ABNER: The ASA Computer
Part II: Fabrication, Operation, and Impact
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This is the second excerpt from Mr. Snyder's study of ABNER, a project originally established under the Army Security Agency, and then adopted by AFSA and NSA. Part I appeared in the NSA Technical Journal, Volume 25, Number 2 (Spring 1980).

(U) It was probably not just a coincidence that at about the same time (July 1948) we were negotiating with the National Bureau of Standards (NBS) for their design and consulting services. Dr. Solomon Kullback, Chief of Research and Development at ASA, effected reorganization that made available the nucleus of the team of engineers that built ABNER. A new division, CSGAS-77, had been created, headed by Charles Schierlmann, to be responsible for analytic equipment development. In July 1948, a new branch, CSGAS-77A, was formed, with the specific responsibility to learn about the new electronic computers. Dwight Ashley headed the new branch. Roger D. Moulton and Kirk V. ("K.V.") Bell were among the first to join Ashley; Ray Bowman had been requested, but was not released from his other assignment until about a month later. As far as I know, my 11 August 1948 lecture to Ashley's group, about computers and the basics of computer programming, was their first exposure to the principles of computer logic and to some of the ways we thought a computer could be used in Agency applications.

(U) It was during July and August 1948 that several internal discussions and meetings with Bureau of Standards officials resulted in the agreement which has been described in Part I. Among those who took part for ASA were Leo Rosen, Schierlmann, Ashley, and Moulton. Since the agreement with NBS provided that ASA would build its own computer using designs and drawings to be furnished by NBS, it seemed that our people would have to "mark time" until the ASA Computer design was completed for us. Of course, during the next five or six months, they were not exactly idle. There were several meetings to settle the design details of our computer, and also a regular series of lectures by NBS for our engineers' indoctrination. In these tutorials at NBS, conducted by Samuel Labkin (at first), Sam Alexander, Al Leiner, Bob Elbourn, and Ralph Slutz, the principles of computer logic, serial dynamic circuitry, and the implementation of arithmetic processes with binary logic were described. Ashley, Bell, and Bowman were the ASA engineers who met regularly with NBS, and within the first few weeks they
were already testing some of these design principles by laying out for themselves what they felt our computer might be like.

(U) By December 1948 the engineering staff had begun to grow, and specific assignments in the various specialties were being made. Tom Lane joined the group in September 1948 and was given responsibility for timing, instrumentation, and basic pulse circuitry. Kirk Bell had begun a study of one of the most important components in all serial dynamic logic, the electric delay line (more on this later). Carroll T. Robinson assisted K.V. with delay lines, and also concentrated on pulse transformers. Walter McCough joined the group in December 1948 and started work on gate structures. William Syphax was responsible for the main power supply, and later worked in the input-output area. Ashley and Bowman were the chief logic designers. This latter relationship worked out very well, although Ashley more and more became the overall administrative supervisor, while Bowman spent almost full time on logic design of individual instructions.

(U) ASA Design Decision. On 15 December 1948 a conference took place in Dr. Kulback's office, at which we discussed the delays in NBS' getting started on our design work and in placing the order for the mercury delay memory. The following day these sentiments were passed on to NBS people, with inconclusive results. The Bureau was still considering two companies, Sylvania and Technitrol, for the memory work. The issue was finally settled in February 1949: Technitrol Engineering Company of Philadelphia got the contract to build mercury delay memories for both NBS and ASA. The Bureau's computer was to have a 512-word memory (one cabinet containing 64 8-word tanks), and ASA's would be for 1,024 words (two cabinets).

(U) In the previous section, we have described some of the design changes from the basic EDVAC which were being proposed and later adopted for our machine. This was an exciting time for us all, particularly because of the mutual stimulation among programmers and engineers, which brought about the many refinements for which ABNER has been noted. But Ashley and company had an additional stimulus, and a very serious responsibility: they were undertaking to build the computer.

(U) Among the early questions considered was how we planned to express data and instructions for input. That is, since the computer would deal with everything in binary form, should we attempt to get into that form before entering the computer, or use the computer itself to do the conversion? We were already familiar with ATLAS and its octal system (three binary bits = one octal character) for expressing the binary values (data and instructions) stored and manipulated by the machine. We decided to adopt the same system for the ABNER computer a system of decimal and alphabetic representation that did not require a programmer to learn an unnatural system of notation. Because the memory memory was limited in size and would be needed for actual program problems, it was decided to perform the necessary conversions from decimal or alphabetic to binary form externally. Thus, the first actual
called "phases," so that the logical designers could assign to phase 1, 2, and 3 the different logic steps into which each instruction might be broken down.

(U) Another critical component in ABNER's dynamic circuitry was the electric delay line. Bell and Robinson early in the project made an investigation of commercial sources. The type more or less readily available was that known as "lumped-constant," which was felt to be too restrictive. That is, for the complex logic involved in many ABNER instructions, it would be desirable to have one finer tuned or with more flexible choice of lengths of delay. The NBS cut lengths of coaxial cable, called Millen line, to achieve this delay, but this was quite bulky. Bell and Robinson decided to experiment with methods of building the "distributed-inductance-and-capacitance" type of delay line. The result was a unique design that had certain advantages: small size, flexible lengths, and satisfactory electrical characteristics. The delay line was made of a polystyrene rod with silver coating containing cuts, or slots, in the silver; around the silver-coated rod was wound fine insulated wire. One problem that caused some setback arose when it was found that the cutting of slots in the silver layer gave rise to
view of one such cabinet, partially completed, positions for 32 delay lines are visible—the other set of 32 are in back and would be accessible from the other side of the cabinet.

(U) Input-Output. Consider a relay race: runner number two is poised to receive the baton from runner number one. As runner number one approaches, runner number two begins to move into position; in fact, he accelerates to a speed almost equal to that of runner number one, so that he can accept the baton and continue the race with minimum slackening or loss at transfer. Even if the speed difference at transfer were great, such as two-to-one, the race could be continued. If the ratio of the two runners' speeds were several thousand-to-one, however, the race might be forfeited; at best the acceleration time would constitute a serious loss.

(U) Like the relay race, computer input-output must address the problem of "interface," that is, the boundary or point where open accommodates the difference in speed between the human's and the computer's normal operating mode. Since ABNER's speed (actual memory recycling rate) was more than 20,000 nine-character words per second, it is easy to see why special provisions were required to take care of the man-machine interface. This interface problem usually has been overcome in two or more stages: typically, a keyboard (operated by a human) produces punched paper tape or punched cards. The tape or card may be "read" at somewhat higher speed and converted to magnetic tape. The magnetic tape can then become direct input to the electronic computer, at still higher speed, and the data or program received and stored in computer memory, where the information is processed at even greater speeds. Similarly for output from computer.

(U) In the case of ABNER, we further compounded the input-output difficulties by deciding to provide maximum flexibility (read that "maximum variety") among input-output media. From the beginning, it was planned to have Raytheon magnetic tape drives; a CXCO electric typewriter and paper tape reader and punch were to be the mechanisms for producing the initial record. It was soon decided to add the capability to read and punch IBM cards, add a Ferranti photoelectric paper tape reader, and acquire a high-speed line printer. Add to this the capability of converting punched cards to magnetic tape and vice-versa, independent of computer operation, and it is apparent that ABNER engineers were putting together the world's most sophisticated input-output capability, as well as the computer with the most advanced logic.

(U) In September 1959 a sub-task was set up, called "Tape Preparation for ABNER," to give needed additional support to ABNER's input-output and conversion problems. In January 1951, William Syphax began work, part-time, on design of circuitry and devices required to put information on magnetic tape from paper tape or punched cards. "Sy" had completed his work on the power supply, and he was required only part-time to supervise its performance as the rest of the computer was being checked out. A converting unit was constructed to serve as a means of making magnetic tape from IBM punched cards. Since it contained its own buffer memory and control circuitry, it could be used to prepare magnetic tape while ABNER...
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ABNER (PART 2)

was in operation. The converting unit could also be used to "input" data to the computer directly from punched cards, and also to prepare punched cards as output. A standard IBM Collator was the mechanism for card input (16 words per second) and the output used a keypunch (2 words per second). About the time Syphax and company were designing circuits to operate on magnetic tapes, three Raytheon magnetic tape drives were on order. There was some question at first whether the machines would be delivered, but in May 1951 the first magnetic tape drive was received. It was found to have faulty bearings in the capstan drive, and the defective unit was later replaced.

A second tape machine came in July 1951, and 12 additional tape drives were ordered, several to be used with other analytic equipment.

(U) During the next several years, most of the effort under this project was concentrated upon attempts to achieve reliable operation of magnetic tapes. Many difficulties were attributed to poor magnetic head design or to mechanical defects in the Raytheon tape drives. Alignment problems were found to be due to poor design of tape guides. The quality of tape itself was one of the most serious difficulties; scratches and lack of uniformity in magnetic coating were principal obstacles. Not the least of our problems was that we were moving tape at 45 1/2 inches per second, a speed these drives were not designed to attain. In fact, Raytheon's own first computer project, HURRICANE, used the same type of drive at 60 ips in computer operations and only 15 ips in peripheral use. In February 1953, J.C. McElvy and Ed Groff were lent to the section and under McElvy's direction, a new attack was launched which eventually led to success.

(U) Because of the lack of uniform quality of magnetic tapes, each reel had to be inspected and a "sync" track recorded, which served as a mark to identify "good" places on tape. At each position on tape so marked, the five-bit-wide data could be recorded, and in subsequent use, read into computer memory or rerecorded with changed information. The most serious problem was caused by read-write-write operation; that is, the machine would read a sync pulse (identifying a good place on tape) and immediately write up to five bits of information, physically adjacent to the pre-recorded sync pulse. Unfortunately, the voltages required to record on tape gave rise to "cross-talk" which affected the ability to read the sync pulse. This effect caused prolonged difficulties and resisted many efforts at a solution.

(U) These problems were finally solved by a combination of several strategies. The core windings on the two sides of read-write heads were connected in opposite polarities, thus greatly reducing the impact of the write signal on read transformers. Damping circuits were designed to get rid of residual oscillations. New improved read heads were designed and built for us. Finally, better tape ("Irish") was obtained from Ovando Co.

(U) Besides the design flexibilities already mentioned, special note should be made of the following capabilities of the magnetic tape system, finally operational after overcoming so many serious shortcomings. It became possible to interchange tapes; that is, tapes written on one machine could be read on a different machine. This system was one of the country's pioneering efforts in this respect. Also, the ability to read and write tape in either normal or backward direction of tape motion, with selective alteration, was a feature still not generally available almost 25 years later.

(U) There were some occasions when producing output printed copy was too cumbersome via CXCO electric typewriter. The ANELLEX high-speed "print-on-the-fly" printer, developed by Anderson-Nichols Company with partial support by NSA, was ready to be tested, so it was decided to attach this equipment to ABNER. Its operation was under program control, as with the CXCO typewriter, setting a manual switch on the ABNER Console determined which mode of output printing was in effect. There were forty print wheels, each containing 26 letters and 10 digits. The wheels were in continuous rotation, and typed hammer stroke selected the character to be printed. Speed was 8 lines per second, yielding an effective maximum rate of 19,200 characters per minute.

(U) Check-Out. By September 1951 ABNER construction was far enough along to begin checking out individual instructions. Lane and Hickman took on this responsibility. Even though much of the computer was still to be built (console, input typewriter, tape reader not yet connected), and the first power supply was far from reliable, they succeeded, on 5 September, in executing a "write" operation into memory. And on 14 September the first operation of the "add" order took place. Within a few days, several other instructions were successfully executed, and on 21 September 1951 our first real program ran successfully! It was a repetitive sequence of "add" instructions together with test for end; it verified our estimates of ABNER's operating speed by executing 60,000 such operations in 1.5 minutes. The repetition and accumulate features, plus one half register, were checked out on 27 September, and a few days later all three half registers ran perfectly.

(U) In October 1951 the console and control table were installed, and wiring connections for CXCO typewriter and paper tape equipment were being made. The first console and control table included unique mechanical equipment for automatically converting four decimal addresses and alphabetic operation symbol to binary form, for manual input of instructions, and also for binary-to-decimal conversion of data and instructions from memory. The mechanical conversion arrangement turned out to be unreliable, and a few months later it was replaced by one using electrical relays. My diary entry for 31 October notes, "Tom succeeded in executing an automatic tape order!"

(U) In addition to McElvy, Groff, Stikes, and Beswick, others who provided valuable assistance in finally getting the magnetic tape drives into reliable operating condition, were Ted Stewart and J.A. Keeh. A special appreciation should be expressed for creative contributions by R.A. Rosen so loaned to the group.
Information directly into memory. My brief diary comments in those days only hint at the excitement accompanying each triumph.

(U) NBS Design Delivery. On 30 October I received a telephone message from Al Leiner of NBS: they would soon be sending us our ABNER design! We had all but forgotten the Bureau of Standards original agreement—here we were, in test operation of a nearly completed ABNER, and NBS was still promising delivery of their design for a (much less sophisticated) machine for us. It was almost six months later, on 11 April 1952, that Leiner and Sam Alexander finally delivered our computer plans. In a meeting with Kilbyack, Schiermann, Ashby, and myself, they unveiled the rather large package. The description of their work was preceded by the statement that they had used up all our money and had finished the job using part of U.S. Air Force funds—we were getting a bargain! After listening to their description of the design details, we then revealed our little secret by letting them see copies of the ABNER Manual, complete with analytic instructions. I proceeded to describe the system details, and concluded by explaining the operation of a program we would be demonstrating on the actual completed machine: a routine to form an idiomorphic pattern from alphabetic text. Needless to say, our NBS friends were shocked and surprised (maybe “dumfounded” is the right word). By this time, of course, most of the analytic instructions had been checked out, but we were not at all sure ABNER would perform for our visitors. We need not have worried—we fed in the tape containing the program, followed by a data tape, and pressed a button: in a couple of seconds the typewriter was banging out perfect results!

(U) Final Check-Out: Early Operations. On 25 April 1952, the last analytic order, cycle transfer, was checked out. By this time, incidentally, several full-scale programs were operational. However, programs requiring large quantities of input data and others with fairly massive output printing could not be tried, principally because our converting unit was not completed. We also began to make firm plans and design work for attaching a high-speed printer. Of course, at this time (mid-1952) our magnetic tape system was far from operational. In May 1952 we had gotten the Ferranti high-speed photoelectric paper tape reader into operation; it turned out to be the most reliable and popular input mechanism.

ABNER Serial 2

(U) In November 1950, while we were still toying with improved analytic features for ABNER, Arnold Durney remarked that he could foresee the need for designing an “ABNER II.” It was not until June 1951, however, that formal recommendations for building one or more logic copies of ABNER were forwarded. In March 1952 a Purchase Description was prepared; the official designation of the equipment was “AFSAF D-53.” The machine came to be referred to as “DEF-53,” or ABNER Serial 2.
as implemented and delivered. ABNER (12) had 2,048 words of Quality delay lines, including the 12-word SOA memory.

By October 1954, the original estimated delivery date was September 1954, testing at the contractor site followed several more months. On May 9, 1955, installation of ABNER II in B-Building at Arlington Hall began.

ABNER OPERATIONS

A new ABNER design approach in full stage plans were being made to train programmers in anticipation of the use of ABNER for operational jobs. Also, there was growing interest among Agency analysts to study the ABNER approach more closely because it was expected to provide a wide variety of cryptographic capabilities.

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Finally, ABNER has been a large and complex computer, leading to its eventual retirement.
In 1950, the first group of people from the Machine Division (AFSA-22) of the Office of Operations, John Powers, Joe Hyduck, and Dorothy Blum, was given introductory briefings on the ATLAS computer, including programming principles. Of these, only Mrs. Blum spent considerable time working with us. She collaborated with John Rixie on a rather ambitious ATLAS program, BLUEBIRD. Other people from AFSA-22 who got their start on ABNER included Lt. John Richards, William Hooker, John Young, Lt. Larry Michaels, and Emory Coil. Lt. Richards' program HAYSTACKS was one of the first large-scale jobs that ran on ABNER in the spring of 1952, soon after ABNER was checked out. This program, which examined pages of key in a search for certain cyclic characteristics.
Bill Hooker was responsible for producing several ABNER programs, including BICYCLE and DETOUR, an experimental combinatorial analysis job. John Young wrote several ATLAS programs, and for ABNER wrote the DASHBOARD and RAG MOP. L. Michelau produced a specialized sorting program intended to be used as part of a COPPERHEAD job. Mr. Cole's programs included ARTICHOKE, CHATTERBOX, an enigma key generator study, and PECAN. In connection with PECAN, the following quotation from the September 1956 PROD Monthly Operational Summary is pertinent:

The PROD programmers who became ABNER specialists in the early 1950s, probably the two most enthusiastic were L. Russell Chauvenet and Richard A. Bentley. Both found the special analytic features of ABNER most fascinating, once their complexity and variability were mastered. Dick Bentley was responsible for the programs SHOWDOWN, FARO, CZAR, LABYRINTH, MAZE, WALNUT, RENO, and SUICIDE. Several of these programs (CZAR, MAZE, RENO, LABYRINTH) were among the Agency's earliest efforts in "dianization" of high-level systems. FARO made particularly good use of ABNER's unique forward and backward movement capabilities of the magnetic tapes. Russ Chauvenet wrote JONQUIL, VITAMIN, and NIMATIV. The PROD Monthly Operational Summary for March 1954 contains the following references to one of these programs:

perhaps the first use in ABNER of automatic program selection came about as the result of a suggestion by an ABNER operator, later turned programmer. Jim Bostic noted that programs which were routinely retained for reuse involved clumsy storing, filing, and manual retrieval of punched paper tapes. His suggestion was for use of the Raytheon magnetic tapes as library; each reel could hold many programs. Bostic wrote a program, MASTERMIND, that automatically assembled many paper tape programs.

when the first successful demonstration of STETHOSCOPE on ABNER was made in October 1953, George Hurley was among the first to sense its power and future possibilities. He proceeded to launch a campaign among PROD managers and cryptanalysts which soon took on the flavor of a one-man crusade, spreading the STETHOSCOPE gospel to all potential users. George gave talks at meetings of various machine planning panels, as well as to individual PROD operations and management people. In addition, he made constructive suggestions for additions and improvements to STETHOSCOPE. Paul Oyer soon joined with George, not only presenting for cryptography the present power and future possibilities of STETHOSCOPE, but also taking the lead in drafting much of the written record.

By the summer of 1954, STETHOSCOPE was considered operational, and thanks to Hurley, Oyer, and others, was more and more frequently used. But the method for specifying and assembling particular tests for each STETHOSCOPE run were still primitive and cumbersome. To overcome these problems and to expand the diagnostic capabilities of STETHOSCOPE, a new project called LULU was begun. Its purpose was to develop a compiler that would automate the construction of a program from a set of small
subroutines as specified by a user in a higher-level language. This was a bold step because not even assemblers existed at that time. In the fall of 1954, Bill Cherry (from Operations) began the development by creating a set of "utilities"—program dumps, trace programs, selective traces, and the like.

(U) Another essential feature that would be required before a true compiler could operate was a relocater. Bill found this part of the job particularly challenging because ABNER's order code, more than other computers, was sprinkled with "addresses" that were not true addresses, but rather groups of bits varying from 1 to 10 each, which in effect extended the order code. In October 1955 Bill attended a short course of instruction in UNIVAC's A-2 Compiler, given by Grace Murray Hopper. The A-2 was probably the only operating compiler in existence, and Bill's attendance at that course enabled him to make some improvements in the ABNER compiler system under development. The finished product, LULU (also called AVAC Compiler), was enthusiastically received. For the first time, it became possible for the programmer to employ a higher-level language to specify and assemble, from magnetic tape storage, any desired set of pre-coded routines in the STETHOSCOPE library. In fact, LULU enjoys the distinction of being the first locally developed operational compiler to be used on any computer at NSA.

(U) In 1957 a major revision of STETHOSCOPE was made, called SUPERSTETH. Its principal improvements were in greater capacities (alphabet size, volume of data sets), enhanced capability to generate other streams of data from input streams, and additional more sophisticated statistics. For convenience, a sponsor could make selections from the library of routines, using the SUPERSTETH Rebus, together with sets of Rebus schedules, called "prescriptions." The ABNER SUPERSTETH program was written by Don Wood and Jim Bosic. SUPERSTETH was also implemented on other computers, including ATLAS II.*

Operations and Maintenance

(U) By December 1952 ABNER was being run several nights per week by PROD personnel plans were formulated for a team of PROD operators and maintenance people. Mr. Robert Lyons was tapped to head up a maintenance team, to be assisted at first by Bob Winter of the R/D maintenance engineers. The date of 5 January 1953 was set for regular swing shift operation.

(U) Bill has documented LULU in his "AVAC Compiler Manual" [12], and also "Combination of Routines in LULU Library," 25 Jan. 1957. [13] Also, in 1961, Paul Oper prepared a description of the STETHOSCOPE program, designed to assist prospective new STETHOSCOPE users [14].

* SUPERSTETH has been documented by Paul Oper, George Harter, W. Ross Murray, and Erwin Hughey [15, 16, 17].

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efficiency was noted. To assist in isolating sources of malfunctions, a "Dictionary of Operands" was created; this served to supplement the R/D engineers' own catalog showing all possible variations of each of the instructions. Besides the lack of hardware or software diagnostics, there were instrumentation problems. Oscilloscopes adequate to observe and correct timing problems, for example, were not at first available. Special external circuits were designed and fabricated which in effect provided a delayed sweep capability. These circuits were the predecessors for the delayed sweep feature which is now on all oscilloscopes. Gradually, the MPRO maintenance team, with help from R/D engineers, was able to get control of the situation.

One of the steps taken towards alleviating the pressure was the setting aside of a portion of time each day for preventive maintenance. Marginal checking of the ABNER memory began in December 1953, and was later extended to the whole machine. In August 1953 a second magnetic tape mechanism was being installed, and the converter was successfully used for punched card input to ABNER in an operational job. Also, about this time two standard service routines were in operation for printing and punching out the decimal addresses and letter operation symbols for any selection of consecutive memory locations. By December 1954 a modification was completed making it possible to read paper tapes containing 6- or 7-level coding directly into ABNER. And magnetic tape was used successfully on two operational ABNER programs. Preparation of accurate magnetic tapes for use on ABNER had been among the difficult problems, requiring changes in reading heads and much adjustment of the tape transports. By April 1955 an average of one 8,000-block magnetic tape per day was being made, with 100% accuracy. On 1 August 1955 ABNER was officially turned over to PROD. By December 1955 several steps were being taken to increase its operational time including effective control of preventive maintenance and allocation of blocks of time for checkout of new programs. As a result, available time for ABNER operation was up about 25%.

(U) In February 1956 a modified Remington-Rand line printer was connected to the ABNER Computing Unit, for use with ABNER(2). The R-R printed 10 lines per second, with up to 120 characters on a line. This completed the installation of ABNER's auxiliary equipment, making it now possible to print from the Converter information from a magnetic tape drive, IBM Card Collator, or from ABNER itself. A little later (September 1956) the converting device MAYBE was completed. It could be used to (1) print from ABNER magnetic tape on line printer, (2) convert from punched paper tape to magnetic tape, and (3) convert punched cards to paper tape. In June 1957, MPRO accepted ABNER(2).

(U) The various modifications being made by R/D engineers and technicians, plus adjustments and repairs, occupied so much time that ABNER(2) had not given much productive operation when, in October 1957, it was disassembled and moved to Fort Meade. ABNER(1) of course had not been designed for relocation, so it was dismantled soon after.) After the move to Fort Meade, ABNER(2) actually performed more reliably than before the move. This was, of course, the cumulative result of the series of modifications and additions, some of which we have described, and also partly due to better tools and more experience gained by engineers and operators. But by the end of 1959, the computer engineering art had improved so much that it was no longer worth the effort to keep ABNER running, and the machine was retired in February 1960.

IMPACT

(U) A favorite exercise among writers of history is to speculate, with the benefit of hindsight, on "what might have been." Such an exercise is not often useful, but on occasion may be educational.

(U) As a sometime writer on computer history, I am often inclined to wonder about the direction the computer industry would have taken (if the first few years anyway) if the first modern machines had been planned in response to the needs of business instead of the military (ENIAC's ballistics computations). Or, if this Agency's machine planners had gone a step beyond our World War II Bombs and the like (which were really large-scale data processors and statistical analyzers), and had come up with the first stored-program devices, we might have designed an ABNER-like machine five or ten years earlier. That is to say, if the first applications of stored-program electronic "things" were not arithmetic (or non-mathematical), we might be caling them "analyzers" or "information handlers" instead of computers (how about "dataanalyzers"?)

(U) As a practical matter, I'm not sure that computer history would have been much different; after all,泄露VAC I was designed for the Census Bureau. But I have felt all along that their ability to compute at "out-of-this-world" speeds was secondary, as far as innovative contribution is concerned, to the computer's revolution in logical organization; the stored-program, the "information handling" type."
Comparators DELLA and CICERO grew out of, or were Ray Bowman's inspirational follow-ons from ABNER's "swish" instruction. Even more striking, the HARVEST Streaming Units may be said to have been based on the same ABNER feature.

(List) Probably of more significance to the outside computer world, although not generally known in time to have much impact, was ABNER's immensely flexible complement of input-output features:

(1) ABNER was the world's first electronic computer that could compute simultaneously with input-output.

(2) Blocks of words to be read from or written on magnetic tape could be either consecutively numbered or individually addressed words in memory.

(3) Direction of tape motion could be forward or reverse.

(4) Block size on magnetic tapes could vary, in multiples of eight words.

(5) Output printing could interpret each word's set of nine characters as being read in forward (right to left) or backward (left to right) direction.

(List) Of course, as we have said earlier, the very comprehensiveness of all these input-output options was impressive if not unique: conventional paper tape reader and punch; photoelectric paper tape reader (315 characters/second); IBM card reader and punch; four magnetic tape drives operating at about 250 words per second; output typewriter, high-speed printer (Anacle), eight 40-character lines/second, Remington-Rand line printer on ABNER(1), ten 72-character lines/second.) In addition, it was possible to convert data among the above media, simultaneous with computation, using the conversion unit, as well as enter or read out data manually from the console, binary, decimal, or binary.

(List) Not much has been said about software for ABNER. In fact, programming was done at machine-language level. But N.S.A. first operating compiler was developed for LULU, the outgrowth of STETHOSCOPE. And of course SUPERSTETH built on and expanded that still further.

(List) Finally, as in most large innovative developments, a great impact was felt in respect to the personal and professional growth of all those involved in ABNER—the planners, designers, builders, programmers, operators, maintainers—even the administrators whose "yeses" came through when needed! We who were associated in this pioneering effort in a pioneering industry can look back on one of the most rewarding experiences that can come to anyone, and we are thankful for the support we all enjoyed.

REFERENCES


[16] (U) Oyer, Paul and Hickey, George, PROD-03 Informal No. 12, 18 January 1957, "SUPERSTETH Routines and Statistics (Revised)" (S-95-428).