The availability of interactive programs to search structures and to search biological activities provides a tool which permits the working chemist to address large banks of information individually. This capability leads to better and more imaginative research as well as increased performance of the user. Users recognize this, and several of our top scientists are now using these programs.

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Evaluation of the IBM Administrative Terminal System and Magnetic Tape Selectric Typewriter for Text Processing*

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The Administrative Terminal System (ATS), designed by IBM for use with System/360, is a remote, on-line, timesharing, input-output device which allows interaction with the Central Processing Unit (CPU) in a conversational mode and with computer peripherals. ATS operations are detailed, the use of ATS for text processing is evaluated in comparison with the IBM Magnetic Tape Selectric Typewriter (MTST), and the importance of the interaction of ATS with computer peripherals is described.

Typing is an essential operation in practically every communication system. Yet it is today what it was when the first typewriter was introduced: a completely human-controlled operation. Even though the typewriter of today is far superior to its predecessors, the productivity of the average typist is about 60 words per minute, or about the same as it was 40 years ago. In most working environments, however, the average typing output from dictation or hand-written copy is something under 30 words per minute, after corrections and changes by the writer.

Because typing is a time-consuming and costly step in the communication process, and particularly so in most phases of chemical documentation, we have tried to be alert to new methods or mechanisms that reduce typing time and costs[1,2,8]. We have studied and designed new posting methods, investigated and utilized the IBM 870 Document Writer[6], and evaluated TEXT 360[7].

This paper reports our evaluation of the ATS (IBM Administrative Terminal System) relative to the MTST for text processing of translations, technical reports, manuals, form letters, directories, mailing lists, etc. Our understanding of the ATS software indicated that it could be particularly suitable as a remote, time-sharing, input-output terminal for text processing[4].

ECONOMIC CONSIDERATIONS

If we assume the cost of a typist to be $5.00 per hour with overhead, then the use of an MTST or ATS must increase the productivity to more than offset the additional cost.

A one-tape MTST rents for about $200 per month and a two-tape MTST for about $300 per month; an ATS plus a Data Set rent for about $130 per month. The MTST rentals add $1.20 and $1.80 per hour and the ATS terminal rental adds $0.77 per hour to the cost of the typist based on 168 hours per month. Thus, the productivity of the typist must be increased by at least 24% or 36% with the MTST, or 30% or 45%, respectively, when we add the cost of the magnetic tape cartridges ($40 per month replacement cost) to the rental of the MTST. In the case of the ATS, whereas the terminal rental requires a productivity increase of only 15%, the cost of the computer can run from $1.50 to $7.50 per hour for terminal connect time, depending upon how many terminals are time-sharing the same CPU block. Assuming a computer cost of $3.00 per hour, the ATS must increase the productivity by at least 75%.

It is quite apparent from these economic considerations that the MTST and ATS are not for all typing assignments. They are not economically feasible, for example, for typing assignments that are not subjected to revisions by the writers or that are not repetitive in part or in whole. They are most economically feasible for repetitive typing assignments, for text that needs to be revised and updated, and for text that needs to be communicated in different formats.

FEATURES OF ATS vs. MTST

Table I, which summarizes the features of ATS and MTST, shows that the ATS is a far more flexible system and provides many features not available on the MTST. The greater flexibility and additional features of the ATS are possible because it is on-line with the 360, whereas the MTST is a self-contained unit:

Table 1. Features of ATS and MTST

Feature	ATS	MTST
1. Page Depth Control	Yes	No
2. Right Margin Justification	Yes	No
3. Automatic Line Numbering	Yes	No
4. Underscore	Yes	Yes
5. Automatic Page Numbering	Yes	No
6. Automatic Repeating of Headings and Footnotes	Yes	No
7. Automatic Centering of Text	Yes	No
8. Stop Codes	Yes	Yes
9. Print Interrupt	Yes	Yes
10. Print Options	Yes	No
11. Extensive Input Corrections or Changes	Yes	Yes (two-tape only)
12. Output Corrections	Yes	Yes

Figure 1. ATS machine configuration

ATS MACHINE REQUIREMENTS

ATS input is by means of an IBM 2741 communications terminal, which is a Selectric Typewriter with electronic controls for transmission of input to the computer through a telephone line. Tie-in to the telephone line is by means of a Data Set or Data-Phone (obtained from and installed by the Telephone Company). Each ATS interfaces with the computer through a single IBM 2703 Communications Control Unit, as shown in Figure 1.

The ATS software (in Assembler language) and input operating storage requires a minimum of 22.5K bytes of CPU for approximately up to 20 terminals with no apparent evidence of delay time at any terminal. ATS is possible in System-360 Model 40 or better because of the availability in these models of the multiplexor and selector channels, which allow the ATS user to interface with peripherals, such as magnetic tape, card read-punch, and high speed printer.

The ATS Supervisor function, a multiprogramming system control, uses 11.7K of the 22.5K. This function is the software that allows the use of any of the 39 application programs (not resident in core) and for switching and task scheduling operations. Input from ATS uses 8.2K, and accessing working and permanent storage and tie-in to additional terminals use 2.6K of the 22.5K.

Of the 39 application programs IBM provides for ATS functions, 19 are dedicated to terminal operations—e.g., four programs for terminal typing output, one for moving lines of text, one for storing a document, etc. The remaining 20 programs are for utilizing computer peripherals, such as the high-speed printer, card read-punch, tapes, disks, etc. The size of the programs range up to a maximum of 8.2K. ATS operations normally use one to four application programs simultaneously, and thus require a CPU core allocation ranging from the minimum 22.5K to a maximum of about 50K.

ATS INPUT[3]

The upper right-hand key on the IBM 2741, marked "ATTN" (attention key, in the same position as the "index key" on a normal Selectric Typewriter), ties the terminal into the computer. Signing on the ATS consists of turning on the typewriter, touching the ATTN key, and specifying the terminal call number. The computer responds by typing out the line length, page depth, and tab settings of the last term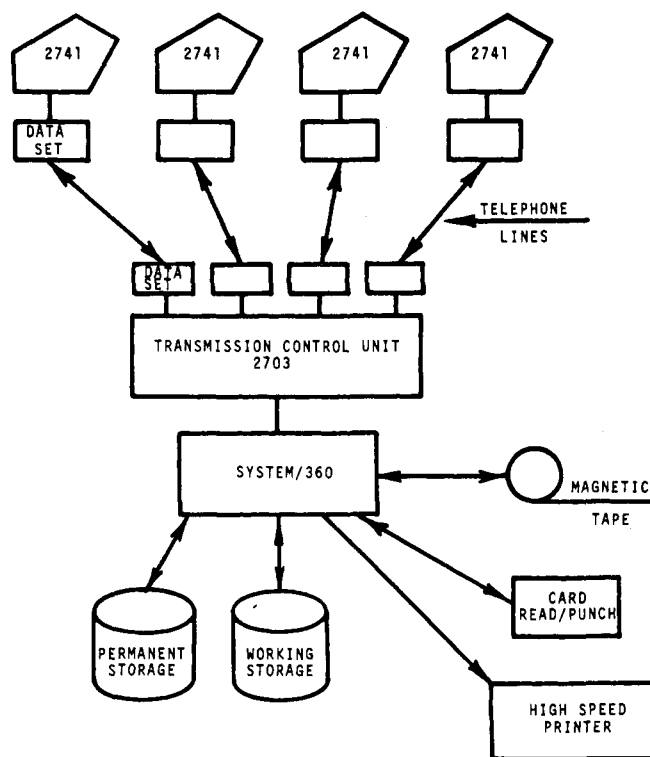inal input; the operator changes these by merely specifying the ones to be set for the document to be entered by again touching the ATTN key, the lower case w key, the desired length of line (a number such as 50 for a 50-character line), the semicolon key, the desired number of lines per page (a number such as 55 for a 55-line page, and then returning the carriage. In this example, the following specification is typed: w50;55. This is maintained until changed by the operator.

Lines are input in unformatted or formatted mode. When signed on, the system is automatically in the unformatted mode which yields an output identical to the input. Placing the system in the formatted mode by the ATTN key, a lower case tf, and a carriage return (the terminal responds by typing out FORMATTED MODE) allows the operator to control paragraphing with a fixed line length. Paragraph indentation is established in the first line and the left-hand margin is established in the second line of the paragraph. Thereafter, typing in succeeding lines may be in free form. For example, some operators find it convenient to start each sentence on a new line (for easy revision) in the formatted mode.

Although typing on the IBM 2741, on a line basis, is like that on any Selectric Typewriter, there is a 0.3 second delay in the carriage return before the next line can be typed. This delay, imposed by the computer for transferring each input line from core to working storage, is quite noticeable and bothersome to experienced typists, and requires them to adjust at the expense of their typing rate.

Two needs of a chemistry-oriented environment, specifically the need to use chemical formulas and abbreviations, cannot be handled directly in the ATS. To get around the special characters and subscripts in chemical formulas, stop codes (which stops the typewriter in the output step) are inserted with the requisite space allowed for manual typing during the output. ATS treats periods as at end of a sentence. Undesirable breaks may occur with abbreviations at or near the end of a line of text. We avoid this problem by not using periods with abbreviations.

Decisions for automatic page numbering, repeating of page headings, and avoidance of starting a new paragraph within the last few lines of a page are made during input. For example, to have each page automatically numbered after the first page, the operator enters the following command:

ATTNtuh23
−ATTNATTN−
ATTNt+4

The *tuh* places the number at the top (*tuf* places it at the bottom) of the page, *23* instructs the computer to start numbering on page 2 and to continue numbering each page thereafter, and *t+4* instructs the computer to continue typing four lines below the number. The double *ATTN* plus a space, during input of text, commands the computer to stop the typing until the operator commands it to resume typing.

To avoid starting a long paragraph at the bottom of a page, the operator commands the computer to count the number of lines in the paragraph. This is done with a lower case *t* (at the beginning of the paragraph and *t*) at the end of the line, such as the third line. This command places the complete paragraph on the following page, if at least three lines were not available on the preceding page.

Errors by the operator during input can be corrected by one of three ways:

If the error is near the end of the line, back-spacing to the error deletes everything on the line back to the error, and the deleted section is retyped.

If the error is near the beginning of the line and detected before the carriage is returned for the next line, striking the *ATTN* key and one carriage return deletes the entire line automatically and allows the operator to retype it.

If the error is detected after additional lines are typed, the operator can correct the specific mistake by the command: *ATTN−x; incorrect word; correct word*, where *x*=the number of lines back for the line with the error to be corrected.

Because ATS is only as reliable as the computer system, which, as computer users know only too well, can fail for a variety of reasons, we place input of long documents into permanent storage every several pages of input, primarily as a safeguard against a system failure that might erase the input from working storage. Generally, however, a system failure results in the loss of only the last line of input. Input from the terminal resides in working storage until the operator commands the computer to place it also in permanent storage. Input is placed in permanent storage with the *ATTN* key, a lower case *s* (*ATTNs*), the document name, and a carriage return; the computer responds with the statement *DOCUMENT**STORED***. Signing off the ATS automatically deletes the document from working storage. Consequently, the operator must be careful that it is in permanent storage before signing off the ATS. When the operator signs on, the document in permanent storage is brought into working storage by the following statement: *ATTNg* (document name). The document resides in permanent storage until deleted by the operator as follows: *ATTNd* (document name); the computer responds with the document name, to which the operator must input a lower case *y*, and the computer responds with: *DOCUMENT* (document name) ***DELETED***.

ATS OUTPUT (PROOF COPY)

Whereas the maximum typeout rate of the ATS and MTST is 130 words per minute (by our observation), the rate for proof copy output is no more than 110 words per

minute. This decrease in rate for the ATS results from the automatic numbering of each line in a right hand column two spaces beyond the line width initially specified, which requires the carriage to travel the length of the line width specified plus two spaces plus the line number regardless of the number of words (one or more) in each line. The line number is the basis for corrections, deletions, and additions in the proof copy.

In producing proof copy with the IBM 2741, typing stops at the end of each page, and is resumed on the next page by pressing the *ATTN* key twice. This ties the operator to the ATS during the typeout of proof copy or alternatively, if the operator is busy with non-ATS work, the ATS is on-line during the page stop period (with a computer charge) until the *ATTN* key is touched. The net effect is a slight reduction in typeout rate from 110 to 90–100 words per minute with attention by the operator and a nonproductive period for the operator, or an increased computer cost.

The MTST, on the other hand, yields its typeout at 130 words per minute. In the case of a one-tape MTST, however, only one typeout is possible and this is done as corrections, additions, and deletions are made so the copy ends up as the final copy. Thus, the final copy produced is not stored on the tape.

The major advantage of the ATS is the option of using a high-speed printer off the computer for producing the proof copy at a computer plus printer cost of approximately $0.06 per page. This is the route we use for documents larger than a few pages.

After the proof copy is edited by the writer, the operator signs on the ATS, transfers the document from permanent to working storage, and makes corrections, additions, and deletions from the end of the document. Working from the end to the beginning is desirable as the computer automatically renumbers the lines because of the added and deleted lines, thus allowing the operator to use the initial numbering of the lines yet to be corrected or changed.

A word is corrected, such as typst in line 22 as follows:

ATTN22;typst;typist

A line is deleted, such as line **22**, as follows:

ATTNe22

Consecutive lines are deleted, such as lines **22–26**, as follows:

ATTNe22;26

A new line is added, such as between lines 22 and 23, first by typing the new line, which the computer automatically numbers as the last line in the document, such as line number 237. The command to insert (move) the new line to its correct position is as follows:

ATTNm22;237

After the corrections, additions, and deletions are made, the document is maintained in permanent storage as a revised version and with a new document name.

ATS OUTPUT (FINAL COPY)

Final copy output with the ATS is at 130 words per minute, except that the automatic stop at the end of each page reduces it to about 115 words per minute. As for the proof copy, the document is processed preferably on the

high-speed printer. The ATS also allows output to any computer peripheral, including another terminal. A major advantage of the ATS over the MTST is the ease with which additional corrections can be made even at the final copy stage.

A productivity study of input-output by electric typewriter, MTST, and ATS showed the following costs per page by each method for technical text:

One page of error-free text by electric typewriter is produced in 42 minutes at a cost of *$3.50* (using $5.00 per hour for cost of typist, but neglecting amortization and maintenance costs).

One page of error-free copy with the MTST (one-tape) is produced in 30 minutes at a cost of $2.50 (typist) + $0.71 (for MTST rental and tape replacement cost) or a total of *$3.21*.

One page of error-free copy with the ATS (using the IBM 2741 for typeout) is produced in 33 minutes at a cost of $2.75 (operator) + $0.42 (for ATS rental) + $0.83 (computer cost at $1.50 per hour) or a total of *$4.00*.

One page of error-free copy with the ATS (using the high-speed printer for proof and final copy) is produced in 20 minutes at a cost of $1.67 (operator) + $0.26 (ATS rental) + $0.50 (computer cost) + $0.12 (printer cost for two pages) or a total of *$2.55*.

These productivity studies were made under actual working conditions, and included work interruptions as well as erasures and retypings in the case of straight typing work and corrections, additions, and deletions in the case of ATS and MTST work.

OPERATOR TRAINING

A computer-assisted, programmed instruction package in a conversational mode, called LEARN ATS[5], consists of an introduction and seven lessons in the ATS. A workbook introduces ATS and LEARN ATS and guides the operator through the seven lessons in LEARN ATS with a variety of exercises. Although it takes about eight hours to complete LEARN ATS and the exercises, the operator is able to use the ATS effectively after the first four lessons and their associated exercises.

Our operators learned MTST by attending a two-day IBM course.

CONCLUSIONS

ATS and MTST are well-conceived processing devices for typed input and output with high potential for time- and cost-savings in a variety of communication operations.

It would be difficult to justify either for relatively short documents, such as two pages or fewer, that are one-time communications, except for the esthetic value of erasure-free copy. They are particularly outstanding devices for communications that undergo minor changes, such as form letters; that require periodic updating, such as directories, manuals, and inventories, for which the major portion remains relatively constant from issue to issue; and that require extensive and several editings, such as technical reports and proposals and creative writing.

Typewriter input-output with the ATS is not economically competitive with the MTST unless the computer cost for ATS is ignored. The economic disadvantage of ATS *vs.* MTST disappears, however, for text subjected to extensive and many editings or for text of many pages that need to be stored for recall over a long period of time for periodic updatings and partial or complete typeouts.

Typewriter input and high-speed printer output for proof and final copies with the ATS is not only more economical than the MTST, but provides options not available with the MTST, such as right margin justification, automatic page numbering at the top or bottom of the page, automatic running heads or footnotes, and page formatting. In addition to text processing, the ATS is a flexible on-line conversational, computer terminal which allows us to interact with the CPU and the computer peripherals in the processing of information.

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