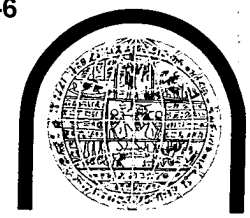

"Record Protection in an Uncertain World"

WORLD CONFERENCE ON RECORDS AND GENEALOGICAL SEMINAR

Salt Lake City, Utah, U.S.A.
5-8 August 1969

COMPUTER INPUT AND OUTPUT TOOLS AND TECHNIQUES

Part III

Video Data Terminals and their Applications

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With the advent of computer on-line mass memory capabilities, the techniques of entering records to these files has undergone some rather significant changes. It is no longer necessary, nor economically justified, to "batch" entry of records. The availability of these records, on an on-line basis, has also caused some drastic changes in information retrieval.

Terminal devices have, until recently, been oriented to punched paper tape, card or on-line typewriter equipment with hard copy output as a byproduct. The desire for higher speed terminals and some significant breakthroughs in electronic circuitry, smaller and lower cost components, have made it possible to produce reliable and low cost video terminals in large quantities. Until recently, devices of this type were limited to rather large and expensive military command and control consoles. It is now possible to obtain video terminals in the same price range as teletype and keypunch equipment. As is always the case, the development of new devices breeds new vendors in some direct relationship to the number of potential customers. This creates a very healthy, competitive situation, but it also confuses the potential user when attempting to select the proper device for his application.

Some basic criteria and developing standards for video terminals can now be specified. Before going into these details, fundamental system classifications should be made:

Video data systems generally fall into two categories; "stand-alone" and "modular". The "stand-alone" terminal is distinguished by its ability to be connected directly or remotely to a computer, in a single station complex, without the need of further controllers. This means all logic, character generation, storage and line interface capability is contained within a single terminal. The modular system consists of a "controller", character generators and terminals. The logic, character generators, storage and interface are shared by a number of terminals. This type video data system is most often utilized when it is possible to cluster groups of operators within certain physical limits. This technique tends to reduce the cost of the system on a per terminal basis because of its hardware sharing concept.

The standardization which is taking place in these products appears to be dictated by user requirements and transmission media rather than by any "standards group" or the vendors themselves. Some of these standards are:

Screen capacity maximum requirements of approximately 1000 to 1100 characters.

The screen size is 12" in a diagonal measurement.

Maximum line length of 80 characters.

The character set is 96, containing both upper and lower case alphabetics, numerics and special characters.

Two basic keyboards, a typewriter layout and a keypunch layout.

Three erase modes - character, line and screen.

Cursor movements of forward on a line, backward on a line, down a line and up a line. The movement is single character and "slew" (continuous).

Remote transmission speeds of 1200 to 2400 bps (120 to 300 cps). This, of course, is now being moved upward with the increased modern capabilities.

With these basic standards we can now expand them to include other desirable features which increase the capability of the equipment, simplify the operation of the system and improve the reliability of the data. I believe I would rate screen legibility as one of the prime considerations. Continuous use of the video terminal by an operator should not cause eye fatigue; and random use should not lead to errors caused by misinterpretation due to poor legibility. The affecting factors are:

(1) Character generation technique.
(2) Character refresh rate.
(3) Picture tube phosphor.

Now we will look at each of these in a little more detail:

CHARACTER GENERATION:

1. *Dot Matrix* - Generally, this system uses a pattern of five dots wide by seven dots high for a total of 35 dots. The characters are created by selective activation of any number of dots to build a character. The dot matrix character is considered the least acceptable from a legibility standpoint. It is also very difficult to create readable lower case alphabetic characters. As an example, the tails on the letters, P,Y,Q and G are above the line rather than below, where they belong.

2. *Stroke* - Characters created by this technique are somewhat better and more flexible than the dot system. Up to 16 strokes, which are connecting lines, are generally used to create any character. There are systems using as few as eight strokes and as many as 40. Both of these are outside the average. Again, legibility suffers on special characters and lower case alphabetics.

3. *Monoscope* - Characters generated by the monoscope technique are fully formed on the screen by sine wave scanning of a character which has been die cut in a metal disc, also referred to as a "target". The target is encased in a metal monoscope tube, which is about seven to ten inches in length. The signal which is read out of the monoscope tube causes the same image to be traced on the picture tube simultaneously with the scanning. It is possible to create any desired characters on the disc almost without loss of legibility. The monoscope system is considered superior to either of the other techniques.

REFRESH RATE:

The refresh rate refers to the number of times a character is refreshed on the cathode ray tube (CRT). Refresh systems now in use vary from 30 to 60 times per second. The higher the refresh rate the less "flicker" on the screen. The flicker is caused by partial fade out of a character before it can be refreshed on the screen. Any refresh rate lower than 54 times a second is considered vulnerable to early fade and flicker.

PICTURE TUBE PHOSPHOR:

Many phosphors are available in CRT's, which vary in color and image retention. The retention rate has a direct relationship to the refresh rate. Lower refresh systems use high retention phosphors in an attempt to overcome the fade out prior to refresh. The high retention phosphor tubes are prone to image burning (burned out phosphor in areas of high use), also ghosting of characters and early failure. It then becomes apparent that the better systems utilize a lower retention phosphor with a high refresh rate. The major systems in use today use either off-white, green or yellow phosphors. The merits of any one color as compared to another is largely a matter of taste. The only comment I can make is that you don't see any green or yellow television screens, therefore the research and human engineering work done by the manufacturers of television sets must indicate the desirability of off-white and on a gray background.

I mentioned earlier the importance of certain features, in addition to the cursor controls and erase functions, which increase the capability and simplify the operation. These are the editing functions of the video terminal and deserve some review.

Additions to text or form material should be accomplished without having to retype any

subsequent data. On the RCA terminals this is referred to as "Data Insert". Activation of this feature causes the text to shift to the right and down the screen as the additional information is typed onto the screen. This can be accomplished a character at a time for simple error correction on misspelled words; or it can be used to interpose new words, lines or paragraphs within the text. No longer is it necessary to throw away the record and start over.

In addition to being able to add to previously prepared text it is possible to delete information and close up the text or data. When characters are deleted the text to the right of the deletion point shifts to the left and fills in the space of the deleted information. Some systems close up the complete page, others the affected line. I feel the line approach is easier for the operator to control and comprehend.

Operator assistance is of course of prime concern with any terminal device. One of the most beneficial features of some video data terminals is the ability to display a form, or format, on the screen which the operator "fills in". With this capability it is possible to work directly from source documents (without recoding) with fewer operator errors by use of screen layouts with direct relationship to the source document. With the RCA terminals this is the "Data Format Feature". Any number of "formats" may be stored in the computer and be called out and displayed on the screen as field headings with variable entry fields following. The entry market (cursor) positions only in these variable fields, and jumps over the headings as a field is justified, and theoperator may only enter data within the variable fields. Upon transmission, only the variable data is transferred to the channel, thereby minimizing the total volume of data entering the computer (and the total time required for transmission).

When using the video data terminal as an inquiry/response device it is desirable to retain the inquiry on the screen and also receive the response from the processor. Other applications such as record retrieval and data entry may not require this capability and therefore do not support the sacrifice of screen capacity. This capability must be available but also selectable to provide complete flexibility.

The requirement for hard copy output from the video terminal has not been mentioned as yet. This is not because of its lack of importance, but more because it is considered a side benefit. It is possible to print directly from the memory of the video terminal without additional transmissions from the processor or installation of added communication facilities. Since most low cost printing devices also operate at lower speeds than the video terminal, consideration must be given to the amount of printing that should be done through the system. The real benefit in printing from the video terminal is derived by being able to review a series of records on the screen, select the desired record and obtain a printed output. It is also possible to select the printer from the processor and accomplish the printing without the intervention of the operator.

By reviewing the desirable features, we can see that a video terminal may be a "stand-alone" station, or clustered with a shared logic controller and operates at reasonably high rates of speed. It is also possible to connect the "controller" directly on a computer

system without communication facilities at much higher rates of transmission up to magnetic tape speeds. The screen capacity is about 1100 characters with a maximum line length of about 80 characters. Other formats are available and should be used to fit applications. The keyboards are oriented to typists or keypunch operators and provide the ability to correct data without having to throw away any previous work, to add to the text at any point without having to overwrite and the prepared material may be reviewed or proofread in its readable form, prior to transmission and interupt of the processor. The same terminal used for preparation of data or records is used for receipt of data from the processor. The terminal is quiet because there is no typing or punching mechanism, and it fits in well within an office environment.

The video terminal is now being used in almost every industry, and for many varied applications. The broad categories of use are: data entry, inquiry/response, text editing and record retrieval. Inquiry/response applications have received the greatest amount of news coverage because of the public's close association with these operations. I am sure you will recognize from your own experience requests to airlines for reservations, telephone directory service, banking inquiries, and requests for public utility service. The benefits derived by these industries from use of the video terminal for customer service are numerous. Of course the most direct benefit is faster and more detailed response to customer's inquiries, and secondly, a reduced cost per service inquiry. Text editing and record retrieval applications really fall within the general inquiry/response category since all transactions of this type start with the retrieval of a basic record. The benefits of text editing with video data terminals are obvious after review of the hardware specifications. Record retrieval capabilities need little explanation when considered as a response to an inquiry. Actual retrieval techniques are beyond the scope of this presentation or terminals.

The application with the greatest potential for savings and increased efficiency is data entry, or record entry. The ability to enter data or records directly on-line to the processor provides an economical and timely method. For many years the batch method of data entry was the only system available, not because the keypunch and card reader were the only devices, but because of the limits imposed by the processor state-of-the art. It was batch oriented, one job at a time and with limited communication capability. With the third generation hardware available now, the data entry methods are changing to take advantage of the multi-programming capabilities. The first change noticed was the gradual switch away from punched cards to the key-to-magnetic tape systems. Some of these systems utilize small tape cassettes, others use industry-compatible full size magnetic tape as the collection media.

It appears the system users are moving toward direct on-line data or record entry. It is known that the most accurate method of entering data is the most direct system with the fewest rerecordings or translations. The more intervening steps, the more error potential. The video terminal is a natural for this application because there is no longer a need for the interviewing documents, such as cards or paper tape and their handling and storage requirements. Those used to card entry systems immediately raise the question of verification with video terminals.

By use of a CRT device it is now possible to take advantage of sight verification of data. Punched tape and cards do not lend themselves to this mode of checking. Sight verification plus validation provides the most accurate system of checking data entry into the computer system. Definitions of verification and validation may be in order at this point.

Verification is a process designed to check the accuracy of the keyboard operation. This is normally accomplished by another person rekeying the same information and comparing the results. It is still possible to verify by double entry with two operators and processor comparison when using video terminals. One of our users made a rather complete statistical analysis of the errors which were caught during validation in an effort to pin down the source. It was discovered that 60% of the entry errors were introduced into the system by the verification operator. This user has now changed to a more comprehensive sight verification and validation system and has realized almost double the through-put with less errors. The same statistical data is not available for card punch operation because the errors are detected and corrected by the operator prior to entry. It must be assumed, however, that the rate of errors generated by the verifying operator would be approxmiately the same for both techniques.

Validation is an operation in which a processor reads records intended for entry, and applies certain programmed standards of correctness or reasonableness to all or some of the data. Some of the more common kinds of validation are:

(1) Testing for the presence or absence of data within a defined field.

(2) Testing for numeric limits (dates, quantities, etc.).

(3) Testing for consistency between fields, for example, is a repeated name the same in both fields.

(4) Table lookup to determine the validity of special codes or identifiers.

(5) Self-check number calculation and comparison.

(6) Control totals on numeric fields, especially dollar amounts.

The applications for use of the video systems are being enhanced by low cost business graphic terminal which display statistics in graphic form, and by color displays to aid the operator in preparation.

In conclusion, the video terminal is now in wide use, its future is outstanding and the changes to be made in the hardware and applications will be dramatic over the next few years.