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ABSTRACT

As part of an overall education and training program to instruct Air Force Base Civil Engineering personnel in the concepts and use of the Base Engineer Automated Management System (BEAMS), a simulation of the system was developed, covering a period of one week at a hypothetical Air Force Base. The simulation, which gives students experience in using BEAMS as part of their daily activities at their bases, consists of a data base and a series of transactions that update the base. The sequence and interdependence of the various transactions are described in an accompanying scenario. Because the simulation was specified for use in a number of different courses, oriented toward both management education and technician training, it was designed to be independent and self-contained, as well as modular. Therefore, it can be adapted easily to any of the courses. (Author/EH)

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AN EDUCATION AND TRAINING SIMULATION OF THE USAF BASE ENGINEER AUTOMATED MANAGEMENT SYSTEM

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FOREWORD

As part of the Air Force Project INNOVATE, this study was initiated jointly by the Personnel and Training Requirements Branch, Training Research Division, Air Force Human Resources Laboratory, in cooperation with the Civil Engineering School, Air Force Institute of Technology of the Air University. This part of Air Force Project INNOVATE (Project 686F) is concerned with the application of recent advances in the areas of training and education to professional education and particularly to the training of Civil Engineers in the new Base Engineer Automated Management System (BEAMS). This report is one of several being prepared under Contract No. F33615-68-C-1076 during the period September 1967 and September 1969 by Technical Communications, Inc. (TCI), Los Angeles, California. It is concerned primarily with the development of a BEAMS education and training simulation. Mr. Joel M. Kibbee was the principal investigator. While the primary responsibility of TCI, the development of the simulation represents a joint effort between various USAF and TCI personnel. The authors thank all those individuals who made contributions, assisted in the testing of the model, and were active in this study. These included personnel at the Civil Engineering School, Air Force Institute of Technology; the Directorate of Civil Engineering, Headquarters, USAF; the Air Force Data System Design Center; and Sheppard Technical Training Center at Sheppard Air Force Base. SITC also provided access to a B-3500 computer for simulation testing. Mr. Melvin Snyder and Capt. Larry Sayre of the Training Research Division were the contract monitors, Col. Robert Armstrong of the Civil Engineering School was the technical advisor. In addition to the authors, various members of TCI's Technical Staff who worked on the development of Sim A, under the overall direction of Mr. Kibbee, include James Wigle, John Stevenson, Robert Stout, Ellen Dent, and Douglas Menville.

This report was submitted by the authors in September 1969.

This technical report has been reviewed and is approved.

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ABSTRACT

As part of an overall education and training program to instruct Air Force Base Civil Engineering personnel in the concepts and use of the Base Engineer Automated Management System (BEAMS), a simulation of the system was developed. This simulation, designated Sim A, covers a period of one week at a hypothetical Air Force Base, Hardnose AFB, and is intended to give the students an understanding of, and experience in, using BEAMS as part of their day-to-day activities at their bases.

The simulation consists of a data base for Hardnose AFB and a series of transactions that update the data base; the sequence and interdependence of the various transactions are described in an accompanying scenario. Because the simulation was specified for use in a number of different courses, oriented toward both management education and technician training, it was designed to be independent and self-contained, as well as modular. It can thus be easily adapted to any of the courses.

SUMMARY

Base Engineer Automated Management Systems (BEAMS)
Education and Training Simulation

1. PROBLEM: The USAF Phase II Base Level Data Automation Standardization Program consists of the replacement of a variety of different brands and models of existing computer equipment with a single advanced computer system, the B-3500, at base and major command levels throughout the Air Force. In addition to developing the system software, the Air Force is faced with the major task of implementing this system at approximately 200 bases. In order to speed the implementation, understanding, and use of the new Base Engineer Automated Management System (BEAMS), which is one of the major Phase II systems, the Phase II Plan included the requirement for the education and training of Base Civil Engineer personnel in advance of system implementation. Courses in BEAMS were to be offered at two locations: Officers and officer-equivalent civilian personnel were to attend courses at the Civil Engineering School, part of the Air Force Institute of Technology (AFIT), Air University, at Wright-Patterson AFB, Ohio, while enlisted and equivalent civilian personnel were to attend courses at the Sheppard Technical Training Center (STTC), Air Training Command, at Sheppard AFB, Texas. In both cases, it was decided that simulation of the BEAMS was vitally necessary if the students were to achieve the degree of understanding required to effectively use the system once it was installed at their bases. The research covered by this report is concerned with the problem of developing a BEAMS simulation for both AFIT and STTC.

2. APPROACH: The four courses at STTC were designed to train functional specialists and technicians in each of the major functional areas: Cost Accounting, Real Property Management, Work Control, and Industrial Engineering Analysis. The course at AFIT was designed for all middle and upper management personnel, covering all aspects of BEAMS, but stressing its use as a management tool. To preclude the development of five different system simulations (one for each of the four technician specialty courses at STTC and one for the AFIT management-level course), the decision was made to develop one overall BEAMS simulation, parts or all of which could be used in any one of the five separate courses. A basic design concept then was one of modularity wherein, for example, the Real Property course students would interact with the computer simulation through the Real Property subsystem module, the rest of the BEAMS system and data bank being handled and updated automatically by the computer. Cost Accounting students would likewise deal only with the Cost Accounting

module. Further, a decision was reached to rely solely on the BEAMS software programs as opposed to developing additional computer programs, since it was found that a very sophisticated simulation could be developed with this simple and straightforward approach.

3. RESULTS: BEAMS, as an information-management system, consists of a large data base which changes as various types of transactions occur, basically either "add," "change," or "delete." Thus in operation, Base Civil Engineer personnel are engaged in continual updating of the data base through various transactions which occur either by punched card or by remote keyboard/printer. The BEAMS simulation resulting from this research likewise consists of a data base which changes in time. The data base itself is patterned after a real base though modified to some degree to suit the purposes of the simulation. The data base changes in time based on the scenario transactions that occur during a simulated six days of operation. Depending on the course being taught, various aspects of BEAMS can be emphasized by having the students perform the particular transactions required by the situation described in the scenario. Because of its modular design, the simulation is usable for both education of management personnel at AFIT and technician training at STTC.

4. CONCLUSIONS: Simulation is a very necessary part of the BEAMS courses because of the necessity of teaching the operation and use of this system prior to its implementation at the bases. In particular, it is felt that the hands-on experience to be gained in the BEAMS simulation is an important factor in developing the knowledge and confidence required to make BEAMS a usable and effective management tool. Obviously the development of education and training for a system that is itself still under development, as was the case with BEAMS, is more difficult than for a system that is fully designed. However, this difficulty is more than offset by the advantages of having trained personnel in the field at the time of system implementation.

This summary was prepared by Melvin T. Snyder, Personnel & Training Requirements Branch, Training Research Division, Air Force Human Resources Laboratory.

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SECTION I

INTRODUCTION

The primary mission of USAF Civil Engineering is to acquire, construct, maintain and operate real property facilities. BEAMS, the Base Engineer Automated Management System, is a set of automated procedures using the B-3500 computer to assist the Base Civil Engineering organization in carrying out its mission.

The installation of B-3500 computers at a number of Air Force bases throughout the world is part of the Air Force Base Level Data Automation Standardization Program, the basic mission of which is to standardize computer equipment, systems, and procedures at bases throughout the Air Force. The Base Civil Engineer (BCE) is only one of the users of the B-3500 installed at the base; others include Personnel and Accounting and Finance. The B-3500 is operated at a central location on the base by Data Automation. The BCE's primary access to the B-3500, and to the Civil Engineering data base maintained in the computer, is by means of remote keyboard/printers, on-line to the computer and located within the BCE facility.

Prior to the installation of the B-3500, many Civil Engineering applications were automated on a B-263 computer. The BCE, therefore, has some acquaintance with automated procedures. BEAMS, however, represents a considerable extension of previous concepts and procedures and introduces such new concepts as a centralized Civil Engineering data base and access to this data base over remote terminals. Since the successful utilization of an automated information system is dependent upon the knowledge and attitude of the users, the Directorate of Civil Engineering at Headquarters, USAF (AFOCE), directed that an extensive education and training program be developed and implemented.

Responsibility for the BEAMS education and training project was assigned to the Civil Engineering School of the Air Force Institute of Technology (AFIT-CES) at Wright-Patterson Air Force Base, Ohio. Of primary relevance to the present report, the project included BEAMS education for management personnel at AFIT-CES as well as BEAMS training for technicians at the Sheppard Technical Training Center (STTC) at Sheppard Air Force Base, Texas.

At the outset of the project, AFIT-CES decided that, particularly for BEAMS, conventional instruction must be supplemented with system simulation, that is, hands-on experience during the education and training courses.

This report deals with the BEAMS simulation that was developed, particularly Sim A, a version of the simulation implemented early in 1969.

Why Simulation

In order to properly use a system one must have both knowledge and experience. Education and training are sometimes thought of as solely providing knowledge, while experience is obtained through using the system. However, experience is sometimes made part of education and training through what is called on-the-job training (OJT). OJT is an extremely important educational and training tool. Unfortunately, there are several reasons why OJT may be impractical or even impossible. In such cases, it is often possible to provide what might be called "on-the-job training off-the-job" by means of system simulation. This is precisely what is done, for example, in the use of flight simulators for pilot training. Simulation can be used, then, when it is too costly or dangerous to permit an untrained individual to gain his experience on-the-job.

The fact that no dire consequences can result from errors is a major advantage of simulation, for it permits the student to make mistakes and learn from his mistakes. Simulation also has other advantages. One is the immediate feedback that can be obtained. In on-the-job training or actual job performance, the consequences of a particular action may not be visible for months or even years. In simulation such consequences can be fed back to the student immediately. In fact, under simulation, time can be compressed. Thus several years of systems experience can be concentrated into a few hours of classroom time. One could, for example, simulate five years of facility management planning and accomplishment within a single week of simulation in a classroom. Finally, one can within simulation also inject problem intensification. Events that occur infrequently can be made part of a simulation. One could, for example, if education be desired, have a number of facilities on the base destroyed through an event such as a hurricane, and provide management with a problem that might be worthwhile for his consideration and solution but one that hopefully he would not encounter on-the-job.

Simulation seems particularly important for systems such as BEAMS. Since BEAMS involves such new procedures as data access and maintenance over a remote keyboard, actual hands-on experience using this remote keyboard/printer is essential, if for no other reason than the increased understanding that one seems to achieve for certain systems by actually touching them. Even aside from the learning that is obtained through simulation, simulation exercises are usually motivational and cause the students to be more open and receptive to other classroom instruction such as lectures.

Perhaps the major objective in education and training for systems such as BEAMS is the development in the student of a positive attitude, of a willingness to go with the new system rather than, as seems to be inherent in most of us, to resist change. Simulation seems to be a particularly useful tool for whetting the user's appetite, encouraging his acceptance of the system, and engendering a positive attitude.

Sim A

As initially planned, Base Civil Engineering personnel were to receive their education and training about 30 days prior to the arrival of the B-3500. BEAMS itself, that is the set of completed programs that would operate within the B-3500, was scheduled for completion (including the testing, packaging, and distribution of the programs) only a few months before the installation of a B-3500 at the first base. Thus it was necessary that the development of BEAMS education and training take place concurrently with the development of the system as a whole. As with many systems, BEAMS was planned to be evolutionary; that is, it would begin with an initial set of capabilities, to which other capabilities could subsequently be added. It was also understood that changes in the initial set of capabilities could be expected from time to time. This meant that the simulation had to be designed in a modular fashion, and be flexible enough to change when BEAMS itself changed.

In October 1967, a BEAMS education and training conference was held at Wright-Patterson Air Force Base, Ohio. (1) As a result of that conference, and consistent with the discussion in the previous paragraph, a particular subset of BEAMS--that is, a particular set of BEAMS capabilities--was designated BEAMS A. The simulation based on BEAMS A was designated Sim A.

BEAMS A itself underwent changes during its development, and Sim A is basically a simulation based upon that version of BEAMS specified as of October 1968. Except for short references to Sim B and Sim C in Section IV, this report deals solely with Sim A.

SECTION II

DESIGN CONCEPTS

The Civil Engineering School at the Air Force Institute of Technology (AFIT-CES) has the responsibility for management education, that is, the education of officers and equivalent civilians. BEAMS education at AFIT-CES consists of a two-week BEAMS course. The course is directed towards Civil Engineering management using BEAMS, and covers the full range of BEAMS capabilities. It includes lectures, seminars, etc., as well as simulation.

The Sheppard Technical Training Center (STTC) is responsible for the training of technicians, normally enlisted men or civilian equivalents, who specialize in particular functions of Base Civil Engineering; STTC provides special BEAMS training for these specialized functions. In particular, STTC conducts the following courses:

- Cost Accounting (three weeks)
- Real Property Management (three weeks)
- Work Control (four weeks)
- Industrial Engineering Analysis (four weeks)

AFIT-CES, responsible for the coordination of BEAMS education and training, called for the development of simulations for each of the four specialized courses at STTC as well as the management course at AFIT-CES. The contractor proposed, however, that a single simulation be developed instead, one that could be used, as discussed more fully below, in each of the five different courses. One reason for this proposal was to reduce the total cost of developing the simulations. However, a more important reason from a pedagogical standpoint, was to provide different base level personnel with similar and related experience, not only management but the various specialists. Since management and technical personnel work together as a team at the base, it seemed advantageous that these personnel receive rather consistent education and training from such standpoints as concepts, operating procedures, terminology, etc. It was thought that a single transaction, used in different ways to suit different needs, would add to the consistency of the education and training.

Conceptually, one might think of a system whose operation requires two different people with two different skills, as, for example, a pilot and a navigator. One can design a simulation which requires the presence of both people for the operation of the simulated system. In fact, where practical, crew training (whether for an aircraft or an information system) has many advantages over individual training. However, a simulation that can be used for crew training can also be used for individual training essentially by programming the computer to take the role of the missing member of the crew.

Applying this concept to BEAMS simulation, one could build a simulation which in principle requires the presence of a manager, work control specialist, cost accounting specialist, etc. But one could also provide procedures for simulating the actions of these various individuals. Thus, if one wished to use the simulation for a course on work control, the computer itself could provide the simulated inputs of management, cost accounting, etc.

One can extend the concepts just discussed to that of designing a simulation that requires no humans at all for operation. And this was precisely what was done for Sim A. Sim A simulates essentially a typical week at a typical Air Force base, including not only the operation of BEAMS but also the actions, primarily in the form of computer inputs, that might take place on the part of various personnel: management, work control specialists, cost accounting specialists, etc. Then, when Sim A is used in a particular course, such as work control, in essence one removes the automated work control inputs and substitutes a student period. The student then develops the input as part of his training while inputs from the other specialties continue to be inserted automatically by the simulation. Thus, in the subsequent discussion, Sim A might be thought of as the simulation of activities at an Air Force base, almost as if one recorded such activities by means of a motion picture film. The manner in which Sim A is actually used for education and training is discussed in Section IV.

Simulation Using BEAMS Transactions

There are various ways in which one might attempt to simulate a system for purposes of education and training. Most often one builds a model of the system, whether a visible model or a mathematical model inside a computer. In other cases one may use the actual system, such as BEAMS, and add various computer programs to drive the system, provide special educational or training products, keep score, etc. However, for certain reasons, discussed in the next paragraph, it was decided to have the simulation rely solely on the BEAMS programs themselves, and not to attempt to develop any special computer programs for use with the simulation.

As previously noted, development of the BEAMS simulation took place concurrently with the development of BEAMS itself. Furthermore, BEAMS itself was being developed concurrently, or at least some of it would be checked out concurrently, with the checking out of other USAF software, and even manufacturer software, such as the Master Control Program (MCP). The various software subsystems have a hierarchical relationship to one another, so that for the BEAMS software to operate it is necessary that other USAF software operate correctly, that the manufacturer-produced Master Control Program operate correctly, etc. It therefore did not seem prudent to attempt to develop and check out computer programs that would be dependent upon, and in concurrent development with, many other programs. As a result of the various briefings provided at the BEAMS Education and Training Conference, previously referenced, it was decided to explore the possibility of developing a simulation that would rely solely on BEAMS itself.

While the decision to rely solely on BEAMS arose from the considerations just given, it turned out that not only was this a feasible approach, but also a simple and straightforward one that might have been taken in any case.

If one looks at BEAMS and its range of capabilities, it becomes quite obvious that one can develop a very sophisticated simulation without the need for developing any new computer programs. BEAMS consists of a large data base which can be changed through the input of various types of transactions. Some of these transactions are input over the remote keyboard/printer while others are input by means of punched cards. For example, if an individual's pay rate changes, the appropriate change in the data base is made through a transaction over the remote keyboard/printer. On the other hand, the arrival of material is input to the data base by means of punched cards that are automatically produced by the base supply system. Outputs from the data base are received either in the form of messages over the remote keyboard/printer, or as more extensive listings produced by the computer on its high speed printer. Thus, in operation, Civil Engineering personnel are engaged in entering various data through various types of transactions and in obtaining information by means of various pertinent reports, whether produced on the remote keyboard/printer or the high speed printer.

Exactly the same capabilities can be used to simulate the types of situations one wishes to induce for purposes of BEAMS education and training. If, for example, one wanted to simulate the fact that a particular employee in a particular shop had resigned and was no longer available for work, one need only use the BEAMS transaction that deletes the corresponding record from the personnel file. Such a transaction would indeed be entered at a base actually using BEAMS in the same way. Similarly, one can control the materials available for work orders by the manner in which one inputs various cards representing the arrival of materials. One could similarly simulate the total destruction of a facility, by fire for example, by utilizing the transaction for deleting a facility from the data base.

While the remarks in the previous paragraph now seem quite obvious, the concept actually arose only as a result of necessity. It fairly rapidly became evident that almost any type of situation desired for educational or training purposes could be simulated through the use of the various input/output capabilities provided by BEAMS. Thus Sim A consists of a data base and a scenario. This scenario is a time-dependent listing of the various input transactions that occur.

To relate the present discussion, then, to a previous one above, we see that Sim A consists of a data base and a series of transactions that simulate certain activities on a typical Air Force base. By definition of Sim A the various transactions are automatically input by the computer. However, to use Sim A for education and training, one removes certain groups of transactions, which then become the responsibility of the student to input. More specifically, if the pay rate of an individual changes, this would be automatically entered by the computer during the work control course, but would be entered by a student during the cost accounting course, since it is a transaction that would normally be entered by cost accounting specialists and not a work control specialist in actually using BEAMS back at the base.

Hardnose AFB

For purposes of the simulation it is necessary to have a hypothetical Air Force base, which is represented in the simulation primarily by a data base and the various transactions. It is possible to develop, ad ovum, a hypothetical Air Force base representative of a typical base. However, it is much more feasible to begin with an actual Air Force base and modify it as desired to produce the desired hypothetical base. Thus, one can take actual data from an actual Air Force base and then modify the data for purposes of the simulation.

There are many reasons why it is easier and preferable to base the hypothetical model on a real base. One of the most important is that of attempting to keep the data in balance, that is, to make certain that different data are related to one another on a similar scale. For example, there is obviously some general correlation, at least in order of magnitude, between the number of facilities on a base and the number of personnel in the Civil Engineering organization. Similarly, given a certain size Base Civil Engineering organization, there will be a certain number of work orders, job orders, service calls, etc.

For purposes of simulation one normally wants as simple a model as possible that will still contain all of the features actually found on an Air Force base. That is, one usually uses a scaled-down representation of the real situation. Beginning with a real Air Force base one can, of course, produce the hypothetical base by merely scaling down the various quantities by some constant factor. However, it became clear that there might be an Air Force base small enough for purposes of the simulation, but at the same time large enough to exhibit essentially all of the activities that might take place on a much larger base. Several such small bases were actually considered, and it was finally decided to explore the possibility of using Oxnard Air Force Base in California as the model for the hypothetical base used in the simulation. One reason for this choice, it might be noted, was the proximity of Oxnard AFB to TCI's office in Los Angeles, where the primary development of the simulation took place.

The BEAMS courses at AFIT devote themselves primarily to BEAMS, and Sim A was developed to simulate BEAMS and be used in the BEAMS course. However, the BEAMS course also includes some instruction on Total Programming, an Air Force planning and programming system. While Total Programming is to be automated as a part of BEAMS, it was a Priority II project and was not to be automated with the initial Priority I system. Thus the Total Programming taught in the BEAMS courses was based on manual procedures. To support the Total Programming instruction TCI was asked to develop a manual management game. This resulted in Top-Man-X. (2) Top-Man-X is relevant to the present discussion since it was decided at the outset to utilize, to the degree possible, the same hypothetical Air Force base, and the same data, that would be used in Sim A. Thus Hardnose AFB is not only the model for Sim A, but also for Top-Man-X.

A simulation model is normally an abstraction of a real-life situation. Although Oxnard AFB is small it was thought that in some cases only subsets of certain data, rather than all of the data, might be placed in the data base. More specifically, BEAMS includes a real property file with a record for every facility on the base. A question arose as to whether Hardnose AFB should include a full set of facilities, or a subset.

In particular, it was clear that only certain subsets of the data could be used for Top-Man-X. Thus, it would have been possible to go to Oxnard AFB and collect only such data. However, a different approach was suggested and actually implemented. Since only certain files might be subset the difference between collecting and converting all of the data to machine readable form, or only a subset of the data, was not of great magnitude. It was therefore realized that it would be better to collect all the data and convert it, that is, to subject Oxnard AFB to precisely the same type of data conversion as would take place when Oxnard AFB itself was converted to a B-3500. Once converted, and amenable to machine processing, one could then use the computer to do any abstracting, subsetting, or data manipulation. In other words, it seemed advantageous to exploit the capabilities of the computer to develop a Hardnose AFB from an Oxnard AFB after the data had been converted rather than before. One might want, for instance, to change the characteristics of a particular Oxnard AFB facility so as to be more useful or appropriate for the simulation education and training. One might, to use a particularly simple example, want to change the total square feet of a building. It is obvious, however, that such a change could be readily made on the data base using the appropriate BEAMS transactions that would be available, rather than manually indicate this change prior to the data being converted to machine readable form. Therefore, with but a few exceptions, TCI gathered all the data at Oxnard AFB that would be required for BEAMS and had the data converted to machine readable form.

In order to install BEAMS at an Air Force base, USAF has developed a special set of implementation/conversion (I/C) programs. These programs provide for the converting of manual data into machine readable data and the use of this machine readable data to build up the data base maintained in disk storage by the computer. It therefore might be assumed that the simplest procedure to be used in developing the Hardnose AFB data base would be to use the I/C programs on Oxnard data. However, in the spring of 1968, when the Oxnard AFB data were being collected and converted, it was thought, on the basis of plans provided by USAF, that it would be necessary to complete the simulation and have it ready for courses at about the same time that the development of the I/C programs was completed.

A different procedure for data conversion was therefore sought. The one finally adopted was based on the use of BEAMS addition transactions; the programs for these transactions were expected to be completed in time for implementation of the simulation. An addition transaction in BEAMS is used to add a record to a file. For example, BEAMS includes an employee master file (EMF). For each new employee, an addition transaction is input adding a record for this employee to the EMF file. Now assume that Hardnose AFB already has 100 employees. One could begin by assuming that none of these employees existed, and then, through 100 addition transactions, build up an EMF file that would contain records for each of the 100 employees.

The EMF file built using addition transactions is, in general, exactly the same as an EMF file that results from the use of I/C programs. However, the first step in either procedure is the keypunching into cards of the data obtained from the manually kept forms. But the format of the cards is different. Because the Oxnard data were keypunched into cards in addition transaction format, rather than in the format that would have been required had I/C programs been used, some minor difficulties did arise. For example, in some cases important data elements in the files could not be entered this way and had to be entered later using special procedures.

Scenario

Sim A takes place over a period of seven simulated days, identified as S0, S1, S2, . . . S6, corresponding to the following actual days:

S0	Friday, 22 March 1968
S1	Monday, 25 March 1968
S2	Tuesday, 26 March 1968
S3	Wednesday, 27 March 1968
S4	Thursday, 28 March 1968
S5	Friday, 29 March 1968
S6	Monday, 1 April 1968

The actual dates were selected for two reasons: First, since a major aspect of BEAMS (or at least the October 1968 version on which the simulation is based) has to do with daily labor reporting, a simulation timing based on days rather than some other periods seemed appropriate. Second, Friday, 29 March 1968, is the last day of a week, month, and quarter, and thus the last day of the simulation gives rise to daily, weekly, monthly, and quarterly reports. One could have used the last week of a year, thus adding to the above list annual reports; however, most of the annual reports were either accumulations, over a longer period, of data available from quarterly or monthly reports, or did not add significatly in other ways to the total management information desired for the simulation. It was therefore decided to avoid the somewhat increased artificality that would arise from a simulation based on the last week of a fiscal year.

Sim A begins at the closing of day S0, which is the same as the opening of day S1. That is, all of the various daily and weekly processing has taken place as of the close of business on Friday, 22 March 1968, and those using Sim A are faced at the beginning of day S1 (Monday morning) with all of the reports that would have turned out at the end of the previous week.

Sim A then proceeds day by day through S1-S5. At closing on S5 (Friday evening) a full set of daily, weekly, monthly, and quarterly reports are produced. These reports are available for analysis at the beginning of day S6 (the following Monday). Sim A then ends; that is, no transactions take place on S6.

There need be no specific relationship between a simulated "day" and an actual course day. The complete simulated week (S1-S5) could be run on a computer in the course of a single day. On the other hand, one could run S1 on the computer one day, and then run S2 on the computer several days later. Consider a specific course, such as the Real Property Management Course, which, exclusive of a first week on ADP, devotes two weeks to BEAMS Real Property Management capabilities, and utilizes Sim A over that two-week period. For that course it might be decided to run S1 on course day 6, S2 on course day 8, and S3 and S4 both on course day 9. Regardless of the actual calendar days, at some particular point during the course, the instructor announces to the students that it is now S2, that is, 8:00 a.m. on Tuesday, 26 March 1968, at Hardnose AFB.

Different courses have different schedules for the simulated days, and on the same calendar day at STTC, for example, the BEAMS Cost Accounting Course may be in simulated day S4 while the BEAMS Real Property Management Course is in simulated day S2.

As previously stated, Sim A exists independently of its education and training objectives. For example, perhaps on day S3 a new individual work order is added to the data bank. This work order can be added automatically by the computer in the form of an addition transaction. However, if a particular course is in day S3 and the performance of the students calls for adding a work order, then the students are instructed to add the work order through the remote keyboard/printer. Thus, Sim A runs on its own. For education and training we remove a module and plug in a student instead.

The complete set of transactions that are used in Sim A over the five-day period is known as the Sim A scenario. The complete scenario has been documented, (3) and the illustrations used in the following discussion are reproduced from the document and provided here as typical examples of the scenario.

Hardnose AFB contains a dozen or so shops, of which one is the carpentry shop. The carpentry shop consists of ten people. Each person is available for 8 hours a day, and therefore there are a total of 80 labor hours available to the carpentry shop. In the October 1968 version of BEAMS,the labor cost distribution system was based on a labor exception principle which, while making it necessary to report hours by various work orders, job orders, etc. did not associate these hours with a specific individual. In other words, one might say that for purposes of labor cost distribution, the costs were computed on the basis of an average shop rate. Therefore, for purposes of the simulation it was necessary only to show how the total 80 hours were distributed to various types of work; it was not necessary to tie these hours to a particular employee. The manner in which these 80 hours of the carpentry shop were distributed each of the five days of the simulation is shown in Figure 1. For example, on Monday, 40 hours were spent on job order number 1020, and 7 hours on service calls. It can also be seen (at the bottom of Figure 1) that throughout the week a total of 19 hours were devoted to service calls. Figure 2 shows a brief description of each of the tasks. Thus on day 1 there were two service calls, one to repair a roof and one to replace a window, and one job order involving the replacement of slats on benches.

BEAMS distinguishes between work orders and job orders. A much oversimplified distinction between the two is that work orders are usually larger jobs, involving more than one shop, etc. Thus note in Figure 1 that on day 3 the carpentry shop is involved for 8 hours with work order 20888. Figure 3 is a description of work order 20888. It involves 8 hours of the carpentry shop and also three other shops. One of the procedures in BEAMS is entering work orders into a work order file. In Sim A the computer automatically enters work order 20888 so that it is already in the file when the various shops report work against this work order. However, for certain courses it is desired to give the students experience in entering work orders. For those courses, then, instead of having the computer enter the work order the students are asked to enter the work order over the remote keyboard/printer. To add realism the students are provided with a copy of the work order as they would actually receive it (see Figure 4) rather than the summary of the data given in Figure 3. The student workbooks used with the simulation, and discussed later, contain forms such as that shown in Figure 4. Figure 5 summarizes the various service calls that the carpentry shop will perform throughout the week, and Figure 6 gives similar information on the various equipment maintenance tasks that will be performed.

While in principle a total of 80 hours is available each day for direct labor, certain of these hours may be used up for nondirect labor purposes such as training, sick leave, etc. In Figure 1, for example, the column headed "Other DC" shows for each day the number of hours

	Work Orders nr.	Work Orders hrs.	Job Orders nr.	Job Orders hrs.	Equip Maint nr.	Equip Maint hrs.	Serv Calls nr.	Serv Calls hrs.	Total P/hrs.	DC 11 hrs.	DC 20 hrs.	Other DC code	Other DC hrs.	Total A/hrs.
MONDAY S1			01020	40			04014 01013	2 5 7	47.0	64	8	91	8	80
TUESDAY S2			01006 01018 01016 01034	16 12 1 6 35	01020	4.6	04100 04014 04015	1 1 1 3	42.6	64	8	91	8	80
WEDNESDAY S3	20888	8	01006 01015 01013	3 8 2 13	01009 01006	4.0 8.4 12.4	04101 01037	4 1 5	38.4	62	8	91 58	8 2 10	80
THURSDAY S4	20718	47							47.0	60	8	52	12	80
FRIDAY S5			01009 01020 01505 01013	3 8 10 4 25	01006 01020	14.0 4.6 18.6	01016 01018	1 3 4	47.6	48	8	59	24	80
TOTAL	55 hrs.		113 hrs.		35.6 hrs.		19 hrs.		222.6	298	40	62 hrs.		400

Figure 1. Sim A Labor Distribution

W/O Nr.	Type	Description	Day	Std. Hrs.
01013	SC	Repair roof	S1	5.0
04014	SC	Replace front window	S1	2.0
01020	JO	Replaces slats on benches	S1	40.0
04100	SC	Replace broken window	S2	1.0
04014	SC	Replace broken window	S2	1.0
04015	SC	Repair closet door	S2	1.0
01020	EM	Door overhead	S2	2.3
01020	EM	Door overhead	S2	2.3
01018	JO	Fabricated water catches	S2	6.0
01018	JO	Repair screens	S2	6.0
01016	JO	Issue lumber	S2	1.0
01034	JO	Construct form	S2	6.0
01006	JO	Repair window screens	S2	16.0
04101	SC	Repair floor tile	S3	2.0
04101	SC	Replace acoustical tile	S3	2.0
01037	SC	Repair fence	S3	1.0
01009	EM	Hoist chain	S3	2.0
01009	EM	Exhaust system	S3	2.0
01006	EM	Door hangar	S3	2.8
01006	EM	Door hangar	S3	2.8
01006	EM	Door hangar	S3	2.8
01006	JO	Issue plywood	S3	2.0
01015	JO	Replace broken tile	S3	8.0
01013	JO	Repair screen door	S3	2.0
01006	JO	Issue lumber	S3	1.0
20888	WO	Remove floor tile and replace	S3	8.0
20718	WO	Manufacture single frame window, three each; cut door opening in frame wall and door frame, two each; install new door in new frame, includes lock; erect wall studding; install rafters and decking	S4	47.0

Figure 2. Production Count Cards Submitted During Week of Sim A

W/O Number: 20888	Installation: Hardnose AFB
Facility Number: 00238	Work Class: C
Cost Account Code: 57401	Category Code: 740316
Installation Priority: 2	Organization Priority: 2
Labor: 21.0 hours, $61.00	Material Cost: $20.00

Description: Remove water lines in floor and cap off where machines are removed. Remove damaged floor tile and replace. Cover floor drain with metal 7" x 7" square.

Work Center	Job	Hours
442 Paving	Cut floor to cap off water lines.	8.0
453 Plumbing	Cut water line and cap off.	2.0
471 Electrical	Check circuit and remove wire from floor.	3.0
451 Carpentry	Remove floor tile and replace.	8.0
		21.0

Figure 3. Work Orders in Actual Progress During Sim A

BASE CIVIL ENGINEER WORK ORDER

1. DATE:
2. WORK ORDER NO.: 2088-8
3. INSTALLATION: HARDNOSE AFB, EVERYSTATE
4. RP VOUCHER NO.:
5. COST ACCOUNT CODE: 57401
6. CHANGE ORDER NO.:
7. ORGANIZATION: CSEEC
8. REQUESTER: Devine
9. TELEPHONE NO.: 2172

10. DESCRIPTION OF WORK

Remove water lines in floor and cap off where machines are removed.
Remove damaged floor tile and replace.
Cover floor drain with 7"x7" square metal.

SHOP	LABOR COST	MAT COST	SUP ITEMS
Pavements	25.00		
Plumbing	6.00		
Electric	10.00		
Carpenter	20.00	20.00	1

11. SIGNATURE OF AUTHORIZED OFFICIAL: WILLIAM R. ROME CAPT. USAF DIRECTOR OF PROGRAMS

12. WORK REQUEST NO.: 132-8
13. PROJECT REQUEST NO.:
14. CONTRACT NO.:

	15. APPROVED COST	16. ACTUAL COST
A. LABOR	61.00	
B. MATERIALS	20.00	
C. OTHER	81.00	
D. TOTAL		

17. WORK CLASSIFICATION: C
18. INSTALLATION PRIORITY: 2
19. ORGANIZATION PRIORITY:
20. FACILITY NO: 233
21. CATEGORY CODE: 740-316

22. TYPE OF ORDER: A. MAINTENANCE AND REPAIR; B. PREVENTIVE MAINTENANCE; C. STANDING ASSIGNMENT; X D. OTHER

23. PERFORMANCE AREAS: X Plumbing; X Electrical; X Carpentry; X Pavements

24. WORK PLAN

WORK CENTER CODE	NAME	JOB NO.		PERFORMANCE NET-WORK NO.	STD (M Hrs)
442	Pavements	70.28	Cut floor to cap off water lines		8.0
453	Plumbing	91.17	Cut water line and cap off		2.0
471	Electric	25.27	Check circuit and remove wire from floor		3.0
451	Carpenter	13.2	Remove floor tile and replace		8.0
			Total		21.00
	Pavements				8.0
	Plumbing				2.0
	Electric				3.0
	Carpenter				8.0
			Total		21.0

25. WORK CENTER:
26. DATE COMPLETED:
27. SIGNATURE OF RESPONSIBLE PERSON:

AF FORM FEB 64 327 PREVIOUS EDITIONS OF THIS FORM WILL BE USED UNTIL STOCK IS EXHAUSTED

Figure 4. Sample Work Order

W/O Nr.	JO Nr.	Description	Fac Nr.	Days	Hours
01016	56101	Repair door panel	00221	S5	1.0
01018	57201	Replace broken window	00246	S5	1.0
01018	57201	Repair window	00246	S5	2.0
04101	57111	Repair floor tile	00320	S3	2.0
04101	57111	Replace acoustical tile	00320	S3	2.0
01037	58724	Repair fence	06002	S3	1.0
01013	54401	Repair roof	00219	S1	5.0
04100	57111	Replace broken window	00312	S2	1.0
04014	57111	Replace broken window	01024	S2	1.0
04015	57111	Repair closet door	01037	S2	1.0
04014	57111	Replace front window	01042	S1	2.0
					19.0

Figure 5. Sim A Service Calls

W/O Nr	Equip Code	Description	Fac Nr	Day	Hours
01006	03180001	Door hangar	00119	S5	2.8
01006	03180005	Door hangar	00119	S5	2.8
01006	03180006	Door hangar	00355	S5	2.8
01006	03180010	Door hangar	00355	S5	2.8
01020	03180011	Door overhead	00133	S2	2.3
01020	03180016	Door overhead	00133	S2	2.3
01009	03200001	Hoist chain	00341	S3	2.0
01009	03100001	Exhaust system	00155	S3	2.0
01006	03180002	Door hangar	00161	S3	2.8
01006	03180003	Door hangar	00161	S3	2.8
01006	03180007	Door hangar	00213	S3	2.8
01006	03180008	Door hangar	00213	S5	2.8
01020	03180021	Door overhead	00135	S5	2.3
01020	3180023	Door overhead	00135	S5	2.3
					35.6

Figure 6. Sim A Equipment Maintenance

spent on various codes other than direct labor. For example, it will be noted that on Monday, Tuesday, and Wednesday there were 8 hours for code 91 which is sick leave and 2 hours on Wednesday for code 58 which is chasing stock. A description of the various nondirect activities that take place in Sim A, for some of the shops, is given in Figure 7. As for other parts of the simulation, a computer can either enter this automatically, or the problem can be presented to the student. Thus, depending on the course, the students might be presented with the fact that Airman First Class F. Porteous is sick Monday, Tuesday, and Wednesday. The students would then be expected to make the necessary transactions to indicate this information to the computer.

A variety of work orders are handled during the simulated week. A brief description of some of these is given in Figure 8. An important aspect of BEAMS is the automated recordkeeping of materials for the various work orders, that is, the daily updating of appropriate files as to whether materials have arrived, are on order, etc. In BEAMS various types of material transactions are input corresponding to the ordering and arrival of materials. Similar transactions had to be developed for Sim A. Figure 9 contains a brief description of some of the material transactions.

The above discussion is an example of the structure of Sim A and the manner in which it can be used for purposes of education and training. The complete scenario covers all the information-flow aspects of Hardnose AFB that in some way or other are important to BEAMS. All the data are interrelated and balanced with one another. By that it is meant that the number of people in the EMF file for a particular shop will correspond to the number of hours of work reported for that shop on any one day.

Similarly, the total amount of work to be done on the various work orders and other tasks, as carried in various BEAMS files, must in turn add up to the actual number of hours that were worked, etc. A major activity, then, in the development of Sim A was the development of an integrated and balanced data base and set of transactions. This task was made easier by beginning with actual data from Oxnard AFB, and then modifying the data so as to suit education and training needs, but modifying it in a systematic way so as to preserve the balance that it automatically has in reality. As previously stated, it was precisely to simplify such procedures that Hardnose AFB was a modified replica of a real Air Force base instead of a hypothetical model.

Implementation Concepts

Sim A was designed as a self-contained simulation that could be

442:

Airman D. Holloway spends seven hours Monday on shop clean-up. (52)
Mr. G. Fernandez and Mr. J. Quintana are on their annual leave all week. (90)
Tech Sergeant B. H. Green spends four hours working on shop equipment Wednesday. (54)
Airman R. Ostrander spends five hours Thursday and four hours Friday cleaning the working area. (52)

451:

Airman First Class F. Porteous is sick Monday, Tuesday, and Wednesday. (90)
Airman First Class M. Lewis chases stock for two hours Wednesday. (58)
Staff Sergeant B. Knight and two other men clean shop Thursday afternoon. (52) All twelve hours are reported on Knight's card.
Three men go on temporary duty Friday. (59) All twenty-four hours are reported on Mr. Q. Dennis' card.

452:

Sergeant R. Martinez is assigned temporary duty all day Monday, Tuesday, and Wednesday, and half of Thursday. (59)
Staff Sergeant R. Rucher has other military duty Tuesday through Friday. (82)

453:

Three men spend the morning cleaning shop. All twelve hours are reported on Airman First Class H. McDermott's card. (52)
Sergeant A. Chieppo and Staff Sergeant F. Shaffer are on vacation all week. (90)
Airman First Class D. Sayer spends three hours cleaning shop Tuesday morning. (52)
Airman First Class M. Lorenz has other military duties all day Tuesday and four hours Wednesday. (82)
Airman First Class H. McDermott spends five hours cleaning shop on Thursday. (52)

Figure 7. Sim A Labor Exceptions Narrative

W/O Nr	Fac. Nr	Description
14728		Purchased electricity - CE Management and Engineering
20208	00224 00258	Install air conditioning units (15 ton) in two buildings, 4 units per building
20268	00165	Install 220 volt power service and switches; install air and water lines to washers
20398	00213	Modify existing floor plan
20508	00166	Install new roof over boxes, gutters, and flashing; extend redwood fence; remove block partition; install new office partition; relocate double doors; install three doors with locks; install window (6'x4'); install electrical fixtures; install new SS sink; paint all completed work
20628		Install fire hydrants at Lake Texoma
20668	00209	Install heating ducts and exhaust system in Management and Procedure office and provide additional heat in Chief of Supply Office
20718	00240	Construct partitions in the present Fire Chief's Office, and modify offices and rooms as per the attached sketch
20768	00502	Restripe center line of runway and overrun, approximately [illegible] sq. ft.
20788	05005	Install colvert; raise drainage bed to meet existing road; install gate at corner of fence; grade area from fence to existing concrete pad
20808	00233	Replace bird baths with bottom feed; Rooms C305 - 2 each/ C-205 - 1 each/ A305 - 2 each/ A205 - 2 each. These are to be stainless steel
20858	00143	Repair draft stops on in attic
20868	00252 00256	Replace gas fires space heaters in buildings 252 (3) and 256 (4). Salvage old heaters
20888	00238	Remove water lines in floor and cap off where machines are removed. Remove damaged floor tile and replace. Cover floor drain with 7" x 7" square metal
20908	00213	Rearrange wells and reconfigure briefing counter in weather briefing section
20908	00213	Change order no.1. Install two electrical ducts and run power line from vicinity of building 217 to building 213

Figure 3. Principal Sim A IWO's

W/O Nr.	Shop	Description
MONDAY:		
Due-Out Release:		
20718	471	Fixture lighting floures
20668	463	Grill vent
Issue:		
20858	451	Nail plasterboard
20868	463	Nipple pipe block 1/2 x 3
20868	463	Union pipe block 3/4 in.
20868	454	Screw tapping 8 x 11 in.
20908	471	Box connector 1/2 in.
20908	471	Junction box rectangular utilities
20908	471	Bushing conduit reducing
20908	471	Entrance cap 2 in. conduit
20908	452	Tape joint wallboard
20908	451	Wallboard gypsum
20908	451	Lumber pine 2 x 4
20908	451	Lumber pine 1 x 6
20908	451	Counter top formica
20908	451	Nail box 16D
Due-Out:		
20858	451	Wallboard gypsum
20858	451	Lumber common pine 2 x 4
20858	451	Lumber common pine 1 x 12
20858	451	Nail box 16D
20868	463	Heater space 3500 BTU
20868	463	Union pipe block 1/2 in.
20868	463	Nipple pipe block 1/2 x 3 in.
20868	463	Nipple pipe block 1/2 x 6 in.
20868	454	Elbow downspout
20868	454	Pipe downspout galvanized steel
20868	454	Screw tapping 8 x 7/8 in.
20888	451	Tile asphalt floor
20908	471	Wire electrical solid bl.
20908	471	Wire electrical solid bl.
20908	471	Fixture lighting floures
20908	471	Conduit electrical 1/2 in.
20908	471	Conduit electrical 3/4 in.
20908	471	Box connector 3/4 in.

Figure 9 Sim a Material Transactions

used in different ways for different courses. This meant that it was necessary to develop procedures whereby two different courses could interact with the data base at the same time without interference. Various possibilities existed.[4] One was to provide each course with its own data base representing, in effect, a different Hardnose AFB. In fact, BEAMS provided a particular set of capabilities for facilitating such a procedure. Each Air Force base in BEAMS is assigned a parent installation code; every record in the data base carries the parent installation code. Furthermore, BEAMS permits records from different bases, that is, records containing different parent installation codes, to coexist in storage. Records can even be intermingled, since the computer programs when updating files or preparing reports do so on the basis of parent installation code. Similarly, transactions from different bases can be intermingled, being correctly handled on the basis of the parent installation code. This procedure was designed into BEAMS precisely to make possible the use of a single B-3500 and BEAMS software to handle more than one base. Normally the computer would be installed at one base, with the other bases being satellites to this primary base. Thus, for the simulation, by merely changing the parent installation code, each course could have its own data base, even though the data bases were exactly the same, differing only in installation code.

Beginning with Sim A containing only one parent installation code, it had been planned to eventually build up duplicate data bases with other parent installation codes. This procedure has not, however, been implemented in the prototype version of Sim A, for reasons discussed later.

Other procedures for permitting Sim A to be used in more than one course were implemented. For example, let us assume that Sim A includes a transaction that adds to the data base a new record for a new facility number 3001, and that there are not any facilities already existing with numbers 3001 to 3099. Without interference, then, different courses could add this facility as 3001, 3002, 3003, etc. In fact, if the instructor so desired, each student in the course could input the same transaction using all of the same data, except using different facility numbers 3001 to 3099. Similar techniques were used with work orders, etc. In other words, Sim A contains a specific transaction, but in any one course the instructor can use different transaction numbers. The numbers that can be used, and certain rules for assigning them, are included in the instructor guide.[5, 6]

To fully understand the above procedures, it is also necessary to understand the manner in which Sim A is actually run, from the standpoint of the computer. Prior to, but independent of any courses, Sim A is run through the full five days of simulation including all the transactions. One begins with a reel of magnetic tape on which is contained the data base for Hardnose AFB as it exists at the close of day S0 (Friday), which is the same as the opening of day S1 (Monday). The data on this tape are then transferred into disk storage, which is the normal on-line storage used in BEAMS. Each of the transactions for day 1 are now input. BEAMS updates the various files and goes through other procedures, finally resulting in a data base representing the closing of business on day 1, which is the same as the opening on day 2. At this point, for purposes of preparing Sim A, the data base on disk is transferred to tape. One now has on magnetic tape a data base representing the opening of day 1 and a separate data base representing the opening of day 2. One can similarly run the day 2 transactions and have a data base representing the opening of day 3.

Thus, Sim A exists as six different data bases on tape representing Hardnose AFB as of the opening of days 1 through 6. This means that no matter what the students might do on day 3, one can always start day 4 under the assumption that the input from the students was correct. Thus, using our previous example of a new facility, if Sim A adds new facility number 3001 on Tuesday, then that record for facility 3001 will be in the data base for Wednesday, Thursday, etc. However, if the students add 30 or 40 other facilities with numbers 3002 to 3099, records for these facilities will be in the data base on Tuesday, but will not be in the data base on Wednesday if we begin Wednesday with the Sim A tape for that day.

The use of the above procedures provides for considerable flexibility in using Sim A for various courses. Note that it does not provide for a particular aspect of simulation, which is sometimes referred to as sequential dependence, in which if a student makes an error that error will continue to be carried forward throughout the simulation. As explained in the conclusion, Sim A was specifically designed to exclude sequential dependence, such dependence not being introduced until Sim B.

Sim A then exists as what one might call a canned simulation being usable for various educational and training purposes. One could, for example, run Sim A preparing all the reports that one would normally be preparing during the simulation. These reports could then be used as backup for a sort of manual simulation should for some reason the computer not be available during a course, perhaps because of maintenance problems. Thus a fundamental design concept in Sim A was the simultaneous development of a conventional type simulation permitting any sort of desired student interaction, and at the same time a sort of stand-alone canned simulation, which actually provides the instructor with increased flexibility, so that he can use all of the simulation, or only parts of it, or even have students observe a simulated week of BEAMS operation at Hardnose AFB without any student participation in inputting transactions.

SECTION III

DEVELOPMENT AND IMPLEMENTATION

Beams, as initially conceived, was to be an evolving system. At the time of the BEAMS education and training conference in October 1967,[1] certain BEAMS capabilities were designated as Priority I, others as Priority II, and still others were discussed but were not specifically identified. It was thus necessary to plan a modular and flexible simulation that could grow and change as BEAMS grew and changed. However, for reasons that are not relevant here, BEAMS underwent a considerable number of changes throughout its development, and a number of changes greater than one might have anticipated. Some of these were minor from a normal education and training standpoint. Thus if a particular field and a particular record in the computer were changed from six positions to seven, perhaps to accommodate a larger expected value, this would not interfere with any basic concepts, or seriously affect education and training, but it did interfere substantially with Sim A insofar as data had already been committed to punched cards. Of greater significance, certain capabilities in BEAMS around which Sim A was designed were later eliminated or at least delayed. However, in spite of the many changes that took place in BEAMS, both the Sheppard Technical Training Center and the Air Force Institute of Technology had to proceed with their various educational and training courses. Sim A was therefore very carefully designed, and changed (when necessary), to be as independent as possible of subsequent changes in BEAMS.

That a large number of changes might be expected in BEAMS was already apparent in December 1967. In fact, it was not until then that those designing BEAMS were informed that USAF had finally selected the B-3500 as the standard Phase II Base Level computer. In theory, computer programs written in machine independent languages such as COBOL should run equally well on any third generation hardware. In practice, differences in hardware, and more importantly, differences in software operating systems, do necessitate changes in system design.

A series of simulations of increasing complexity and scope was therefore planned. Specifically, Sim A was defined to be an essentially stand-alone, canned simulation as previously described. Furthermore, Sim A was defined to simulate precisely those BEAMS capabilities that would be checked out and implemented 60 days before the first BEAMS courses were to be conducted. Thus, the first BEAMS courses would use Sim A and new capabilities introduced into BEAMS after Sim A had been completed would be subsequently incorporated into a Sim B, which would at some later time be introduced into the courses.

Development effort was then concentrated on Sim A. In early 1968, after a visit by contractor and AFIT-CES personnel to Oxnard AFB the final decision was made to use Oxnard data as the basis from which to develop the hypothetical Hardnose AFB simulation data.

Data Base

The implementation of BEAMS on the B-3500 was the responsibility of the staff at the Air Force Data Systems Design Center (AFDSDC). As a result of various meetings between contractor and AFDSDC personnel, it was decided that it might be mutually beneficial if both cooperated in the development of the data base. The concept was if a Hardnose AFB data base were to be converted to machine readable form it could provide AFDSDC with an excellent test data base to assist in testing BEAMS programs. At the same time, of course, the contractor would benefit in having essentially a clean and checked out data base along with the BEAMS programs themselves which were to be furnished by AFDSDC.

Beginning in March 1968, a series of working papers was developed describing the format and contents of the data base; these were transmitted to AFDSDC for comments. (7-10) After AFDSDC responded with corrections and comments, collection of the data from Oxnard AFB began. The data were collected and transmitted in various forms. In some cases data already existed in the form of punched cards. In other cases, keypunch coding sheets were prepared from raw data. The data were punched onto cards, and a set of listings of the cards was produced. These listings were reproduced, bound together, and distributed to AFDSDC, AFIT-CES, and STTC, as an initial display of the Hardnose AFB data base. However, this initial display was later replaced by a bound set of listings obtained through computer printout of the actual Hardnose AFB data base. This new display of the complete data base has been distributed as a separately bound appendix to a report describing the data base. (11)

At each Air Force base, the Base Civil Engineer is responsible for the preparation of a base brochure which describes the base and its facilities in some detail. In order to support Sim A as an educational and training tool TCI prepared a complete base brochure for Hardnose AFB. The first page of this brochure, which provides an overview of the base and its history, is provided here as Figure 10. The complete copy of the base brochure is included as Appendix I in the Sim A Scenario report.(3)

For purposes of simulation education and training, there are several other documents that would normally be provided to the students in addition to the base brochure. One might wish, for example, to give the students a list of facilities or a list of BCE personnel. It was realized, however, that most of such documents appear as BEAMS products. It was therefore not necessary to collect such documents from Oxnard AFB. Thus the data collection process consisted of collecting 1) the data needed for the BEAMS files, 2) the information needed to produce the Hardnose AFB base brochure, and 3) certain sample work orders and other documents used in the Scenario. Much of the reference material that would be available to the BCE could be produced by the computer once the data base had been implemented and BEAMS was in operation.

Transactions

Sim A consists of a data base and a series of transactions that update the data base; the latter include addition, change, and deletion transactions. Certain transactions are input in real time over the remote keyboard/printer. Others are input as batches of punched cards at the end of the day. All the transactions necessary for each of the five days of Sim A were completed and converted to keypunching coding sheets by 1 October 1968. Certain revisions were made during testing, and also to accommodate changes in BEAMS specifications. A complete documentation of all transactions is given in the Sim A Scenario. (3)

As previously noted, Sim A corresponds to that version of BEAMS as specified in October 1968. In that version of BEAMS there was one concept of particular importance, not only from the standpoint of computer and manual procedures, but also because it represented a major change from previous procedures. This concept was known as "labor exception reporting." In short, using labor exception reporting the workers did not report, for purposes of work control and labor cost distribution, the time they worked on a particular job. The computer assumed that all their time was spent on direct labor, unless a special input message stated that a certain number of hours had been devoted to indirect labor. The various shops did report, by means of production cards, the number of standard hours of work that had been accomplished by the shop. For purposes of cost accounting, the computer would distribute the total direct labor hours used by a shop to the various work orders proportional to the standard hours of work completed on each work order. There are

History

Hardnose Air Force Base is situated in Erewhon County, Everystate, about 5 miles north of Everycity. It is charged with protecting Southern Everystate, primarily the Everycity area, against air attack by an aggressor.

An Air Command Command (ACC) installation, the base is the home of the 999th Fighter Group and 12 subordinate and attached units. It has approximately 1300 military and 244 civilian personnel.

The brief history of what is now Hardnose AFB goes back to 1942. A landing strip was built by the Bureau of Public Roads to accommodate light planes. The advent of World War II caused Erewhon County to change plans for the field, and the U. S. Army Air Corps became its occupants. In July 1942 a squadron of P-38 aircraft was assigned to the field. The Army Air Corps remained until mid-1943, when the field became a U. S. Navy Auxiliary Air Station. Torpedo bombers and drone aircraft first occupied the field, attached to the Naval Air Station at Point Magoo.

In 1949 the Department of the Air Force began an extensive survey of the Everycity area for a site suitable for an Air Command Command base. In 1950, the area now comprising Hardnose Air Force Base was approved. Construction and major renovations began in August 1951, and by March 1952 sufficient construction had been completed to warrant assignment of the 3333rd Air Base Squadron to the base. Major construction was completed in December 1952, and the 666th Fighter Interceptor Squadron, equipped with P-51 Mustangs, began moving into Hardnose AFB from their old home at Short Beach.

In February 1953, the first jet aircraft began to arrive. The 777th Air Command Group was activated and the fighter squadron was assigned Lockheed F-94 jets.

On August 18, 1955, the 777th Group and the 666th Fighter Squadron were deactivated, and the present units, the 999th Fighter Group and the 222nd Fighter Interceptor Squadron, were activated. In December 1955, the first Northrop F-89 Scorpion jets arrived to replace the F-94's. By March 1956, the change-over was completed. Between January and April 1960, the F-89's were replaced by high-performance interceptors, the McDonnell F-101B Voodoos.

Although Hardnose AFB is relatively small and compact, its excellent operational and recreational facilities are unusually complete.

Figure 10. Hardnose AFB Base Brochure
Sample Page

both advantages and disadvantages to such a reporting procedure. This is not the place to discuss these advantages or disadvantages, but since labor exception reporting was to be used in BEAMS, and since it represented a major change from existing procedures, it was important for educational and training purposes that the students both understand the procedures and leave the course with a positive attitude toward them. For this reason, and also because of their importance in quantity and complexity, labor exception transactions and production count transactions formed the major part of the Sim A Scenario.

Or to put it more strongly, Sim A was designed primarily around the function of work control as exemplified by production count processing. Thus, the choice of a time period for the simulation--five days of a single week--slanted the simulation toward day-to-day operations, in contrast, for example, to a simulated time period of months or even years that might have been chosen had the primary purpose of the simulation been to exhibit BEAMS capabilities for assisting the BCE in planning and programming. And indeed the Priority I capabilities of BEAMS, which were to be implemented first, were themselves directed to day-by-day operations rather than long-range planning. This ordering of priorities was necessary because BEAMS would replace certain existing automated procedures done on a B-263 computer and it was first necessary to provide for continuity in these procedures.

The Sim A Scenario has a detailed and completely worked-out set of data showing precisely how many hours each shop devoted to different types of activities each day, as has already been exhibited in Figures 1 through 9. Sim A does, of course, include every other possible transaction within BEAMS. Thus, one particular BEAMS transaction is entering into the proper cost accounting files the cost of a purchased utility. One or two such transactions are included in Sim A. Such transactions, however, are straightforward and identical in concept with previously existing manual procedures, and are therefore not emphasized in the Sim A Scenario. Thus, a quick look at Sim A gives the correct impression that the simulation is primarily concerned with work control, and with the associated function of material control.

Testing

Sheppard Technical Training Center has the responsibility for training B-3500 programmers and operators, as well as, through various special departments, functional users of the B-3500 such as Civil Engineering, Accounting and Finance, etc. Two B-3500 computers were installed at STTC for this purpose. One was used exclusively for programmer and operator training; the other was available for functional user training.

For the latter, several remote keyboard printers were installed on-line in the classrooms of the Department of Civil Engineering. Two additional remote keyboard terminals were installed on-line (that is, over communication lines from Ohio to Texas) at the Civil Engineering School at AFIT for use in BEAMS education. The terminals at the Department of Civil Engineering at STTC and at the Civil Engineering School at AFIT were available for testing Sim A.

Testing of Sim A began in October 1968. Concurrently, AFDSDC was completing certain system tests on a B-3500 at Bolling AFB and implementation and operational testing in cooperation with base personnel at Andrews AFB; Hardnose AFB data were in some cases used as test data, and an implemented Hardnose AFB data base began to emerge.

Although the regular BEAMS courses at AFIT were not scheduled to begin until January 1969, two special courses for implementation/conversion (I/C) teams from the various Air Force commands were given by AFIT in November 1968. These I/C teams consisted of the personnel who would be traveling to the various bases to assist the bases in the implementation of BEAMS. The I/C course, which was a modified BEAMS course with the primary emphasis on implementation/conversion procedures, provided an opportunity to begin to use some of the capabilities designed into Sim A. In fact, it was the possibility of giving the students hands-on experience with the remote terminals--which had not yet been installed at Wright-Patterson AFB--that caused AFIT to decide to give the course at Andrews AFB rather than Wright-Patterson AFB.

The collection of programs for running BEAMS was stored on a reel of magnetic tape and was known as the Civil Engineering-Functional System Tape (CE-FST). Consistent with good system checkout procedures, AFDSDC would use the CE-FST with actual data and then, if any errors were detected, would correct the programs and produce a new CE-FST. In addition, certain lower priority capabilities were added from time to time to the CE-FST. As each new CE-FST was produced, a copy was sent to STTC, where it was available for further Sim A testing, and also for use by STTC and AFIT-CES to run those capabilities of Sim A already operational. Thus, subsequent courses were able to incorporate additional parts of Sim A consistent with the capabilities on the latest CE-FST.

Because it was necessary not only to develop the education and training concurrently with BEAMS itself, but also to actually begin courses before all of the BEAMS capabilities were operational, considerable flexibility, and in some cases patience, was necessary on the part of the instructors both at STTC and AFIT-CES.

Consistent with the status of the CE-FST in January 1969, at the time that courses began at AFIT-CES, it was decided that it would not be feasible to run the full five day Sim A, but that many of the benefits of the simulation, particularly the hands-on experience on the remote keyboard/printer, could be obtained through utilizing merely day 1. For this reason, a particular set of student exercises, separated into inquiries using the remote keyboard/printer and into file maintenance type transactions, all associated with day 1 of Sim A, was packaged. This particular "simulation" was identified as Mod A1. [5, 6]

Work on the data base and the transactions was completed in March 1969.

Prototypes

In early 1969, it became necessary for USAF to make some major changes in BEAMS to coincide with certain new USAF financial management concepts. For example, it was necessary to give up labor exception reporting for the shops, and work with actual hours. Irrespective of the degree to which BEAMS might or might not look conceptually different to the user, it was necessary for AFDSDC to make some major changes in the computer programs. Any changes in the computer programs or procedures, of course, affected Sim A. To use the same example given above, since Sim A used exception time cards as one set of transactions for the simulation, these would have to be replaced by a different set of transactions to meet the need of the modified BEAMS. Furthermore, some reformatting of BEAMS files also was planned, and this meant the necessity of introducing modifications to the Hardnose AFB data base.

USAF decided that, rather than modifying Sim A consistent with the modifications forthcoming in BEAMS, it would be more worthwhile to USAF to package and complete final documentation of Sim A as it existed in March 1969. Furthermore, since it has not been possible, consistent with the available BEAMS CE-FST, to implement all of the capabilities defined for Sim A, Sim A has been designated a prototype simulation, as contrasted, one might say, with a production model.

This prototype version of Sim A, fulfilling the terms under Unit VI of the overall BEAMS education and training contract, exists in the form of a master tape at STTC containing the Hardnose AFB data base and documented, as previously noted, in the Sim A data base report[11] and a set of transactions for a period of five days as documented in the Sim A Scenario. [3]

In addition, various student workbooks and instructor guides for Mod A1, for use in each of the four courses at STTC and the management oriented course at AFIT, were completed and put into use by USAF.

SECTION IV

CONCLUSION

The BEAMS education and training program called for a variety of products, including simulation, to be used both for various technician courses at STTC and management courses at AFIT. Detailed information on the various BEAMS courses held at AFIT-CES and at STTC, as well as the special implementation/conversion course held at Andrews AFB, is contained in other reports.[12-14] As noted earlier, a single simulation was developed which, because of its modular nature, could be used for different purposes by different instructors. Sim A consists primarily of what might be called input and output exercises, that is, experience in using various BEAMS capabilities for inquiries into the data base, for maintaining files, etc. Sim A is particularly well suited to the type of technician training conducted at STTC.

Sim A is also useful in the educational courses at AFIT-CES. However, for purposes of management education one would prefer a simulation more oriented towards managerial situations. The various information that management could obtain through inquiries, or the file maintenance transactions that would result from the decisions he makes, would be part of the management simulation as distinguished from ends in themselves as they are in Sim A.

The management decision-making simulation to be used at AFIT-CES has been designated Sim B in contrast to the procedure oriented simulation Sim A.

In addition to Sim B, a Sim C has also been defined. It will be recalled that the overall planning, programming, and budgeting system used for Base Civil Engineering is known as "Total Programming." Total Programming was not automated as part of the Priority I BEAMS system. For this reason, a separate manual management game which illustrates Total Programming concepts and procedures, was developed and is being used in the BEAMS courses. Sim A and Sim B do not include Total Programming concepts and procedures. Sim C is then defined as an integrated simulation that brings together into a single management decision-making situation, both the planning, as exemplified in Top-Man-X, and the operations, as exemplified in Sim A and B. Because of the major modifications that have been made to BEAMS, and because the automation of Total Programming is now proceeding, it was decided not to implement Sim B, but to proceed with Sim C. As of the time of this report, only a minor amount of conceptual planning has been done on Sim C. To the degree appropriate and feasible, the data base and transactions of Sim A, are available for incorporation into Mod C.

Two main conclusions can be drawn from the experience gained through the development of Sim A. It is first to be recalled that the development of BEAMS education and training proceeded in parallel with the development of BEAMS. Obviously the development of education and training for a system that is itself still under development is more difficult than for a system that has been completed and is operational. This difficulty, however, is more than compensated for by the advantages to be gained: mainly, the ability to have in the field at the time a system is being installed personnel that have already received education and training on the system. Very often a system, whether an automated management system or some other type of system, can proceed quite far in development, and even sometimes into implementation, before adequate plans have been completed for education and training. This was not the case with BEAMS, education and training having been developed in parallel with system development.

Developing educational and training materials, including simulations, along with the development of the system itself, however, makes it necessary to structure the education and training materials in such a manner as to make them particularly easy to modify and change should modifications or changes occur in the system. In particular, a simulation should be kept as modular as possible, and be continually well documented. This is true, of course, for any simulation, but is even truer and more essential for a simulation that is being developed concurrently with the system it simulates.

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Because of the lack of formal identification and the limited distribution of some documents, TCI has assigned a unique number to each document the company either generates or receives, for purposes of identification and retrieval. In the case of TCI publications, this number also serves as the document number; in the case of non-TCI documents, the number is included at the end of the entry.

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13. ABSTRACT

As part of an overall education and training program to instruct Air Force Base Civil Engineering personnel in the concepts and use of the Base Engineer Automated Management System (BEAMS), a simulation of the system was developed. This simulation, designated Sim A, covers a period of one week at a hypothetical Air Force Base, Hardnose AFB, and is intended to give the students an understanding of, and experience in, using BEAMS as part of their day-to-day activities at their bases.

The simulation consists of a data base for Hardnose AFB and a series of transactions that update the data base; the sequence and interdependence of the various transactions are described in an accompanying scenario. Because the simulation was specified for use in a number of different courses, oriented toward both management education and technician training, it was designed to be independent and self-contained, as well as modular. It can thus be easily adapted to any of the courses.

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