APPLICATIONS

Computer Graphics

For a number of years the general purpose computer has been extensively used as a fundamental tool in commerce, industry and science. However, full use of computers has not been made because they have not been regarded as simple to operate. The necessity to program problems and to convert such programs to punched card or tape has excluded all but computer programmers from using a computer. Furthermore, the basic language of the machine—highly ordered machine code—is far removed from everyday technical language.

The advent of high level language compilers has simplified the programming, therefore encouraging the use of a computer as a problem-solving tool. Nevertheless, a fairly high degree of specialist knowledge is still required of the user and it is still necessary to transcribe the data to the computers' conventional input media, i.e card or tape.

An X2000 data display system with a single 17-inch display unit

Electronic circuit design using a light pen

More recently, multi-access systems, based on the use of on-line teleprinters or typewriters, have started to be developed and used. These, by virtue of complex and highly versatile resident application programs and executive software, enable the user to operate the computer in a 'conversational mode', but it is necessary to use a stylized language and to observe procedural restrictions.

Currently, users and manufacturers alike, conscious of the well-proven power of the computer as a problem-solving device, are striving to improve the man-machine interface in order to couple more closely man's creative and intuitive abilities with the high-speed computing, data retrieval and data handling potential of the machine.

A number of interface devices are being examined, but perhaps the most pertinent is the use of cathode ray tube displays. Since a large proportion of scientific and industrial problems can conveniently be expressed in diagrammatic form, and because their solutions can be more readily assimilated when presented graphically, a visual interface with the computer which makes use of man's most informative sense, sight, enables very direct, dynamic, man-machine interaction to be achieved.

The Marconi Company has been developing and applying cathode ray tube displays for data presentation and system monitoring purposes. These have ranged from advanced radar to general purpose alpha-numeric display systems. The most recent development using cathode ray tubes is the X2000 series display system. This system, in conjunction with a suitable real-time processor and appropriate input devices, provides a fully dynamic, graphical and alpha-numeric man-machine interface. Generically, this type of system has come to be known as Computer Graphics and provides a very powerful facility in the many aspects of computer-aided design. It allows an operator to feed data directly to the processor by 'drawing' on the c.r.t display using a 'light-pen' or 'tracker (rolling) ball'. Auxiliary data is fed into the processor by means of an alpha-numeric keyboard or touch wire system, overall control of the system being

achieved by means of 'mode' and 'control' keys.

Alternatively 'light button' techniques can be used in conjunction with the light pen. These techniques depend on the display of the functions on the c.r.t display itself, and selection is achieved by pointing to the appropriate function (now termed a 'light button') with the light pen.

In all such input operations the processor is intimately engaged, since it is this that up-dates the display in accordance with data fed to it by the operator. A computer-display-operator servo loop is therefore set up and this is operated until the processor has been furnished with sufficient information for it to undertake the required computation or analysis. The and if they are unsatisfactory the operator results can be displayed on the c.r.t, can take steps to modify or re-formulate the input data, continuing the process until the desired result is obtained. At any stage, a permanent record of such a process can be furnished by means of the 'Hard Copy' equipment which provides a paper or photographic record of the c.r.t presentation. Results of computation can also be provided on the conventional processor output media—line printer, paper tape etc.

Because the servo loop demands rapid response from the computer, particularly for functions such as 'light pen' tracking, the processor which drives the display system must have on-line real-time

Design of integrated circuit masks using a tracker ball

capability. Here too, stemming from its work in radar-based, air-defence systems, The Marconi Company has extensive experience in the design and application of on-line, real-time computers. The current series of general purpose integrated circuit machines, known as MYRIAD, forms the control element of various real-time systems and is admirably suited for computer graphics work. The machines have a 24-bit word structure, a comprehensive instruction repertoire and a powerful, interrupt-orientated input/output system.

MYRIAD I, II and III differ in engineering form and detail but are otherwise fully compatible. MYRIAD II is employed at the present time in Marconi Computer Graphics systems. These machines are described on pages 322 to 324.

Computer Aided Design

The Marconi X2000 Graphics System enables designers to converse with the computer with a speed and facility hitherto impossible, thereby exploiting the full capabilities of both the man and the machine.

One may consider such a system to be a design tool which not only relieves the designer of many onerous tasks, but also contributes its high speed, accuracy and data retrieval capabilities to the job in hand. Thus the specialized knowledge of the designer, engineer or draughtsman can be used to the optimum, their valuable time not being wasted on onerous and time consuming tasks such as referring to catalogues, file searching, parts listing etc.

Two projects currently being handled by Automation Division illustrate the benefits to be gained from the use of a computer-aided design system with graphical display facilities.

Design of Gear Boxes by Computer

Gear box design is a field in which many of the onerous tasks normally carried out by an engineer or draughtsman may be undertaken by a computer. The calculation of gear ratios, wheel sizes, number of keys, form of keys, are relatively simple, but time-consuming, operations which the computer can handle with ease. A large number of drawing man-hours may also be wasted in the design of components which already exist but which may only be discovered by the engineer after a considerable amount of searching. The computer-aided design system under development by Automation Division is designed to relieve engineers of these duties and release them for more exacting tasks.

The prime function of the system is the storage of the topology, dimensions and mechanical characteristics of a large number of standard gear box components, this being achieved by the use of a real-time computer having a large, fast access, disc store unit. An X2000 cathode ray tube display system connected to the computer enables the designer to enter and retrieve data from the store.

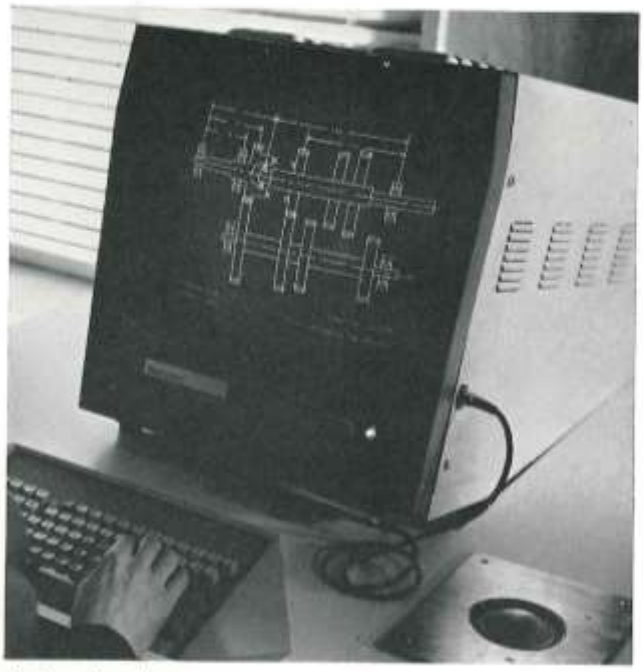
The operator communicates with the computer by using a tracker ball or light pen for drawing directly on the screen face, and a keyboard for entering alpha/numeric data. The keyboard also contains a number of simple function keys for selecting the various modes of operation.

The disc store will be loaded with full details of some 10,000 components which are already in existence. Since these components can be reduced to a relatively low number of standard shapes, this task can be completed with the minimum of effort. In fact, once the basic shapes have been drawn on the screen, they may be recalled at any future time and used as the basis for detailed drawings, in which only the dimensions and characteristics of the components need be entered into fixed formats generated by the computer. A typical format is shown on the right. When this initial task is complete, new components will be automatically catalogued in the computer after they have been designed on the display. The computer is also capable of preparing tapes for numerically-controlled machines so that parts may be produced with no further manual intervention.

Once the computer is loaded with the parts catalogue, the gear box designer will be able to enter the specification of a required unit into the computer, which will then offer a number of alternative basic configurations for his appraisal. If these are not acceptable, the operator may produce a non-standard configuration using the basic layout as a starting point, or alternatively, he can produce a completely new layout, merely using the components from the catalogue. The new layout could then be contained in the computer as a basic form. The computer will calculate the required characteristics of each component in the unit and select suitable parts from the catalogue. If the catalogue contains no suitable parts, the computer will display the characteristics required to the designer, who may then take action to introduce a new component into the store. When the design of the unit is complete, the system will produce on demand, a complete parts lists and a permanent record of the unit using a standard pen plotter.

Automated Chemical Plant Design Office

Modern chemical plant such as oil refineries, town gas plants, etc, can be spread over an area of several square miles and may use many thousands of components. The drawings from which the plants are constructed must necessarily hold every component, and must be drawn in three dimensions and isometrically, in order to ascertain that components, for instance crossing pipes, do not interfere.



Design of gear boxes

At present, a number of plant designers are assigned a section of the plant for which each designer produces a schematic layout. From these layouts isometric drawings for models are produced, in order to ascertain the correct construction of the plant, and when fully checked these layouts are used by draughtsmen for the production of detailed drawings and schedules.

Much of this work however, can be done automatically by the computer with several ensuing by-products. The basic system uses a MYRIAD II computer in either the 16k or 32k configuration, with disc stores and graphical display consoles. Up to 6 consoles can be connected to the system to allow up to 6 designers or draughtsmen to work simultaneously on the computer. The disc store system is a modular system allowing the computer access to up to 8 disc units, each of which can carry the information required for 100–150 drawings. The disc packs are removable so that complete drawing files may be permanently stored on the discs and access to any set of drawings may be obtained in a few minutes.

The plant designers use the display screens to draw plan and elevation views of each section of the plant, using the light pen or tracker ball available in the X2000 system. Data, such as lengths of pipe, diameter of pipe, type of valve etc, can be entered using the display keyboard. The computer will automatically select correct valve sizes, gaskets, cleats and basic components such as bolts etc, from the information input by the designer. Full details of each of these components are held in the disc store unit, so that once they have been entered they are immediately available to any of the designers. More important, a change to any of the component details is automatically reflected throughout all the drawings in which the component has been used thus removing the necessity for re-drawing.

When the designer has completed his job he may request the computer to produce a full isometric view of the drawing, to ensure that the computer has produced a viable design with no conflictions. The designer may also call for a full parts list which will include the prices of each item and the current stock situation.

The benefits to be obtained from this system therefore include a considerable reduction in both manpower and the number of human errors.

Monitoring and Control of Power Generation, Distribution and Processing

The use of computers and cathode ray tube displays to monitor and control large networks or complex processes is now becoming commonplace. The economics of replacing conventional instrumentation by a central computer complex are clearly understood and are particularly significant where a new control room is envisaged.

Most power stations being built in the United Kingdom today have duplex computer-display systems, the computers reading in data from all over the plant. In the Wylfa Head Nuclear Station, for instance, there are 4,800 analogue variables and 2,400 contact closures which are monitored by the computer. This data is processed and presented to the operators in a convenient and easily understood form, thereby allowing the boiler and turbine units to be controlled in a simple, safe and efficient manner from a central control room.

The equipment also analyses plant alarm causes during fault conditions, to bring to the operators attention the important alarm needing immediate attention and to recommend the best course of operator action. It will also relieve the operator of simple data recording tasks and permit more comprehensive records to be kept.

In the distribution industries the use of computer display systems to control complex electricity, gas and water distribution networks is becoming more commonplace. In some instances electricity, gas and water networks can be controlled by the same central control equipment.

In the process industries and steel production in particular, Marconi X2000 displays are being used to convey information to operators on the mill floor and to present accurate computer generated data in graphical form.

Monitoring and control of a steel making process

Computer Controlled Power Distribution

A typical application of the computer and data displays in power distribution is the installation in the Birmingham area where consumers will probably be the first in the world to have their power supplies controlled by a computer. The first stages of this network control system, ordered from English Electric's Power and Marine Division by the Midlands Electricity Board, came into operation early in 1969. The system uses the most modern electronic techniques to cope with the increasing problems of controlling the complex and expanding electricity distribution network of Britain's second city, without deterioration in the standards of security of supply.

The system, which incorporated English Electric telemetry links, is built around a Marconi MYRIAD II microminiature computer and Marconi X2000 data displays.

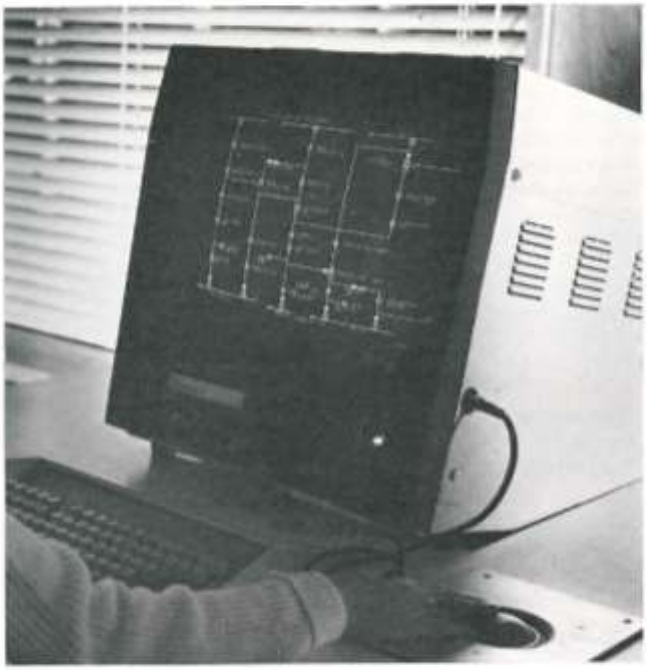
The equipment's purpose is two-fold. Firstly, it stores diagrammatic and associated data on the various discrete sections forming the distribution network and gives access to specific information as it is required by the controllers. As the distribution network expands, new information will be stored by the computer, and additional facilities have been included for storing new information without prior processing. The second task is to control and monitor thirteen primary switching substations within the network. Analogue and state information will be telemetered to the control room, stored in the computer and displayed on request. Conversely, the computer will be capable of switching circuit-breakers and other plant items by a command from the controller or by an automatic switching sequence, on detection, via the telemetry link, of a circuit-breaker malfunction or other fault.

Diagram information relating to each of the network's sections is stored on a magnetic disc file, and the control engineer will be able to demand information on any section. The computer will then refer to the disc file storage system to obtain the selected section diagram information and display it on one of the four 17-inch Marconi cathode ray tube (c.r.t) displays. Control action, to or from the remote substations via the supervisory equipment, may also be observed by the control engineer on the selected diagram.

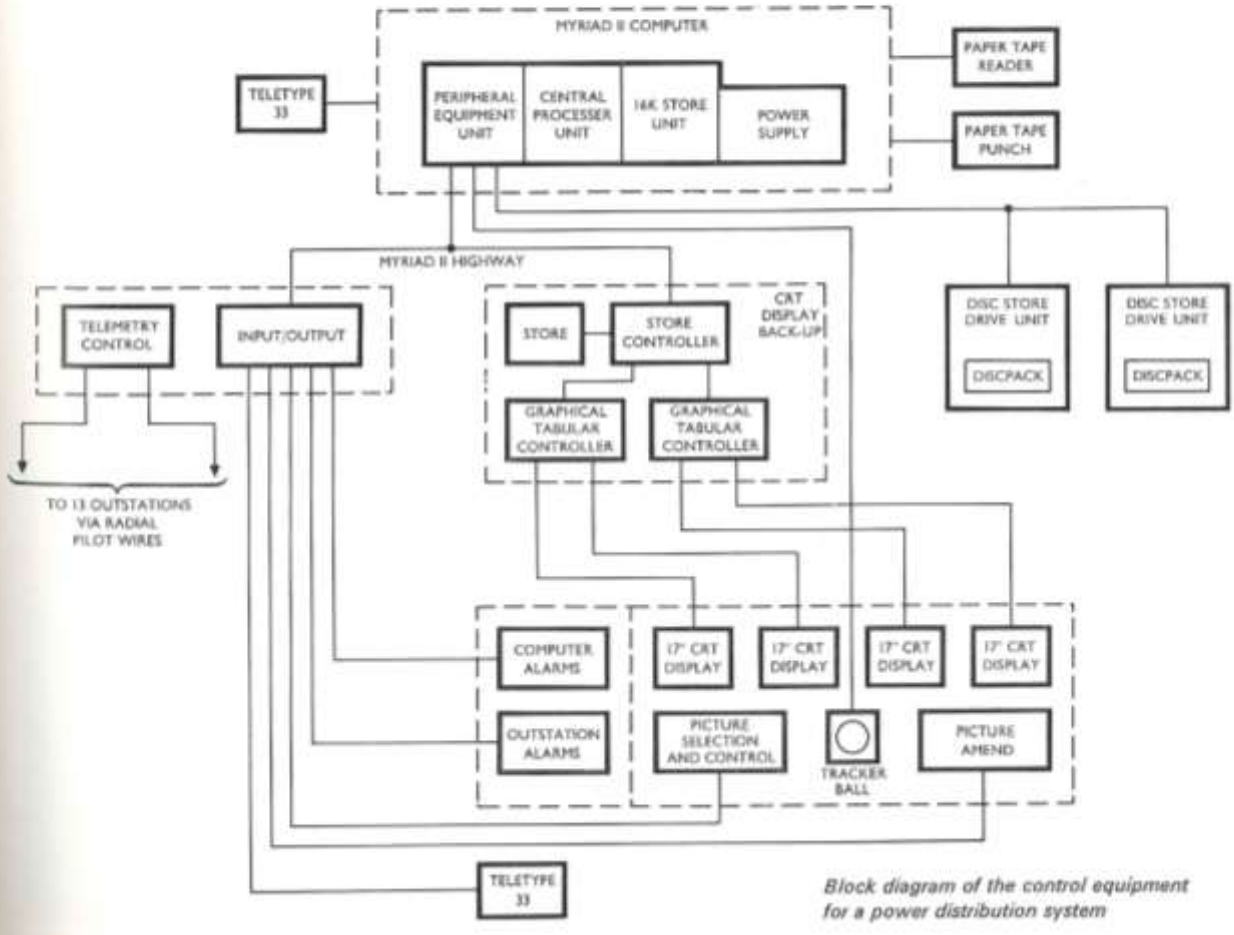
Facilities are provided on the control console which will permit an engineer to enlarge or modify a section of network diagram. This will be achieved by the use of a 'tracker ball' marker direction unit, which enables the engineer to direct a spot on the cathode ray tube face to draw horizontal or vertical lines and position preformed diagram symbols. When completed, the revised diagram will be memorized by the computer and displayed on selection of that part of the network diagram.

Additional data may be fed into the computer by means of the Teletype 33 keyboard/printer devices that are to be included in the computer's peripherals. The second of the two Teletype units shown will perform a data-logging function by maintaining a printed record of all switching operations taking place on the system.

The Birmingham area, with a maximum demand approaching 1200MW, has one of the largest integrated supply systems in Europe. Its rate of growth—with the consequent need to extend the area control room wall-diagram—and its complexity, demanded a 'new look' in control and display. The network control system supplied by English Electric is sufficently flexible to be extended and will meet all future needs, with the eventual control of 56 major substations.



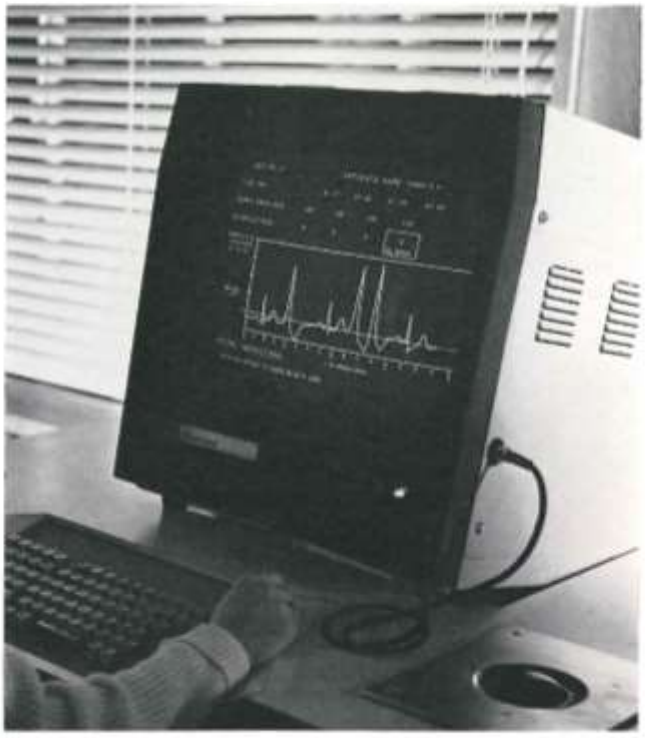
Power distribution network diagram



Block diagram of the control equipment for a power distribution system

Medical Systems

The use of computers will become increasingly common in hospitals in the next few years. They are part of a process that could vastly extend the powers of hospitals in providing individual medical aid and are becoming increasingly necessary in today's society where cost of nursing and clerical staff is rising every year. There are basically two types of computer systems for use in clinical environments, these are: centralized medical record systems, and on-line systems used for patient monitoring and for the monitoring and control of automated laboratory and diagnostic equipment.



Dynamic display format for an intensive care unit system

Medical Records

Medical record schemes consist of a very large scientific or commercial computer, which holds the medical records for a large number of people, and a number of visual or mechanical terminals. The terminals would be sited at patient entry points and at strategic places throughout the hospital. They would also be sited remotely, for instance at clinics and doctors surgeries, giving general practitioners instant access to the complete medical records of their patients.

From these, data may be input into the computer through the terminals, or alternatively, a patient's past history may be called down from the computer's files. The Marconi Company's main interest in these schemes is the provision of suitable terminal equipment. The Video Data Terminal described on page 330 is ideal for such an application, where it is required either to scan through a record file or to input data quickly and accurately.

On-Line Systems

The care and nursing of acutely ill patients who require continuous and detailed monitoring is a major and expanding problem in all parts of the world. Continually improving diagnostic and surgical techniques, drug therapy, ambulance services etc., have resulted in an increasingly heavy burden on facilities provided for intensive care.

Technological advances in medical electronic equipment have made possible the accurate detection and presentation of many important physiological signals. These parameters must still be evaluated and correlated by the observer, in order to assess the immediate condition of any patient, and the detection of impending crises in many acute situations relies heavily on the intuitive skill and experience of the clinician.

Where several patients are being monitored simultaneously, as is frequently the case, the load on the clinical staff in terms of time and mental effort required to extract indications of significant changes in the conditions of patients from the presented data, is extremely high.

Experience gained by The Marconi Company in the use of digital computers in complex control and monitoring systems for defence and industry, leads logically to consideration of their use in the patient monitoring situation. It is possible to use the high-speed iteractive capability of the computer, together with suitable input/output devices, to greatly reduce the load on the human observers, also to achieve earlier detection and identification of significant deterioration in the condition of patients.

In order to achieve these advantages it is necessary for the patients to be 'on-line' to the computer so that the physiological parameters are derived in real-time. This can be by direct connexion to patient borne sensors via amplifiers, or to existing monitoring equipment; in either case the signals are converted into digital form for input to the computer, by a high-speed, multi-channel, analogue to digital converter system.

The range of signals which could be usefully monitored, analysed and correlated is extremely wide, and the rate at which selected signals must be examined in order to extract maximum meaningful information is an important consideration in choosing the right computer for the system.

Speed, which is the important criterion, can be qualified for this application as referring to single word input/output and processing capability, and for this reason, computers used in patient monitoring systems are ideally of the type used in industrial process control, rather than batch processing machines as used in commercial data processing. The MYRIAD II computer is designed for this type of application.

One aspect which is of primary impor-

tance in establishing the viability of a computer based system in an active clinical environment, is the method of communication between the clinical staff and the computer.

The means by which 'system commands' are given must be simple, direct, and natural to the user; any system which requires encoded command sequences, however simple the code, is clearly unsatisfactory in acute situations.

Of equal importance is the means of presenting the derived data to the observer. This must be immediate, intelligible and require a minimum of visual interpretation, if it is to be of real benefit in emergency situations.

These communications criteria can successfully be met by the use of an interactive, graphical/tubular, cathode ray tube display system as the primary interface between the user at the monitoring station and the computer. These displays can present with clarity and high accuracy, complex formats comprising both alpha-numeric and graphical information, virtually at the time of origin of the source data in the computer.

An advantage of the use of computer driven, graphical/tubular displays over conventional oscilloscope displays for the presentation of physiological waveforms, is the fact that the presented information is a highly accurate synthesis of the raw signal which can, by suitable software techniques, be made relatively free of noise, baseline drift etc. A number of display units may share a single control unit and each may simultaneously present different information if required. In addition to their great flexibility as direct output devices, graphical/tabular displays have the further advantage that they can be used in conjunction with such ergonomically suitable devices as keyboards and light pens, to provide a means of direct communication to the computer from the face of the screen, the light pen being used in a 'pointing' mode.

In this mode several alternative input messages or functions may be displayed in text form, whether as a result of operator action or as a direct program reaction, and the selection is made by simply pointing the light pen at the required message or function.

On receipt of the instruction, the computer can provide 'tell-back' to the operator by causing the selected legend to flash, increase in size, etc. This is only one example of interaction using a light pen, the principle may of course be used in a wide variety of input sequences, the important point is the ease with which communication can be established in plain language.

If permanent copy of displayed information is required, this may be provided either by means of direct hard copy from the display screen or by an incremental XY plotter driven independently from the computer. These facilities can of course be backed-up by line printer or teletypewriter for routine bulk printout.

Inclusion of magnetic tape and disc backing storage in the system enables detailed input data to be accessible to the computer for a fixed historical time period so that past events within the history can be quickly recalled for examination.

Such a system can be extended to form an integrated real-time facility within a hospital and may include, in addition to inputs from patient monitoring equipment, inputs from a wide variety of laboratory equipment and may also be applied to such tasks as Isotype scanning, Radiation treatment planning, etc.

Other advantages which accrue from an on-line system in an active clinical environment, are the collection of data for statistical analysis and the maintenance of local patient and therapy records. It is further possible for an on-line system to be connected directly, or via telephone lines, to a centralized medical records computer so that locally obtained data may automatically update the long-term integrated records.

Hospital admission data format

Area Traffic Control

The present rate of increase in road traffic has severely affected the normal vehicle passage time in and around our cities and it is now estimated to cost annually, an average of £10,500 at every stop line in all cities in the United Kingdom. In addition to the normal hazards, adverse weather conditions, accidents, road repairs and civil engineering works have also to be taken into account. Our cities are therefore becoming more and more congested as traffic volume increases and it is essential that efficient central control systems be installed to make more efficient use of road capacity. These systems must be capable of exercising dynamic control, co-ordinating the settings of traffic signals within a specified area so that timing and sequencing are optimized for the prevailing traffic conditions.

The Marconi Company has extensive experience in the design and manufacture of digital control systems in defence, air traffic control and industrial applications, and its range of MYRIAD computers was specifically designed to meet the exacting requirements of such systems. These powerful machines are ideally suited to the real-time situations met in area traffic control.

Among the foremost designers and manufacturers of traffic signalling equipment is GEC Road Signals, which now forms part of GEC-Elliott Traffic Automation Limited. It has provided important traffic control systems in many parts of the world. It pioneered vehicle actuated traffic control systems, and constant research and development has maintained its AUTOFLEX as a premier name in traffic control.

The association of The Marconi Company with GEC-Elliott Traffic Automation Limited provides a unique combination of traffic engineering and automation. The acknowledgement of this combined expertise is borne out by the major participation of these Companies in the most advanced area traffic control schemes taking place in London and Glasgow. These two schemes were sponsored by the Ministry of Transport to evaluate different control techniques. The Glasgow scheme, based on the Marconi MYRIAD computer, is designed to evaluate fully automatic control programs and it is significant that already improvements in journey time up to 16% have been achieved. In London the system was designed to measure the effectiveness of manual intervention, and The Marconi Company has been awarded the contract for the second phase which will include the first use of cathode ray tube displays in a traffic system in addition to a comprehensive MYRIAD Computer installation.

Integrated Area Traffic Control

Although fixed time and vehicle actuated signals have for many years provided benefits, they do have a number of inherent limitations. For instance, although under saturated conditions, progressions can be maintained, the fixed time control schemes no longer apply when the volume of traffic decreases. The best that can generally be achieved, is to provide a number of alternative plans designed to satisfy different traffic conditions and to select the appropriate plan, either by time clock or by sampling the density at fixed points. The limitation of this system, known as the Washington scheme, is that it is based purely on historical information and the programs do not necessarily pertain to the current traffic conditions.

The incorporation of a computer in area traffic control systems permits the use of a large number of alternative methods of control. Various plans can be brought into operation over specified periods of the day, week or year; alternatively, different plans can be called up automatically as a result of monitoring the traffic flow in the area. In addition, the use of a computer permits rapid assessment of the traffic situation and, by applying the most appropriate method of control, can maintain optimum flow at all times.

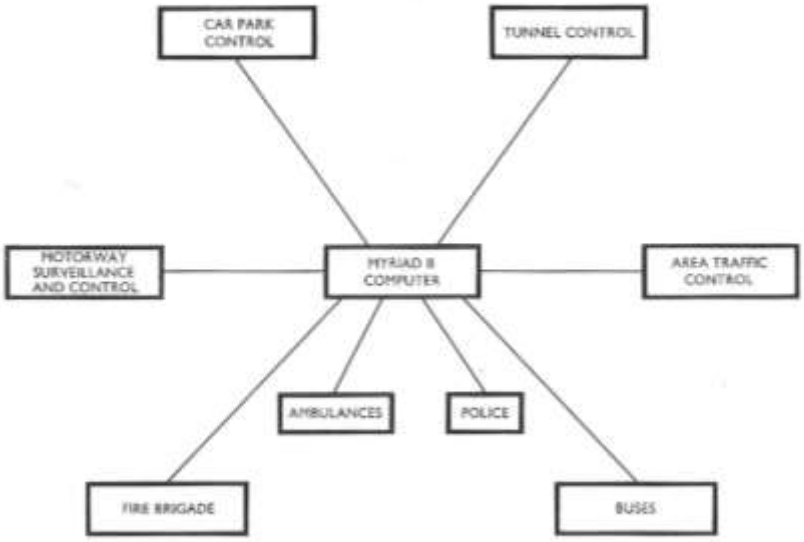
The development of traffic control programs is still at a relatively early stage, although even now significant economic advantages can be shown. The general purpose computer is a flexible machine, and it is anticipated that much more efficient traffic control programs which will run in the same computer, with no changes to the equipment, will become available in due course. In particular, new programs being developed by the Road Research Laboratory for Glasgow will be available for any MYRIAD area traffic control scheme.

In addition, on a general purpose computer such as MYRIAD, it is entirely feasible to operate automatic car park control, motorway surveillance systems, tunnel and bridge control, etc. To implement any of these additional functions or to automate further intersections would involve only small extensions to the computer input and output equipment, the computer itself being quite adequate to run a number of different control routines simultaneously.

Dynamic display of traffic conditions at a road junction

Motorway Surveillance

The necessity to exercise some form of control of vehicles on high speed routes presents particular problems which rapidly turn into emergencies if they are not dealt with promptly. The purpose of motorway surveillance and control is to monitor traffic by installing instruments at the motorway and to operate indication signs to advise motorists of impending hazards. Such hazards include maintenance on the motorway, accidents, ice, fog, etc. In such conditions the advisory speed signals will gradually reduce the speed of the traffic so that on reaching the hazard, traffic will be proceeding at a safe speed. The instruments installed on the motorways for measuring speed etc, transmit information to the control centre where the computer collates and processes the data and makes the control decisions and transmits this information to the Motorway signs.



Integrated traffic control scheme

Centralized Car Park Control

The ability of traffic to park for long periods in city centres requires the provision of multi-storey car parks. Centralized control of these provides motorists approaching a controlled area with information on the state of the car parks. Installed in car parks are detectors, which transmit information back to a central computer which processes the information and determines the state of the car park. Centralized control of a number of car parks provides motorists with indication boards, installed on the approaches, showing the state of the car parks.

A more sophisticated form of centralized car park control may be incorporated in an Integrated Area Traffic Control Scheme. In this a central computer which controls the traffic signals in the area also has information fed back to it from the car park. Traffic can then be diverted to the nearest car park which has spaces available.

Tunnel and Bridge Control

The problems connected with traffic flows over bridges and through tunnels are complimentary and necessitates the separation of traffic on the approaches. Detectors installed on carriageways and at strategic positions are scanned by the computer. This information is interpreted by the computer to determine whether the lanes are empty, congested or persistently queueing and the interpreted information forms the basis for the setting of the signs on the approaches. In addition detectors are installed at suitable positions in the tunnel to indicate whether a blockage has occurred. Closed circuit television may also be used to provide an operator with an overall picture of the situation.

Vehicle Fleet Location

The primary purpose of vehicle fleet location is to increase the utilization of each vehicle in a fleet and in the particular case of buses, regularity of running.

An on-line digital computer, situated in the bus fleet control room scans all the buses by means of a selective calling radio transmission system. The computer can also be used to drive displays showing the position of all the buses and to give details of all situations demanding remedial action by the controller. In addition a continuous log is produced

Dynamic display of bus movements in a city

throughout the day of all major irregularities of bus service occuring on any route within the bus system.

The control room equipment scans in sequence, via a radio data link, all the vehicles fitted with appropriate equipment and receives in return the position of each vehicle along its route. This data (which is obtained automatically without the crews co-operation) can, if necessary, be supplemented with the passenger loading of the vehicle. The computer is therefore able to continuously update a mimic diagram showing the position of each bus on every route. The Marconi X2000 display which is used for this purpose is highly versatile and can possess a selection switch enabling the display of the entire bus system or a single route or a number of routes as chosen by the controller.

A radio telephone link is available for the controller to pass instructions to particular buses. Each bus is identified by a call code, which can be dialled by the controller. A feature of the system, which is of particular value in single man crew buses, is the provision of an emergency alarm button which will allow the driver of any bus to signal in the control room the fact that he is in difficulty, giving the bus identity and its location.

Management Information Systems

In today's fast-moving world of commerce, it is becoming increasingly essential that top management should have access to the data being handled by the business machines, and that this data should be presented to the management in a form which it can easily understand. However, senior managers cannot afford the time to be trained in the use of the computer and its languages. It is therefore necessary that the computers be adapted to suit the man, rather than the man be adapted to suit computers.

A new system, developed by Marconi Automation Division and utilizing the X2000 display equipment, can now be applied to all large business machines currently available, and allows completely untrained personnel to converse with the computer in a manner which is entirely natural.

Simple English language commands, made by the operator at the display, using the light pen or keyboard, are automatically translated by the system into the business machine language. Similarly, data being output from the business machine is translated into English language statements by the system, in a form which the operator can easily understand and assimilate. For example, let us suppose that the manager wishes to analyse the sales figures and forecast for a five-year period including the two previous years.

The manager would first press a 'Start' button, which causes the computer to present on the screen a list of alternative programs which he can use. This list might include the title 'Sales Forecast 1967–1972', which the manager would select by pointing at the general area of the title with the light pen, and pressing the 'Select' button. The computer would then select from its store all figures related to that forecast, and present them to the display system, together with a set of simple calculating rules. The display system constructs a format of figures based on the rules sent by the computer, and this format may include a graphical representation of the figures displayed. The manager can now observe general trends by reading the graphical representation, and for more detailed information can refer to the tables below. If the manager wishes to observe the effect of changing the forecast figures, he can point with his light pen at the data which he wishes to change, and change it numerically using the keyboard. The display system would then recalculate the sales forecast and present a new graph to the operator. Normally the display system is capable of this operation without recourse to the main computer. However, in the case of more complex calculations, or where further data is required, the display system automatically calls upon the main machine. The response time of this system is such that the process described above could be carried out during a Board Meeting, with the display terminal being operated by one of the directors.

The system described uses a small computer to remove the load of display generation and handling from the main machine, and to perform the limited calculations required. Thus, once the initial batch of data has been transferred between the computers, the small machine becomes an autonomous unit which uses the main machine occasionally as a bulk store device. The use of a small satellite computer greatly simplifies the problem of interfacing both hardware and software, and ensures that the business machine is not constantly interrupted while performing its normal work. Two alternative hardware systems are available, which differ only in the size of computer employed. The smallest system is capable of driving one or two displays only, while the larger system can control eight or more displays. The use of the satellite computer also allows the displays to be situated at any distance from the main machine, although of course the time of response then becomes dependent upon the speed of transmission lines employed. Typically, a display screen situated at the end of a 2,400 baud transmission line could be filled to its capacity of 4,800 characters within half a minute of the request being made.

Video Data Terminals

The Marconi video data terminal provides a means of transfer and display of alphanumeric information between a central computer and remote locations. The terminal unit consists of a data entry typewriter keyboard, and a cathode ray tube display unit. Using the keyboard, an operator inputs data or queries to the terminal for display on the tube face, which, after manual correction and verification, may be transmitted in blocks to the remote processor by means of high speed data communication links (e.g Datel services, rented telephone wires). Answers or output data from the computer are received by the terminal in the same

way and presented on the tube face as stroke written characters.

Typical Applications

Reservation systems—Probably the most exploited use of Video terminals; video reservation systems are used by many airline operators. The system provides booking offices with up-to-date seat availability information, on an enquiry response basis. Bookings may be made directly with the computer and tickets printed remotely on demand in cases where hard copy facilities are provided.

The speed and reliability of video terminals is used to great effect in these conditions, where the data base is continually changing, and in which round the clock operation is frequently required. The silence and clarity of data presentation assists in the reduction of operator fatigue, and the comprehensive error control and manual editing facilities make the video terminal one of the most efficient data entry and output peripheral devices available.

Banking—Used mainly for account enquiries and statistical information, video terminals provide a fast and convenient method of information retrieval. As a statement processing medium, terminals can use the powerful calculating capability of large centrally located computers to relieve branch banks of a considerable processing load, thus achieving more efficent use of central resources.

Systems of this type can handle daily branch transactions for both ordinary and investment depositors, daily journals, account updating and standing order payments. Video terminals can also provide a secure means of processing confidential enquiries, and may be readily coupled to personnel identification systems to ensure that misuse by unauthorized persons is avoided.

Insurance—Video terminals have a real contribution to make in insurance applications as a convenient means of making premium and account enquiries. Coupled with real-time analytical disciplines and computer stored actuarial records, the extent of risks can be accurately assessed and made available at short notice.

New business is processed with the minimum of delay and time spent on routine administrative form filling reduced by a considerable margin. As a by-product of this, the amount of paperwork circulating within a company can be significantly reduced, and in many cases more efficent use made of existing personnel.

Stock Control and Inventory—Although basically an information retrieval situation, video terminals can be used as an updating medium and planning aid in stock control schemes. By providing information quickly, faster stock turnover and reductions in supply delays are achievable.

As with banking operations, video terminals may be linked to badge and card reading equipment, thus identifying personnel and products with the minimum of error. In particular, this feature reduces the amount of time spent in entering fixed information into the system and makes the addition of video equipment to conventional punch card systems a relatively painless procedure.

Video Data Terminal

Computer Bureaux—As a program debugging aid the use of video terminals with their comprehensive keyboard editing facilities, provides a sure and time saving method. Eliminating the need for error tape or card punching, this equipment operates in an on line mode, thus minimizing the necessity of lengthy computer printouts.

In future, the addition of local long term bulk storage offers the possibility of on-line programming, thus reducing the costly support services, which so often represent a most significant portion of software expenditure. It follows, therefore, that more efficient use can be made of existing staff, which could prove to be a valuable contribution towards offsetting the problems caused by present and future shortages of programming personnel.

Medical Records—With its simplicity and silence of operation, video equipment represents a viable solution to hospital data handling problems. Patient records filed at a central computer can be made available easily to doctors, consultants, ward sisters, and administrative staff. Treatment and drug records centrally recorded can significantly reduce margins of risk, and remove much of the administrative load from nursing staff. The video method of data presentation is particularly well suited to this application, being easily readable and capable of adjustment to suit differing requirements. The silence in operation of video equipment makes possible, probably for the first time, the siting of terminal units in wards. Thus the data required may be provided at the exact location necessary for treatment, without the acquisition of this data becoming a source of constant patient annoyance, which would result from using, for example, an electro-mechanical printer.

Education—The ability of this equipment to operate readily in question and answer mode provides a straightforward input/output device for programmed learning systems. The flexible nature of the machine, also makes possible more sophisticated disciplines than have been available with conventional teleprinter type equipment.