ENGINEERING DESIGN OF UNISCOPE 100 TERMINAL

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ABSTRACT

The rapidly increasing need for a low cost alphanumeric terminal in quantity permits several avenues of approach which will result in significantly lower cost terminal systems. Discussed are the requirements of the communication system for various applications and system elements which affect total operating costs, including cost of telephone lines. How the terminal accommodates the design criteria of data presentation, data entry/editing, communications capabilities, physical characteristics, and terminal price, along with hardware techniques permitting a low cost family of terminals to be produced, is also discussed.

INTRODUCTION

A trend is clearly evident that the user of the data processing systems of the future will be interfaced with the system through a multitude of low cost terminals and devices which are closely matched to human impedances. A number of human impedance matching devices are available, but in the foreseeable future the most commonly used for input will be a keyboard of various configurations. The most common output will be printed alphanumeric data followed closely by charts and graphs. Hard copy is an optional requirement.

The requirement for trained operators will diminish, but the ability of the terminal to change its human imedpance characteristic will become increasingly important.

A veritable explosion is taking place in the announcement of new terminal devices for use in data processing systems. The UNISCOPE ® 100 is one of these products and is aimed at a broad class of applications which are primarily communications oriented.

SYSTEMS DESIGN CONSIDERATIONS

The UNISCOPE 100 family of alphanumeric cathode ray tube (CRT) display terminals is intended to satisfy a wide spectrum of requirements for interactive communications-oriented terminals. The following were the five major areas of design consideration from a systems viewpoint:

- Data presentation
- Data entry/editing
- Communications capabilities
- Physical characteristics
- Terminal price.

Data Presentation

The principal elements of data presentation resolve themselves into three factors: presentation quality, format of data presented and quantity of data presented.

In earlier generations of CRT displays, the user was willing to tolerate such negative attributes as flicker, low brightness presentation and ill-designed characters in order to realize the performance advantages of a display terminal. However, the market has matured to the point that the user expects the display to be of high visual quality, with ample brightness and contrast, in a well-lighted room. Careful study of the situation convinced Univac that it was economically feasible to provide a high quality, low cost display. Thus, it was required that the UNISCOPE exhibit no visually discernible flicker or jitter, that the presentation be easily readable in normal office-environment lighting, that there be no confusion among characters within the full 96-character ASCII set, that any intensity variation within characters be minor and that data presented on the screen be readable from at least 7 feet.

From the viewpoint of individual applications, format requirements tend to relate directly to the input or output media employed in the application prior to use of the display. For example, if punched cards were used previously, an 80-character line display is required. If teletype was previously used, a 72-character line is normally required. On the other hand, some applications tend to lend themselves to tabular listings of short lines of data. In such cases, it is preferred to have a large number of short (40-character) lines. Because of this wide variation in application requirements, it was determined that the UNISCOPE 100 must provide a number of format options.

Once a line format is selected, the display capacity is, of course, a direct function of the number of lines. It appears that for many commercial applications, a total capacity in the range of 500 characters is adequate and that the vast majority can be satisfied by a 1000-character capacity, provided the display is designed to facilitate rolling of data. The latter requirement arises from the wide use of displays to access large files of data. Since it is not economically feasible to provide a display of adequate size to view a large file directly, an alternate approach is to use the display as a "window" on the data file and, by software, roll the file past the window. However, because of the potentially large number of displays in a system, it is absolutely necessary that the hardware be designed to minimize the burden imposed on the software by the roll function. This is accomplished in the UNISCOPE 100 family by means of a sophisticated algorithum which permits the deletion of any full line of data and repacking of the format by means of a single computer-generated function.

Data Entry and Editing

From the user viewpoint, it is vital that an interactive terminal have not only the capability of natural entry of data, but also of correction and modification of data. Thus, the terminal must provide to the user a significant editing capability. Two approaches will provide this required capability: (1) sophisticated editing logic can be provided in the terminal and (2) computer software can be used to implement the required capability. Again, the potentially large number of terminals within a given system dictated that, in the UNISCOPE 100, editing logic for the most commonly used functions be included in the terminal in order to unburden software. Editing functions in the UNISCOPE 100 include character, line and display erase plus the ability to insert or delete a character within any line or within the entire presentation format.

User data entry into the UNISCOPE is accomplished by means of a standard typewriter keyboard and/or by means of a 10-key pad. None of the data entered by the user is sent to the computer until the complete entry is displayed and verified by the user and the transmit key is pressed. This design approach not only minimizes the entry of erroneous data, but also permits efficient coupling between the capacity of high-speed communications networks and keyboard entry speed.

Because most manual entries involve a relatively small number of characters, it would be extremely wasteful of communication network and processing capacity if it were always necessary to transmit an entire format of information with every entry. Therefore, the UNISCOPE provides the user with the facility to bracket his entry with special characters, and, thus, only the actual entry will be transmitted to the computer.

Communications Capabilities

Perhaps the single most significant aspect of the UNISCOPE 100 from a systems viewpoint is its communications capability. Many of the available alphanumeric display terminals are displays to which communications capability has been "added." This approach leaves much to be desired in addressing the system problems related to reliable operation of the terminal in a large-scale communications network. From the beginning of its design, the UNISCOPE was considered to be a communications terminal first and a display second. This fact exerted a major influence on many of the detailed design decisions on the UNISCOPE.

The first step in design of a communications-oriented terminal is to define the communications environment in which it will operate. There is a very large number of variables related to the communications environment, and it was determined that the UNISCOPE 100 must be capable of covering a large percentage of them if the desired broad market base were to be established. This is accomplished by means of a number of interface options. However, under all options, the same basic communications discipline is used.

A terminal like the UNISCOPE may be used in either a switched (dial-up) network or in a private line multidrop network. A typical switched network usage is in the time-sharing industry. The advantage of this type of network, from the terminal viewpoint, is that the telephone switching network resolves contention situations. That is, only one terminal can be connected to a given system channel at a given point in time. Other contenders for the channel are queued by the busy signal until the channel is freed. In applications such as reservation systems, where each terminal is on-line for a high percentage of the time, economics usually dictates use of a multidrop private line. This type of operation is much more demanding of the communications discipline than the switched network case because it is necessary to provide techniques for contention resolution and addressing in the multidrop environment. The UNISCOPE 100 communications discipline permits operation with both switched and multidrop private line networks.

The UNISCOPE 100 terminals may connect directly to the communications network or interface through a multiplexer. The use of the multiplexer provides three significant system advantages where multiple terminals are required in a single location. First, it reduces the cost of the communications network by eliminating modems. Secondly, in a switched network, it permits more efficient utilization of the communications system in that an individual display would normally require only a small percentage of the available baud rate on a high-speed line, whereas a number of displays multiplexed to a single line provide a better match to available capacity. The third factor relates to the fact that the UNISCOPE 100 communications discipline is based upon polling; that is, data transfer from a terminal to the computer occurs only when the terminal has data to transmit and the computer polls or requests data from the terminal. There are two types of data polls used with the UNISCOPE 100: specific and general. Use of the specific data poll requires the computer to individually access each terminal or terminal component. The general data poll permits the processor to elicit a response from any terminal or terminal component which has an input waiting and whose address is included within the generalized portion of the poll address. The addressing structure used in the UNISCOPE 100 is a three-tiered structure in which, effectively, the first tier pertains to the multiplexer, the second to the display terminal and the third to display terminal components. If a multiplexer is addressed specifically and the rest of the address is generalized, the multiplexer will permit the highest priority (defined by hard wiring within the multiplexer) display terminal with a pending input to respond; if no terminal connected to the multiplexer has a pending input, a single no-traffic response is returned. The systems advantage of the multiplexer in conjunction with the general poll is the facility it provides for limiting the number of poll-points and thus polling overhead in the system.

Throughout the previous discussion, the UNISCOPE 100 has consciously been described as a display terminal. It was recognized early in the design of the UNISCOPE that there are many devices which, when used in conjunction with a display, naturally complement and extend the capability and applications potential of the display itself. These devices include printers, magnetic tape cassettes, and punched card readers. It was also obvious that the terminal provided sophisticated communications electronics and a small high-speed memory which might be useful to a number of types of equipment requiring low-cost remote computer interface if the unit were designed to facilitate access to these elements; thus, an auxiliary (eight-bit, parallel, half-duplex) interface option is provided in the UNISCOPE 100. The auxiliary interface, which permits connection of 12 terminal components, indeed permits the UNISCOPE 100 to function as the center of a remote terminal complex.

Figure 1 reflects the relationship of the various components of the UNISCOPE 100 in a small-scale private line application. The communications line discipline permits connection of approximately 1500 terminal components or devices to a single private line. Furthermore, the line discipline has been carefully designed to permit intermixing of compatible batch terminals on the same line as the UNISCOPE.

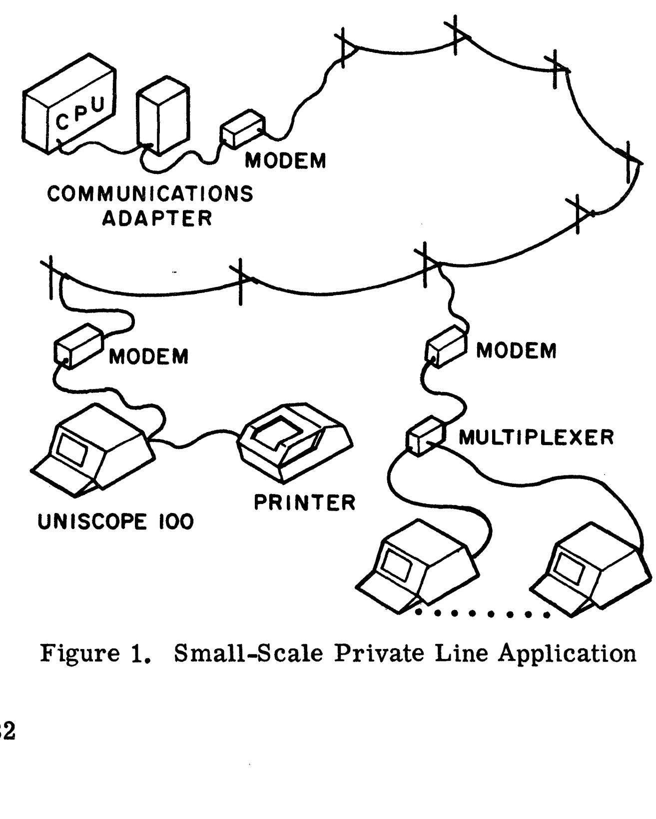

Figure 1. Small-Scale Private Line Application

Physical Characteristics

Careful study of user requirements convinced Univac that for market acceptance of the UNISCOPE, it must be physically small. The general guideline established was that the device be in the general size range of an electric typewriter. Although this requirement imposed severe design constraints, the goal has been fully met (figure 2).

Figure 2. UNISCOPE 100

Terminal Price

Of course, for a display terminal to receive wide market acceptance, it is necessary that it be fully competitive on a direct comparison basis with other forms of remote computer terminals in addition to being priced competitively with other displays. Studies of the marketplace indicated that a monthly rental base of $75 per month including maintenance has been effectively established by the teletype terminal. It should be noted that this goal had to be met without use of such pricing artifices as offering a nonviable configuration at this rental figure. The UNISCOPE is indeed offered in a fully viable configuration at $75 per month. Furthermore, the unit's communications design permits the unit to be used in a straightforward fashion without requiring expensive "black boxes" to permit its use in a system.

HARDWARE DESIGN

The hardware was designed to incorporate what is generally considered to be high performance specifications. These can be summarized as follows:

1. Brightness: a high efficiency phosphor (P-31)

2. Flicker: the display is refreshed at 60 Hz (50 Hz where prime power is 50 Hz)

3. Characters: the stroke technique used is capable of resolving a full ASCII set on a unique basis

4. Memory: a temperature compensated coincident core memory

5. Maintainability: easy to change pluggable modules

6. Solid state: the only vacuum tube is the cathode ray tube

7. Magnetic deflection: no high voltage coupling to electronics required.

Power Considerations

The UNISCOPE 100 was designed using low power techniques. Power consumption is reduced from previous methods by reducing the voltages required and by consuming power only when necessary. The unit uses approximately 100 watts total.

Memory

To conserve power in the core memory, approximately 4 volts is used in the metering voltage for the drive current as contrasted with a typical 15 to 30 volts used in more conventional systems. To achieve equivalent metering accuracy so that "worst case" design criteria can be met, a high performance regulator is used in each of the current metering circuits.

The complete memory (figure 3) is contained on one 9- by 12-inch printed circuit card. The memory contains 8000 bits organized in 1000 eight-bit words and uses a maximum of 10 watts.

Deflection

The UNISCOPE 100 utilizes a single-ended flybackless deflection system. Power consumed is proportional to the distance of the beam from the center of the screen. This system is contrasted from a push-pull deflection system which would use approximately twice the power. Additionally, the voltage needed to drive the yoke is proportional to the required deflection rate. By eliminating the need for flyback, the deflection velocity is considerably minimized. Figure 4 illustrates how the programming of the deflection system eliminates the flyback requirement.

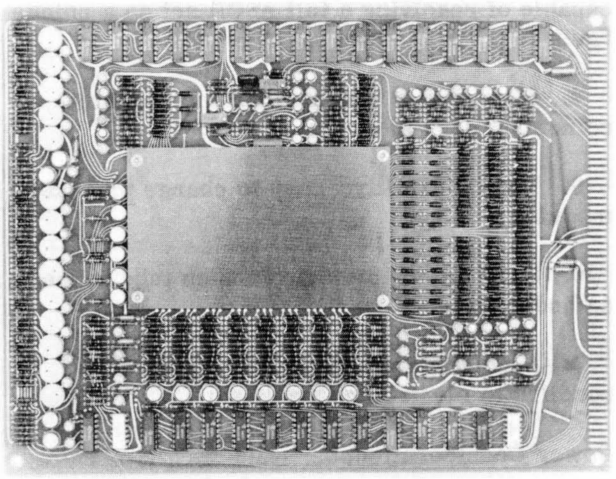

Figure 3. Memory Card

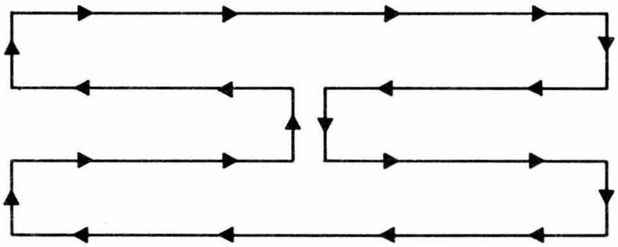

Figure 4. Scan Method

An operator typing information from the keyboard would not detect that lines are refreshed from both directions in that the data appear on the screen in normal typewritten fashion.

Focus

To assure proper ratio of line width to character size, a beam width of 10 to 15 mills is required. A low voltage electrostatic focusing of the beam was developed for several reasons. First, magnetic focus requires heavy coils which, secondly, require extensive attention to mechanical mounting. This total assembly is costly although certainly adequate from a performance point of view.

MAINTENANCE CONSIDERATIONS

A functional module design approach was used to minimize repair time and cost in the field. Each functional element, i.e., memory input/output, deflection, keyboard, etc., is a replaceable pluggable module. Identifying the suspected failed module is reduced to a few major elements and requires relatively little intimate knowledge of the total machine.

This dictates the need for some large functional elements, as shown in figure 5. Suspected failed modules will be repaired at depot level by the automatic methods used in original manufacture.

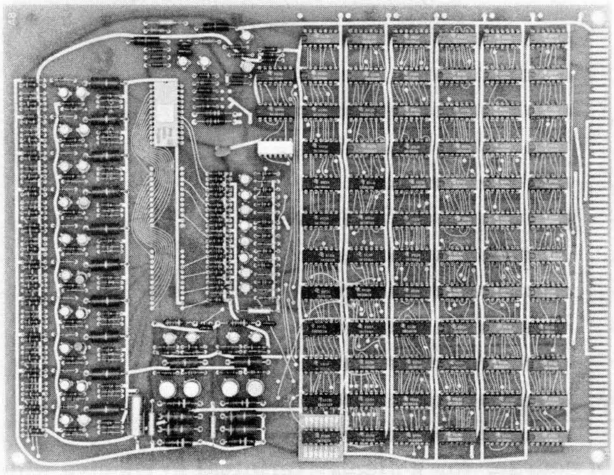

Figure 5. Logic Card

MANUFACTURING CONSIDERATIONS

The difference between success and failure of this product, irrespective of performance, will be price. To achieve low price, maximum use of automation, standardization, and large production runs are basic.

The use of large function cards, which makes isolation of a trouble in the terminal to the specific module an easy task, requires very sophisticated test equipment in order to isolate the trouble to the failed component in the module or logic cards. Manual test equipment would be too time consuming; the logic cards contain as many as 120 integrated circuits. Most of the circuits now used are in the DTL 930 integrated circuit family. These cards are tested by using the brute force approach of checking the output of every logic node with permutated inputs. The test is completely under computer control. The basic program is sufficiently flexible so that if a new failure mode in the card were discovered which the present program could not isolate, the program could be modified so as to readily isolate the problem. The testing time on each card is less than 1 minute, and on the average, each card requires approximately 1000 tests. If there are faulty components on the card, a printed copy stating which component should be replaced is attached to the card at the end of the test. The card is not tested from the connector because all of the logic nodes are not available. The card is probed on the surface with 500 to 600 electrical contacts.

Low cost 930 series integrated circuitry is used for most of the logic application. Because of the functional partitioning of the logic, it would be easy to use larger scale integrated circuitry in this area if the 930 series circuitry were to become uncompetitive.