April 1960 outlines the responsibilities for the SAGE System Training Program for each military echelon of command and the System Development Corporation. (See Appendix I).

Prime responsibility for implementation of the over-all training program in SAGE units is assigned to the Military Training Unit (MTU) authorized in the Unit Manning Document.

5.0 TRAINING DEVELOPMENTS

Training must not only keep up with all aspects of the operational world, but must also attempt to anticipate future developments. Therefore the System Training Program (STP) regularly integrates new features into its capability.

The Training Development Branch of SDC is prepared to investigate day-by-day problems encountered in the field. This group can and does respond to suggestions from Field Commanders regarding modification of training procedures as they affect operational procedures. Improvement of the training materials is the responsibility of both the user and the producer.

Accordingly, an important link in this area is through the Commander and Staff of each SAGE unit.

6.0 ADMINISTRATION AND COMMUNICATION CHANNELS (CHART 9)

The contract is negotiated and administered through the Air Materiel Command to meet requirements established by the Air Defense Command. Technical aspects of the contract work are monitored by the ADC Computer Programming and System Training Office (APASTO). The Directorate of Tactics and System Training is the Staff Agency at Headquarters, Air Defense Command, that has the responsibility for the SAGE System Training Program (SSTP).

Requirements for SAGE System Training Program by Fiscal Year are established through the coordinated efforts of Air Defense Command, SAGE Divisions, SAGE Sectors, APASTO (ADC), and SDC.

Recommendations for improvements can be forwarded to Air Defense Command, APASTO (ADC), or SDC. SDC and APASTO (ADC) are available to provide any assistance required. Although direct contact with the APASTO (ADC) is authorized, any recommendations for major changes to the established program must be forwarded to Headquarters, Air Defense Command, for approval prior to implementation by APASTO (ADC) and SDC.

SDC — ADC CONTRACT

AF 33(600)-37684

(SAGE SYSTEM TRAINING PROGRAM)

1. GATHER DATA
2. PREPARE COMPUTER PROGRAMS
3. INITIATE SSTP
4. PREPARE SSTP PROBLEMS
5. DEVELOP TRAINING TECHNIQUES AND EQUIPMENT
6. INDOCTRINATION
7. FURNISH LIAISON AND OTHER SSTP ACTIVITIES
8. ENGINEERING SURVEILLANCE OF SSTP EQUIPMENT

Chart 8

SSTP ADMINISTRATION & COMMUNICATION CHANNELS

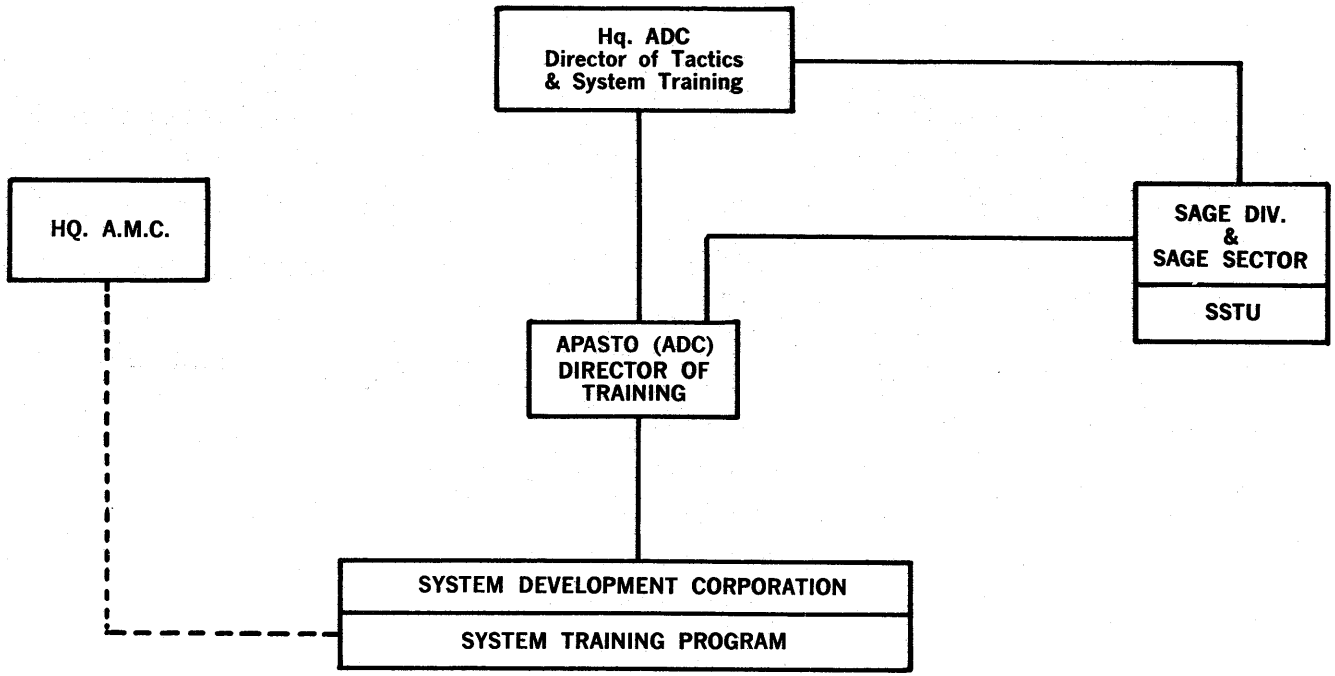

Chart 9

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APPENDIX I *ADCR 50-3

ADC REGULATION
NO. 50-3

HEADQUARTERS, AIR DEFENSE COMMAND
Ent Air Force Base
Colorado Springs, Colorado
4 April 1960

Training

SAGE SYSTEM TRAINING PROGRAM (SSTP)

PURPOSE: This regulation fixes responsibilities for integrating the SAGE System Training Program (SSTP) into the overall training program of the Air Defense Command and the Air Force components of NORAD operating in a SAGE environment.

1. To Whom This Regulation Applies. This regulation applies to all SAGE units of this Command.

2. General. The SSTP is an organized method of providing training for all operational elements of the SAGE direction center (DC) and SAGE combat center (CC) through the SAGE System Training Mission (SSTM).

3. Responsibilities:

a. The Commander, ADC, is responsible for:

(1) Supervision of the overall SSTP.

(2) Furnishing System Development Corporation (SDC), through the 4620th Air Defense Wing, with the information necessary to keep problem materials current with operational requirements.

b. SAGE division commanders are responsible for:

(1) Supervision of SSTP to insure that operational training requirements are met in conjunction with maintenance of adequate air defense.

(2) Determining training requirements and the integration and scheduling of SSTMs to insure benefits of maximum training.

*This regulation supersedes ADCR 50-3, 9 June 1959
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(NOTE: Effective 1 February 1961, unit designation ADC Computer Programming and System Training Office replaced unit designation 4620th Air Defense Wing.)

(3) Forwarding recommendations for conceptual training changes in the training vehicle based on training requirements to the 4620th Air Defense Wing with information copy to Headquarters ADC.

(4) Appointing a permanent SSTP officer. The SSTP officer's position will be drawn from the existing manpower document of the division, and the officer will have a designated combat position under emergency conditions. He will be responsible for:

(a) Scheduling division SSTMs.

(b) Advising the commander and his staff on the conduct of SSTMs.

(c) Advising sector commanders on the conduct of SSTMs.

(d) Advising the commanders on ways to correct observed discrepancies in the conduct of SSTMs.

(e) Training and supervision of Training Operations Report (TOR) teams at the division combat center.

(f) Advising commanders on system weaknesses which have been revealed as a result of SSTMs.

(g) Coordinating the activities of the SAGE System Training Unit (SSTU).

(h) Coordinating the design of division-wide SSTMs with adjacent divisions to insure that operational requirements are met.

c. SAGE sector commanders are responsible for:

(1) Scheduling and supervising the conduct of sector SSTMs in accordance with established procedures.

(2) Scheduling crews to assure a balance of crew training between SSTP, TBS and training with a live environment.

(3) Determining training requirements and the integration and scheduling of SSTMs to insure benefits of maximum training.

(4) Forwarding recommendations for conceptual training changes in the training vehicle based on training requirements to the division commander.

(5) Establishing a Military Training Unit (MTU) which will be responsible for:

(a) Scheduling and support of SSTMs.

(b) Providing a permanent TOR team.

(c) Coordinating design of sector SSTMs to insure training requirements are met.

(d) On-the-job training of SAGE operations personnel.

(e) Model change retraining and retrofit equipment retraining.

(f) Coordinating the activities of the SSTU.

d. The SDC has assumed contractual responsibility for SSTP and is responsible for:

(1) Providing professisnal advice in the training of operations personnel in the SAGE system.

(2) Providing the physical materials for the conduct of SSTMs.

(3) Providing an SSTU located at each SAGE division, and SAGE sector. This training unit is responsible to the division sector commander through the sector MTU or division System Training Program (STP) officer, and can be expected to perform the following functions:

(a) The detailed planning and conduct of SSTMs.

(b) Providing the necessary material to conduct SSTMs.

(c) Training and assisting in the supervision of the simulation and TOR personnel.

(d) Training officers in debriefing skills.

(e) Monitoring and in some cases participating in debriefings.

(f) Assisting in establishing training requirements.

(g) Assisting in the design of SSTMs to meet training requirements to include:

1. Overall design of problem strategy.

2. Design of specific missions which can be created from versatile problems.

(h) Monitoring the results of SSTMs and advising on potential improvements in the operation of the air defense system.

(i) Providing advice and instructions in the interpretation and use of ODAP.

(j) Planning and assisting in the conduct of crew retraining for SAGE model changes and SAGE equipment retrofits.

(k) Requesting division System Training Unit (STU) in the event a training or operational requirement is placed on a sector STU that does not fall within the professional or technical competence of that group. If the matter is one that cannot be resolved by the division STU, it should be passed on to the head of the SAGE System Training Branch, System Development Corporation, Santa Monica, California. SAGE division and sector commanders are to utilize military channels in apprising the Commander, 4620th Air Defense Wing, of any requirements which cannot be met by personnel assigned to the sector and/or division.

NOTE: In general, the SSTUs will endeavor to do whatever they can to further the efficiency of the SAGE sector or division to which they are assigned. Nothing in the foregoing is to be interpreted or used to preempt SDC administrative or personnel procedures and practices.

e. The Commander, 4620th Air Defense Wing, is responsible for:

(1) Providing ADC operational guidance to SDC for the SAGE System Training Program.

(2) Insuring that SSTP requirements established by ADC are compatible with SAGE computer programs.

(3) Insuring that SSTMs produced are based on approved plans and concepts of this Headquarters.

J. H. ATKINSON
Lieutenant General, USAF
Commander

HEADQUARTERS AIR DEFENSE COMMAND
OFFICIAL

ROY A. HARRIS
Lt Col, USAF
Command Director of
Administrative Services