Automatic Data Processing in the Tactical Field Army

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THE use of digital computer techniques has become mandatory in the whole realm of ballistic missile design and guidance. And we are rapidly approaching the era in which computer techniques similarly might well become a necessity in many phases of ground combat. The feasibility of applying these techniques in a tactical warfare environment has been established, and the Department of the Army has a high priority program underway to place a prototype Automatic Data Processing System (ADPS) into its tactical organization within the next four years. This paper will explain the design objectives of this system and the progress to date in the applications area, and describe the extension of several techniques required to make the system function.

The technical design objectives may be summarized in about three key phrases—integrated, common-user service center, employing general-purpose hardware. The system in employment has been likened to the widespread tactical communication system, that is, a network of switching centers operated by specialists but tying together all users or customers, largely through the use of common-user trunks and switchboards. More specific design guidelines include the following:

1) Common-user facilities with a minimum number of single-user processors;
2) Integrated data files;
3) Simple foolproof input devices;
4) Interrogation-immediate reply;
5) GP, building-block hardware;
6) Automatic operation;
7) Flexible output.

The tactical ADPS will consist of several elements. (See Fig. 1.) Simple, foolproof input devices will be located at the source of data input. Connecting the inputs to the data-processing center and centers with each other is the Army's area communication system. According to the work load and applications being processed, each center will employ one or more general-purpose computers. Finally, a whole range of output devices is available according to the type of output desired, or rather required, by the commander to facilitate his making a sound decision—volatile but rapid video-display graphical or map-overlay form, or hard-copy reports.

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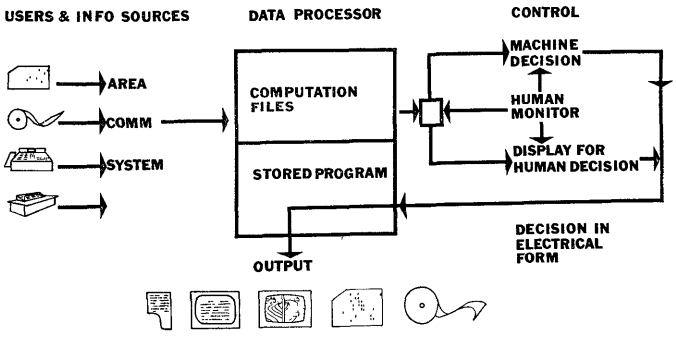

Fig. 1—The elements of the tactical ADP System are located in such a fashion as to minimize the burden on the users of System operation.

Functionally, the system is portrayed as an integration of subsystems according to the military staff function mechanized. The Army's traditional categorization is the well-known G-1, 2, 3, and 4 or Admin., Intelligence, Operations, and Logistics. In each of these categories, however, the uses of information are similar—that is, immediate reaction, longer range planning, and historical preparations. Our system design must be tailored to meet the rigorous specifications of high speed for the immediate reaction use as well as the capacity for large amounts of file maintenance and processing.

Looking at the over-all system configuration, one sees a far-flung complex of data processors and data transmission links, the magnitude of which is presently unique. As is well known, the tactical Army's command structure runs from the Company headquarters to Battle Group, Division, Corps, Army, etc. It appears desirable—and in fact a necessity—to install a data-processing capability within each headquarters from Battle Group back. The physical size and processing abilities will of course increase as we proceed toward the rear of the Combat zone. In fact, at Corps and Army more than one computer will be linked together to make up that data-processing center.

Now, everything described to this point might be called long-range planning. The title of the system discussed is ARMYDATA, and the general time-frame is beyond the immediate future. Nevertheless, we are guided in the immediate systems developments by these objectives. The remainder of this paper will describe the Army's project to attain a prototype ADP System as an intermediate step toward reaching the ultimate.

Slightly less than two years ago, a major project was launched within the Army to place into operation as soon as possible a system which could support the ever-

increasing military requirements for mobility and effectiveness in combat. Because of the long lead-time inherent in the R & D cycle for complex digital computers, the decision was made to parallel the development of the system's hardware and the system's concepts and applications. (The full description of the so-called FIELDATA family of equipment has been left to the companion paper prepared by Captain Luebbert of the Signal R & D Laboratories.)

At the time the decision was made to proceed on the hardware, a plan of action was laid out whereby the entire Army's methods for information handling in the field were to be scrutinized in great detail. The ultimate objective was a detailed description of each user's data-processing requirement with the more immediate by-product of streamlining the manual methods.

Those persons associated with business data-processing systems are familiar with the peculiarity of the systems problems involved in mechanizing integrated business procedures of any magnitude, and here I use the word "system" to mean "procedural" structure. We propose to integrate some 50 or more separate procedures (for as many customers) from concepts developed initially in an isolated fashion. That is, the logistics applications are being derived through systems analysis by the logistics specialists, the combat intelligence applications by G-2 specialists, and so on. To take full advantage of the great power of automatic data processing, we must mold or integrate these individual requirements into a realistic yet imaginative working system which meets the needs of the diverse staff requiring its services. The types of applications to be satisfied again can be broken down into the traditional areas of Operations, Intelligence, Logistics, and Admin. A different categorization according to data-processing techniques might be Combat Control (random access), Combat Support (batched processing), and Combat Computation.

Approximately twenty separate study groups are analyzing some seventy separate potential ADP applications. To assure that these studies will be more directly usable, an instructional booklet has been distributed setting forth a very rigid report format and content. The fact is that the area specialists are not experienced in the techniques of systems analysis, so we designed the booklet more or less to lead the study group "by the hand" through the steps of an ADP application study or systems analysis. Further, through contracts and the use of our own systems analysts, we are providing technical assistance to the study groups, particularly as they reach the phase of proposing an automated procedure for their problem.

Upon completion the individual study reports are subject to a technical review to determine feasibility, completeness, and the amount of dependence on other applications. Analysts return to the agency which conducted the study to fill in details and to eliminate ambiguities. The object of the next step is to define the application to the detail required for programming and to derive certain workload data to be used in the over-all system design.

About this time, too, the preparation of digital models of the system and its parts is to begin. This, I believe, implies the underlying approach to our whole problem: simulation! We shall be utilizing all means and all levels of digital simulation techniques. First of all, interpretive simulation must be employed to permit the preparation and checking out of the computer programs prior to the delivery of the militarized computers. A successful simulation of the MOBIDIC on the IBM 709 has been completed, and so far we have put through successfully a few math subroutines, an intelligence filing and retrieval experiment, a combat surveillance target acquisition simulation, and a limited payroll problem. To extend this technique we are attempting now to develop a simulator generator which will enable us to experiment inexpensively when altering machine parameters or order codes. (This latter is an attempt to lay the groundwork for the later definition of the advanced system characteristics and computer designs.)

Before the detailed design of the prototype system is launched, a subset of the available application areas will be selected for implementation. Only then can we say specifically how comprehensive the FIELDATA system will be in covering tactical procedures. Since it is recognized that the hardware components are experimental in nature, in order to meet a tight schedule without a crash program the FIELDATA system will itself be experimental in nature.

Parallel to the detailed programming of each application will be the use of a digital model of the system information flow to permit a prediction of the needed data rates, alternate routing, and potential bottlenecks. A model is being used now using the 709 which simulates a general army area communications complex. Probability distributions and Monte Carlo techniques are employed throughout, from the preparation of a message entering the system to human switchboard operator actions and to message processing as it progresses toward its destination. A statistical analysis routine produces model-run data reduction and also recommends a sample size according to our level of confidence desired.

To explain the next type of simulation, first I shall outline the organization of the ADPS Test Facilities at the Proving Ground. Computer test facility is around a large-scale computer center, specifically the IBM 709. Herein all of the simulation work will be conducted, and herein will be the means for conducting controlled environmental tests for predicting the validity of our proposed computer procedures. The field-test facilities

are for the purpose implied by the name and will naturally be employed to try to prove out the simulation and model results. Even during these field-test phases we are to utilize simulation techniques. In this context the 709 will be linked to that part of the system being subjected to evaluation in a field operational environment; a single thread employment of equipment will be supplemented by simulation of the remainder of the system. (See Fig. 2.) That is, the computer will provide the data sink to introduce input into the system and to absorb output from these echelons actually being operated.

The Computer Center became operational in February, 1959. The larger part of the application studies are completed, and detailed analysis has begun on several of them with demonstration runs already made on at least two. The major hardware items of the prototype system are on order, with the first to be delivered this coming Fall. Combining this progress with that reported by Captain Luebbert on hardware, transmission, and programming aids we remain confident that our objectives can be attained.

In summary, this paper has reported on an ambitious and futuristic program undertaken by the Signal Corps to provide the Army with a vast tactical Automatic Data Processing System. The proposed system in prototype form is to be operational by 1963 and will incorporate the very latest developments in digital techniques, *i.e.*, new miniaturized general-purpose data-processing devices, computer-to-computer communications, and automatic programming. The research efforts in this project, and certain standards derived, are bound to have an effect on and contribute to related commercial data-processing activities.

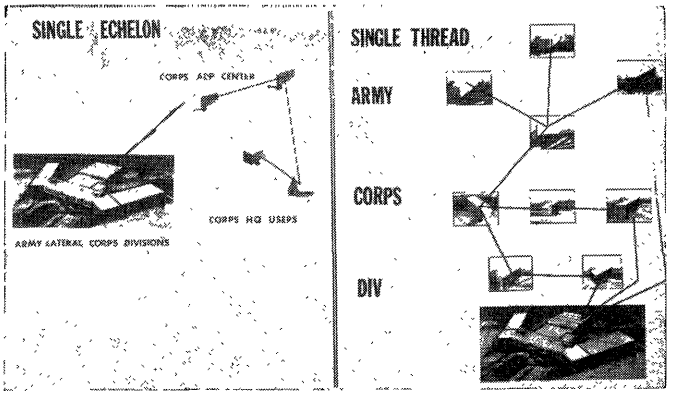

Fig. 2—The IBM 709 will serve as a source and destination of system input and output by simulating the missing echelons during field tests.

Data Transmission Equipment Concepts for FIELDATA

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FIELDATA is an integrated family of data processing and data transmission equipment being developed for Army use. A unique feature of this family is the almost complete disappearance of conventional distinctions between communications and data processing. This paper deals primarily with the concepts and techniques developed to create this evolutionary merger emphasizing the ways in which conventional communications concepts have been adapted to achieve a high degree of interoperability with computers and other data processing equipment, and an extraordinary degree of flexibility and adaptability of application.

In order to explain and illustrate the FIELDATA concepts, this paper makes extensive use of specific examples of design decisions, particularly those dealing with common features such as codes, voltage and impedance levels, data rates, etc. Among the equipments of the FIELDATA family developed in accordance with these concepts and common standards are the following, all of which are scheduled for completion prior to the end of 1960: the MOBIDIC computer (Sylvania), the BASICPAC and LOGICPAC computers (Philco), the AN/TSQ-35 19,200 bit/second data transmission equipment (Bendix-Pacific), the AN/TSQ-33 2400 bit/second data transmission equipment (Collins), the AN/TSQ-32 1200 bit/second data transmission equipment (Stelma), the DATA COORDINATOR, a facilities coordination and control equipment for an integrated communications and data processing system (IBM), and a host of miscellaneous equipments such as magnetic tape transports (Ampex), a flexowriter-like electric typewriter (Smith-Corona), high-speed printers (Anderson-Nichols), security equipment (Collins), etc.

The fundamental capabilities of data processing equipment can be described as the ability to transform

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