Computer and Automation Divisions

Computer Division
Marconi House, Chelmsford, Essex

Automation Division
Great Baddow, Chelmsford, Essex

* New equipment for 1969

The Marconi Company acquired a fund of data handling and transmission expertise in the 'fifties', when it was carrying out advanced research and development work in the automation of radar defence and air traffic control. As a result, it produced the world's first commercially available microelectronic computer, MYRIAD I.

MYRIAD I is a very high-speed, on-line, real-time machine which employs some of the most advanced microelectronic circuits in the world. It has a maximum storage capacity of 32,768 24-bit words and an input/output highway system allowing for the connexion of up to 4,000 peripheral devices. MYRIAD II is a modular version of this machine, enabling users to order only those facilities necessary for specific applications and to extend them at any time. The wealth of software which has been generated for MYRIAD I also applies to MYRIAD II.

A machine of the capacity, speed and flexibility of MYRIAD obviously finds itself at the heart of a wide diversity of automation systems. It is the basis of the systems designed by Marconi's Automation Division; it is the heart of the automated message switching system (MARS), designed by the Company's Line Communications Division, which is already installed in Cyprus and is to be installed for NATO and in the Defence Communications Centre, London. It was used in the tracking systems of the military satellite

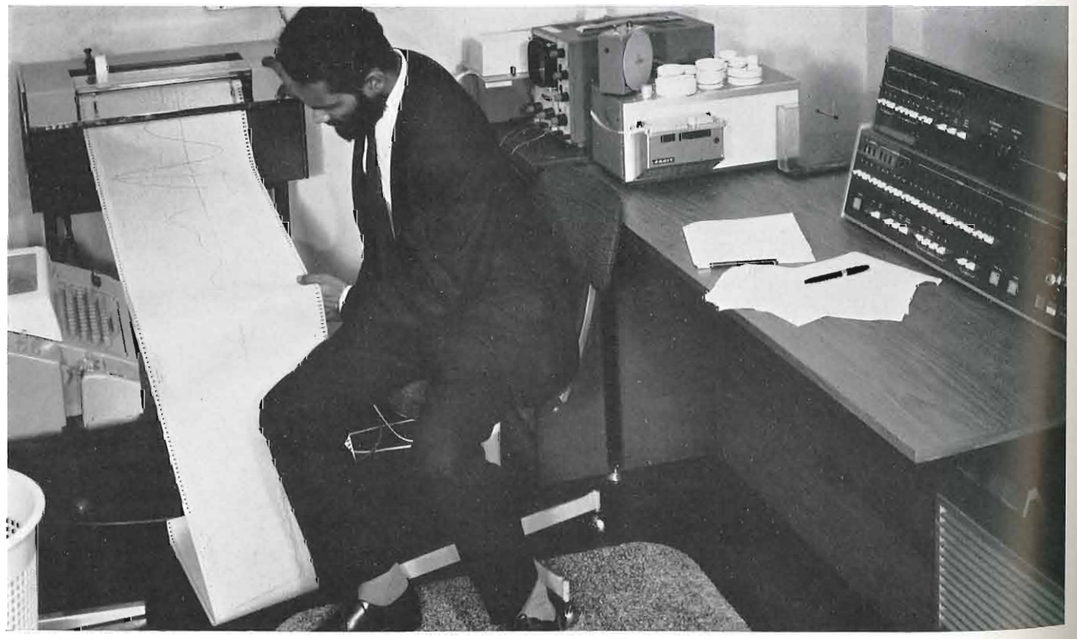
COMPUTER TEST *MYRIAD I computers at the Division's test establishment at Widford on the outskirts of Chelmsford*

communication earth stations, designed and manufactured for the British Government by Marconi's Space Communications Division. It is in the automated meteorological system, ordered by Sweden from Marconi's Radar Division, and in the Australian defence system 'Hubcap'.

MYRIAD computers also play an important role in research laboratories, where speed of calculation and analysis are of paramount importance. They have been installed in Southampton University's Institute of Sound and Vibration Research, the Deutsche Forschungsanstatt fur Luft-und-Raumfahrt, the Royal Radar Establishment and the Central Electricity Research Laboratory.

Computer Division is engaged in developing extensions of the MYRIAD range. Development work is continuously in progress to increase the variety and efficiency of the peripheral devices. Future activities will include investigation and development of even faster logic units, faster random access stores and new machine configurations.

HEADQUARTERS *of Computer Division in Chelmsford*



MYRIAD II *at Southampton University's Institute of Sound and Vibration, where it is programmed to perform sophisticated analyses*

Two factors led to the formation, three years ago, of Marconi's Automation Division.

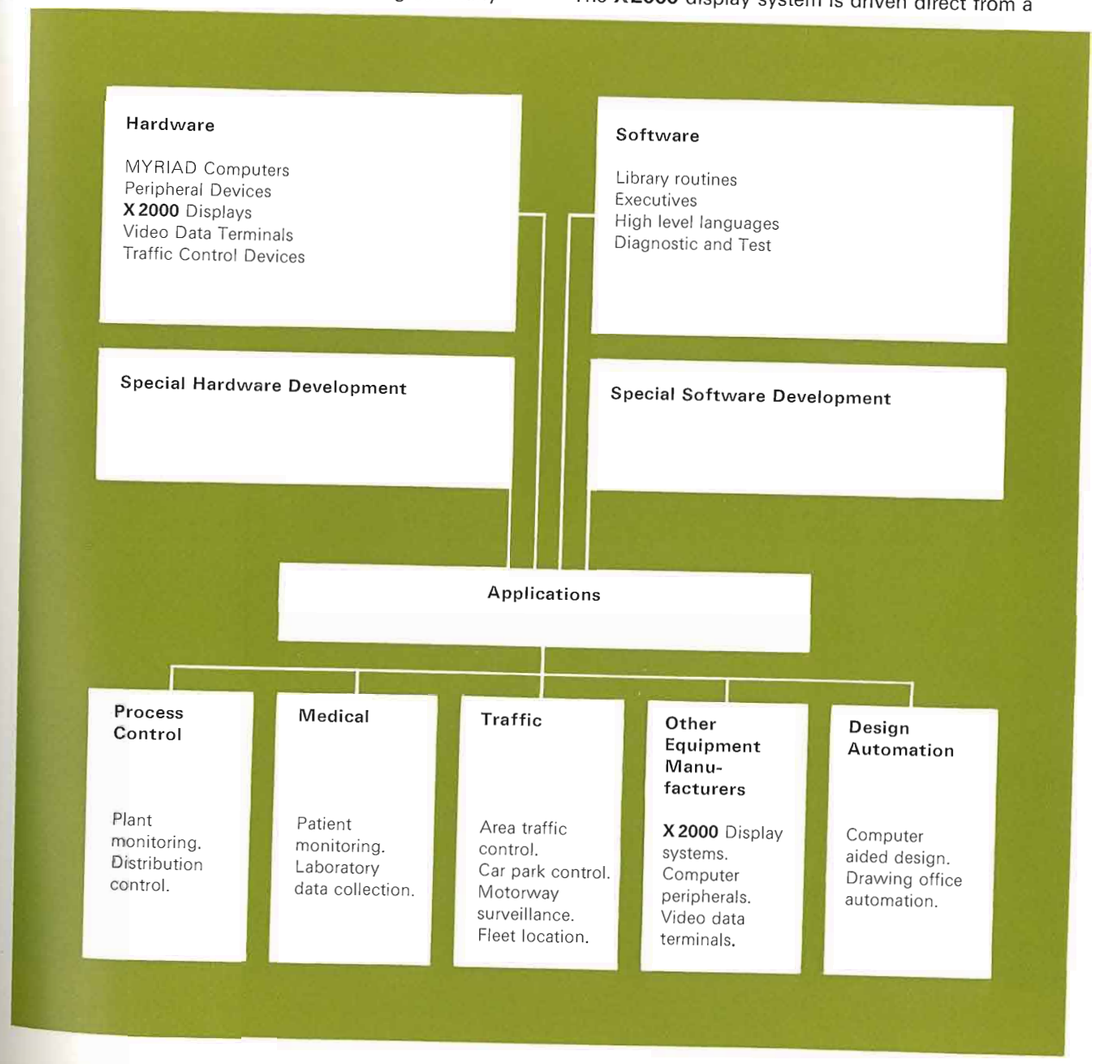
One was the existence of the MYRIAD computer and a considerable software capability, which clearly had applications ranging beyond the automation of military defence and civil radar systems, and which could be of immeasurable benefit in other spheres.

The other was the existence within Marconi of a nucleus of people not only having computer systems expertise but also a knowledge of the long-term and day-to-day problems facing the policy-makers and operators in a wide variety of areas—areas with which Marconi has been familiar for a great many years and which include aviation, telecommunications, broadcasting, industry and commerce. It is therefore, in a strong position to assess where and how automation can promote efficiency.

The capabilities and activities of Automation Division are summarized in the diagram below.

MYRIADS I and II accept direct data which, after computing, they use as the basis for exercising direct, dynamic process control. Thus MYRIADS are real-time machines suitable for all those on-line applications with which Automation Division is concerned.

The **X2000** display system is driven direct from a



Automation Division

computer and shows the high-speed data output in tabular or graphical form on a C.R.T screen. On the input side, it is designed to enable the operator to communicate with the computer either by means of light-pen, touch-wires, tracker ball or keyboard.

Regarding software, 50% of the Division's staff of 245 are employed in the Central Automation Systems Department, which is equipped with four MYRIAD computers. In addition to general purpose program development and the provision of programs for Automation Division's systems, the department is responsible for virtually all the Company's in-house, real-time programming work, and provides operational software for other Marconi Product Divisions such as Radar, Line Communications etc., to satisfy special customer requirements.

Applications

The Division's first significant entry into the automation of process control was made in association with the English Electric Company and was mainly concerned with power generation and distribution and with industrial processes. The systems include MYRIAD II computers and **X2000** displays for the Midland Electricity Board and the British Steel Corporation, **X2000** displays for the Pembroke and Drax power stations, **X2000**s for the Hinckley Point Nuclear Power Station and computers and displays for the Wylfa Head Nuclear

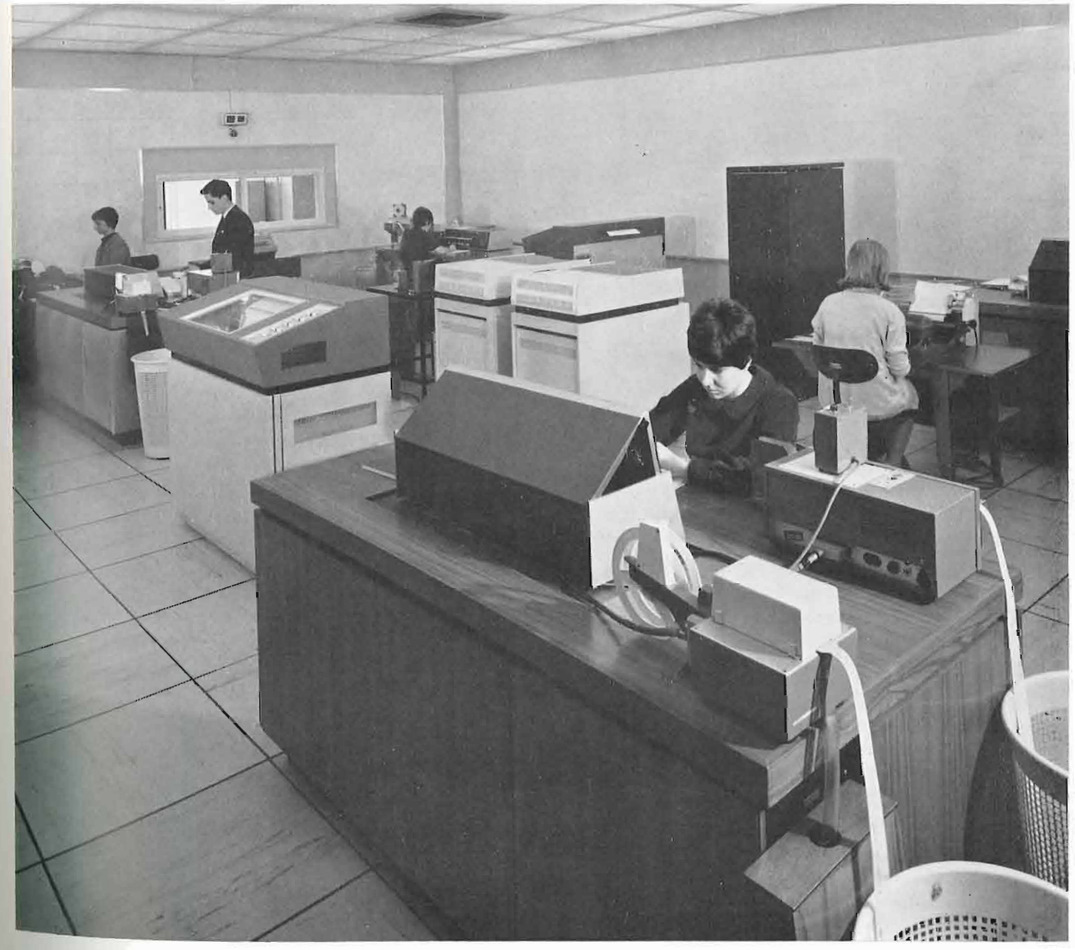
AREA TRAFFIC CONTROL *The MYRIAD I computer in the control centre at Glasgow, where the Ministry of Transport's Road Research Laboratory is carrying out an experimental scheme*

Power Station, where the computers moniter 4,800 analogue variables and 2,400 contact closures.

An example of medical automation is the system installed by Marconi in one of the U.K hospitals, where a MYRIAD II computer and **X2000** displays are used in a cardiac intensive care unit for the early detection of cardiac arrhythmia, and will also be used to evaluate new techniques in the maintenance of drug therapy records and to determine physiological patterns. Clinical staff will be able, via the displays, to input data for storage in the computer. Following the formation of GEC-Elliott Medical Equipment Limited, which Automation Division will supply with equipment, systems and programming support, all enquiries for medical systems should be addressed to that Company at Grafton Road, Croydon, Surrey.

In Area Traffic Control, MYRIAD computers are being used in both Glasgow and West London, where **X2000** displays are also employed. In these schemes the computer reads in data from detectors in the roads and forms a model of the traffic situation. From this model, optimum settings are derived for the signalling equipment at intersections in the area.

The Division has also designed systems for motorway surveillance, tunnel control, centralized car park control, etc. Fleet location systems have also been developed, allowing a central control room to monitor



CENTRAL AUTOMATION SYSTEMS DEPARTMENT *with a staff of over 100 and four MYRIAD computers is responsible for virtually all the Company's in-house, real-time programming work*

LONDON AIR TRAFFIC CONTROL CENTRE *where 100* ***X2000*** *displays are to be installed* Crown Copyright

the position of vehicles. In Marconi integrated area traffic control schemes, all the above control routines may be effected using the same central computer. With the formation of GEC-Elliott Traffic Automation Limited, which incorporates GEC Road Signals, Marconi's Automation Division now provides the new Company with systems and programming effort, equipment and product support for road traffic schemes. All enquiries for applications in the field of Road Traffic, with the exception of Fleet Location, should be addressed to GEC-Elliott Traffic Automation Limited, East Lane, Wembley, Middlesex.

In Air Traffic Control, the vast flight plan processing system at the London Air Traffic Control Centre is based on three MYRIAD Is and peripherals and 100 **X2000**s, while the Air Traffic Control Evaluation Unit at Hurn Airport is using 36 **X2000**s.

Design Automation is one of the newest and most significant applications. In this the C.R.T display enables a designer to create complex drawings on the tube face by using a light-pen or tracker ball and a keyboard. The most significant thing about this drawing medium is the ease with which shapes may be drawn and manipulated. This type of system has very many applications, for instance, microcircuit mask design, civil engineering, the design of structures, architectural design, etc. It is predicted that in a few years' time all major data processing installations will be equipped with C.R.T displays as an integral part of the computer system. They will allow much more efficient man-machine communication than has previously been possible. A system of this type is installed at the English Electric Mechanical Engineering Laboratory at Whetstone.

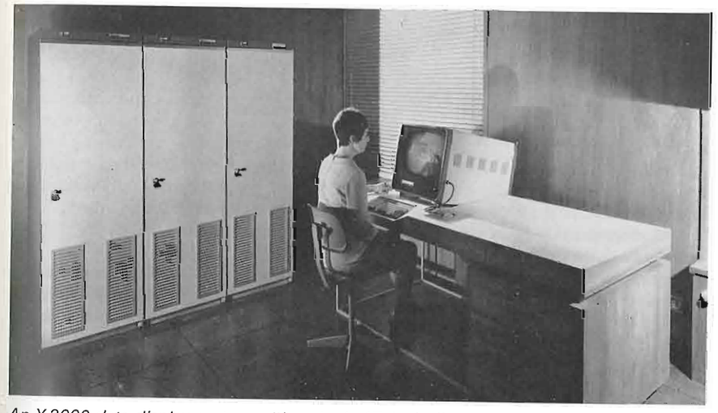
Automation Division also maintains a Graphics Bureau in which time can be bought on a MYRIAD graphics system, complete with C.R.T display, computer disc storage, plotter etc and including a comprehensive graphics software package. From the middle of 1969, several operator positions will be available, all able to operate independently although using the same computer. One of the Bureau's earliest users has been Marconi-Elliott Microelectronics Limited who are desinging a complete microcircuit mask on the screen in a matter of a few hours at very low cost.

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.

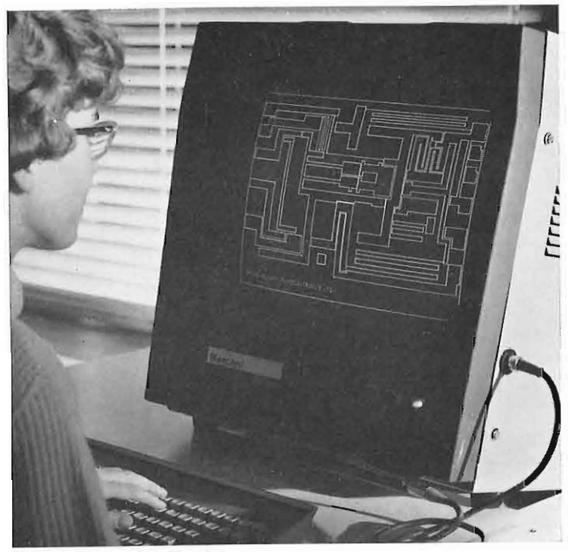
The Marconi Company has been developing and applying cathode ray tube displays for data presentation and system monitoring purposes. These have ranged from advanced radar to general purpose alpha-numeric display systems. The most recent development using cathode ray tubes is the X2000 series display 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.

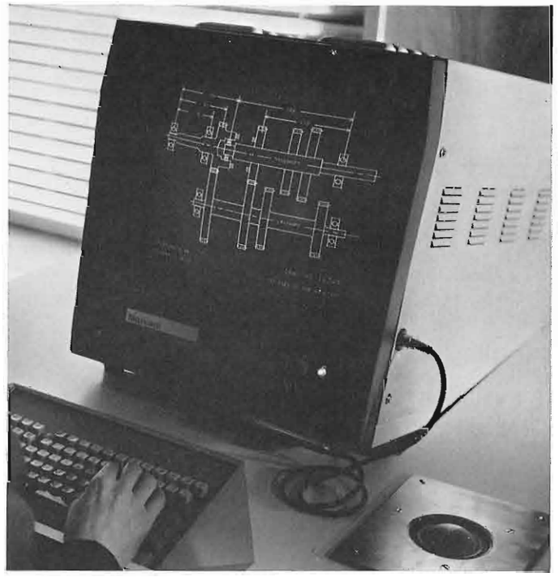
The operator communicates with the computer by using a tracker ball or light pen for drawing directly on the screen face, and a keyboard for entering alpha/numeric data. The keyboard also contains a number of simple function keys for selecting the various modes of operation.

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



Design of gear boxes

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.

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

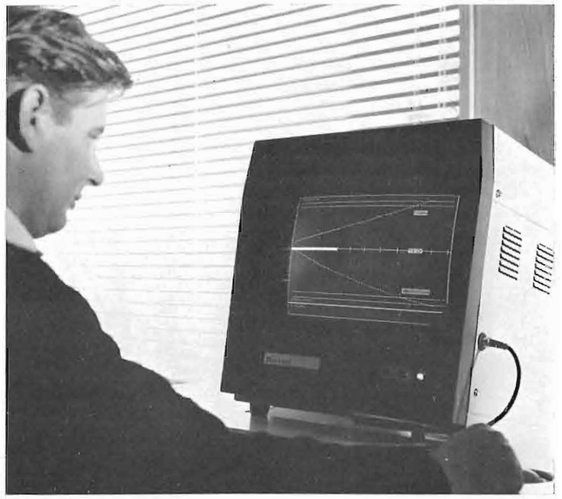
The use of computers and cathode ray tube displays to monitor and control large networks or complex processes is now becoming commonplace. The economics of replacing conventional instrumentation by a central computer complex are clearly understood and are particularly significant where a new control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

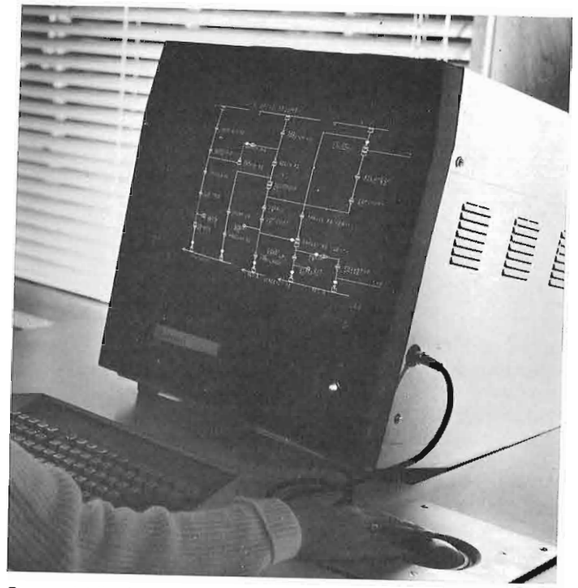
The equipment's purpose is two-fold. Firstly, it stores diagrammatic and associated data on the various discrete sections forming the distribution network and gives access to specific information as it is required by the controllers. As the distribution network expands, new information will be stored 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.

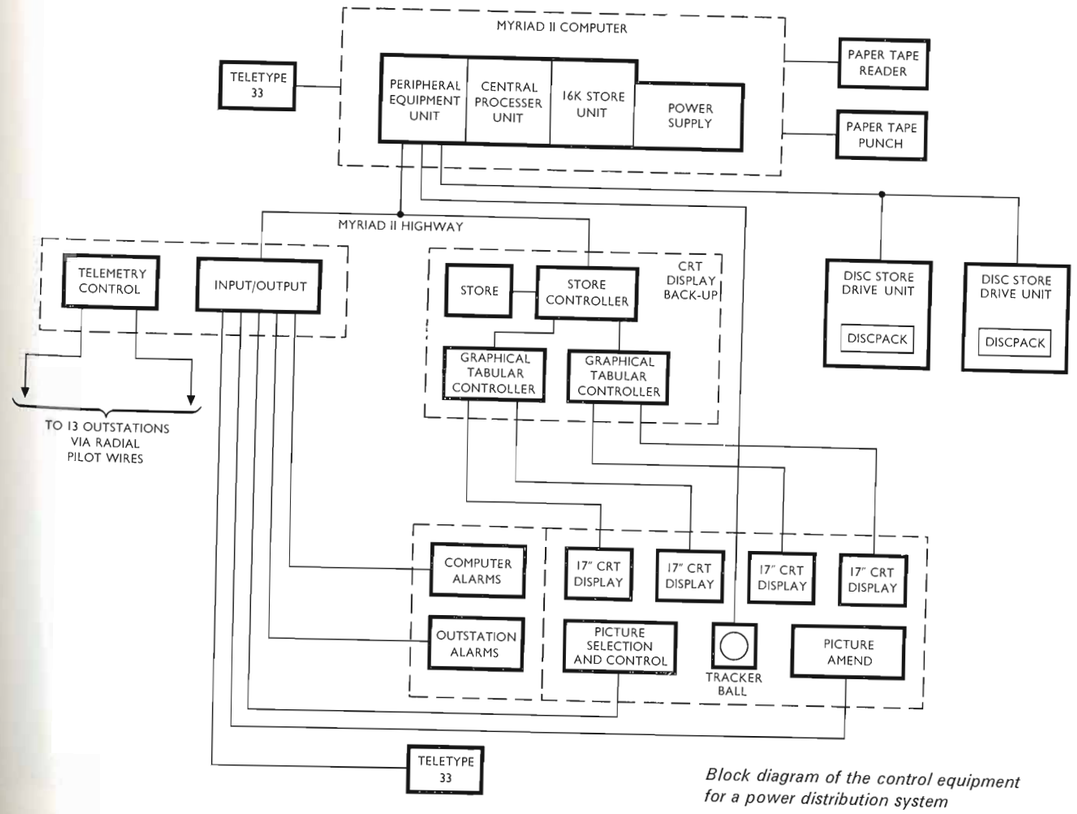
Facilities are provided on the control console which will permit an engineer to enlarge or modify a section of network diagram. This will be achieved by the use of a 'tracker ball' marker direction unit, which enables the engineer to direct a spot on the cathode ray tube face to draw horizontal or vertical 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.



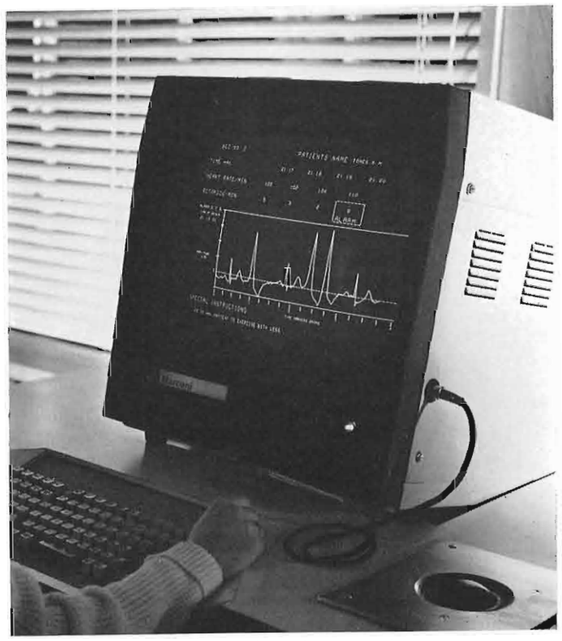
Power distribution network diagram



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 importance 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.

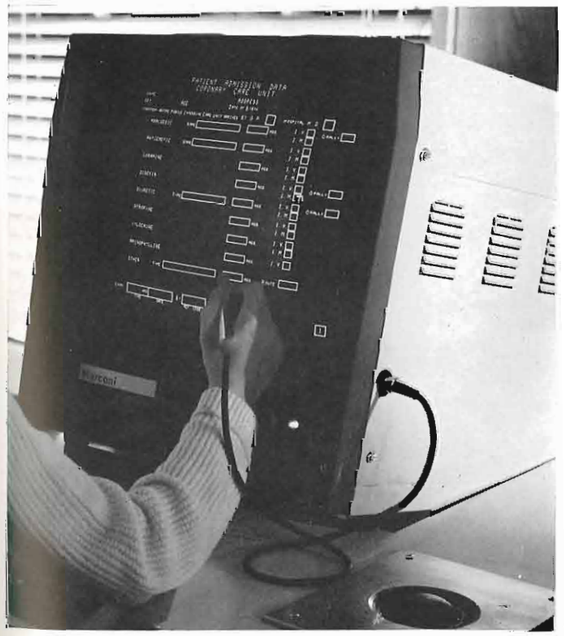
On receipt of the instruction, the computer can provide 'tell-back' to the operator by causing the selected legend to flash, increase in size, etc. This is only one example of interaction using a light pen, the principle may of course be used in a wide variety of input sequences, the important point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

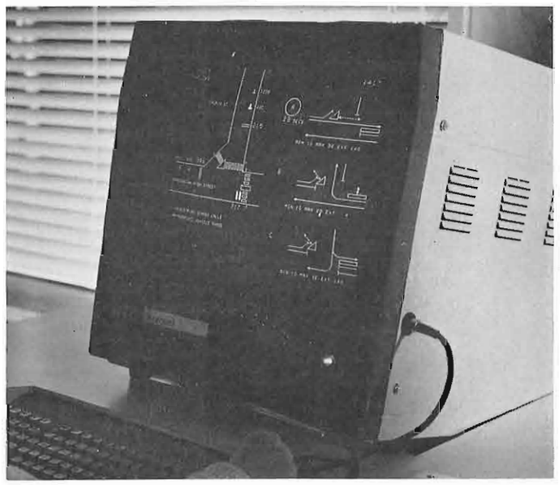
Integrated Area Traffic Control

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.

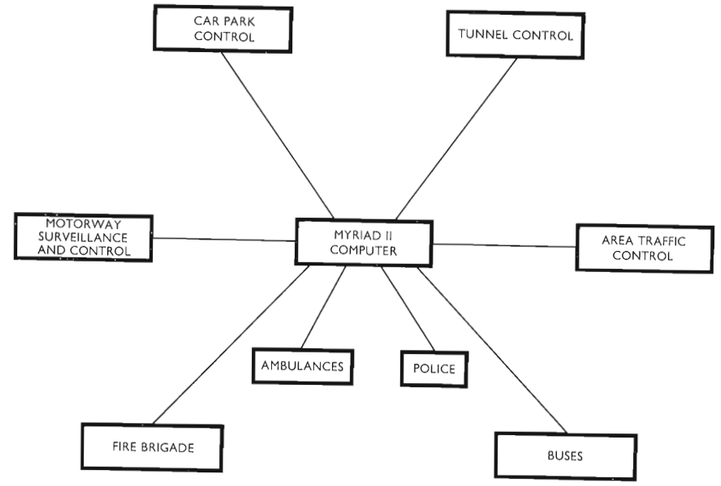
In addition, on a general purpose computer such as MYRIAD, it is entirely feasible to operate automatic car park control, motorway surveillance systems, tunnel and bridge control, etc. To implement any of these additional functions or to automate further intersections would involve only small extensions 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.

EQUIPMENT

'Myriad I' Digital Computer

The MYRIAD I computer is a high-speed parallel machine that combines outstanding computing and control capabilities. It is designed for real-time operation, and employs advanced engineering techniques to give the high reliability so vital to real-time systems. MYRIAD is a parallel fixed point machine with a single address operation, a word length of 24 bits, with facilities for double length working and extensive input/output facilities.

The core store consist of blocks of 4,096 or 16,384 words providing capacities of 4,096, 8,192, 16,384 and 32,764 words directly addressable with a cycle time of 1·4μs. The order code and instruction format have been designed for a real-time environment. A single direct address order structure is used, and 54 orders may be executed by micro-program. Particularly useful are orders allowing fast data sorting and input/output. Each instruction may be modified directly in three ways, with a B register, or the instruction count, or alternatively the address portion may be interpreted as a literal operand. A total of 166 valid instructions may thus be specified in addition to a 'modify' instruction.

Transfer of information between the machine and its peripheral equipment, or with another computer may be performed in two ways, by program or by a very fast interrupt mode. Autonomous data transfers to and from core store can be initiated by peripheral equipment, sometimes a vital facility in a real-time system. Eight interrupt priority levels are provided. If required, a number of peripheral devices can be multiplexed on each level. All transfers of data are performed along 24 bit input and output highways and a feature of the system is the ease with which it may be extended at a later date.

A full autonomous access facility is available on the 16,384 word store module enabling data to be transferred to or from the internal store at a rate of 1·4μs independent of program control. Store Protection is also available, this being a hardware multi programming facility which enables certain areas of the core to be specified as protected areas. Off line compiling, for instance, may then be carried out simultaneously with real time processing.

Myriad I

The computer draws its power from self-contained battery supplies which are continually charged. This enables the machine to withstand mains transients and even complete mains failure for up to three minutes.

A complete range of real time executives and high-level language compilers are available, including a real-time executive, and on-line off-line batch processing system, Algol, Fortran and Coral compilers, and a comprehensive assembly language, which allows program segmentation.

The MYRIAD range is designed to form a part of complex data handling systems, and systems available vary from small control centres to large multi-computer systems, as may be required in automatic telegraph message switching centres and air traffic control complexes for instance.

A comprehensive range of peripherals is available to provide bulk storage, and to construct specialized control schemes to customers' requirements.

Peripheral Equipment

(see page 325)

Features

High reliability with silicon micrologic modules and diode transistor logic.

High-speed add 2·8μs, multiply up to 20·40μs (including store access).

True multilevel priority interrupts.

Expandable storage to 32,768 words directly addressable.
24 bit word length.
Engineered to stringent military specification (DEF133).

Sophisticated programming aids; User Code, Algol, Fortran and Coral compilers.

Data summary

Type: Parallel fixed point single address.

Word length: 24 bits.

Representation: Binary.

Number range: $-1 \geqslant +1$.

Storage: Coincident current ferrite core stores.
(i) 4096 word block.
Expandable to 8,192 words.
Cycle time 1·4μs.
(ii) 16,384 word block.
Expandable to 32,768 words.
Cycle time 1·4μs.
Antonomous access and store protection facilities available as optional extras.

Input/output: Common input and output highways.

Interrupt: 8 levels of external interrupt with priority. Each level capable of being multiplexed to 24 or more sub levels.
Data transfers in 5μs.

Order speeds: Add, Fetch, etc. 2·8μs.
Multiply up to 20·40μs.

Function code: 54 orders working on both registers including:
Fetch, Add, Subtract, Store, Exchange, Collate, Not Equivalent, Complement, 7 shift actions, 5 jump actions, 4 link actions.

Modifiers: 3 are available and form part of the instruction word, they are modify with contents of B register, modify with contents of instruction counter and modify with address of instruction.

Instruction format:

Store address	15 bits.
Function code	6 bits.
Modifier digits	2 bits.
Stop digit	1 bit.

Power supplies:
200–250,
100–125V a.c $\pm$10%.
Single phase 45–65Hz.
1200–2500W.
3-minute no-break facility.

Dimensions:

Width	183cm	(6ft)
Depth	91cm	(3ft)
Height	84cm	(2ft 9in.)
Weight	540kg	(1200lb)

Environment:
Forced air cooling: 10 to 45°C, relative humidity 90%.

Software:
User Code compiler.
Algol compiler.
Fortran compiler with segmentation facilities.
Coral compiler.
Sub-routine library.
Test routines.

Full details are given in TD S3304

'Myriad II' Digital Computer

MYRIAD II extends the MYRIAD range of computers to provide a high-performance, low-cost machine for real-time applications. It employs the same order code as MYRIAD I so that software compatibility exists between the two machines. Many of the features which are built in to the MYRIAD I are available as options on MYRIAD II. This arrangement provides the flexibility to make up a machine to meet specific requirements.

MYRIAD II is a parallel binary fixed-point machine with single address operation having a word length of 24 bits with facilities for double-length working incorporated. Extensive input/output facilities are available in the form of optional modules. Most single-length instructions take less than 3μs with modifiers available on most orders.

The basic machine comprises a central processing unit, a store and either high speed punch and reader or a teletypewriter with paper tape attachments as the standard device for program input and output. Two store unit modules, one of 4,096 words, the other of 16,384 words, provide directly addressable storage capacities of 4,096, 8,192, 16,384, 20,480 or 32,768 words to be associated with the central processor. The store cycle time is 1·5μs in all cases. Store protection facilities are available as options.

Where a small system or sub-system employing only a few peripheral devices is required, the internal machine highways can be extended and the input/output control circuits for the peripheral devices accommodated within the central processor cabinet. For larger systems, 12 or 24 bits of data can be extended along external common input and output highways allowing complete flexibility in system designs.

Interrupt input/output options are available which provide automatic priority selection of interrupting devices at four or eight levels. The interrupt system allows data transfers to be made to or from the computer in approximately 6·5μs, including access.

Myriad II

The multiply and divide options deal with both positive and negative 24 bit numbers.

The engineering form, based on the sub-board/main-board/unit hierarchy, successfully proved in MYRIAD I, is used in MYRIAD II. The basic circuits of the computer are constructed from integrated circuit, diode transister logic similar to the MYRIAD I designs, resulting in an expected mean time between failures of not less than 2,000 hours.

Peripheral Equipment

(see page 325)

Features

High reliability with silicon micrologic modules and diode transistor logic.

High-speed operation—
add, less than 3μs.
multiply, less than 28μs.

Expandable storage to 32,768 words, directly addressable.

True multi-level priority interrupts, highway connection system to external peripherals, multiply and divide orders, and store protection available as options.

Sophisticated programming aids User Code, Algol, Fortran and Coral compilers. Basic software generated for MYRIAD I available for use on this machine.

Data summary

Type: Parallel fixed-point single address.

Word length: 24 bits.

Representation: Binary.

Number range: $-1 \geqslant +1$.

Storage:
Coincident-current ferrite core stores.
(1) 4,096 word block.
(2) 16,384 word block.
Providing 4,096, 8,192, 16,384, 20,480 and 32,768 word storage capacity.

Cycle time: 1·5μs. Store protection facility available as option.

Input/Output: Common input and output highways.

Interrupt: Up to 8 levels of external interrupt with priority. Each level capable of being multiplexed to 24 or more sub-levels.
Data transfers in 6·5μs.

Order speeds: Add, Fetch, etc, less than 3μs. Multiply, less than 28μs.

Function code: Includes Fetch, Add, Subtract, Store, Exchange, Collate, Not Equivalent, Complement, 7 jump actions, 6 shift actions, 4 link actions.

Modifiers: 3 are available and form part of the instruction word, they are: modify with contents of B register, modify with contents of instruction counter and modify with address of instruction.

Instruction format:

Store address	15 bits.
Function code	6 bits.
Modifier digits	2 bits.
Stop digit	1 bit.

Power supplies:
230V+10%−20%.
Single phase 45–65Hz.
1500–2500W.

Dimensions:

Computer

Height	165cm	(5ft 5¼in.)
Width	115cm	(3ft 10in.)
Depth	38cm	(15¼in.)

Control Desk

Height	76cm	(2ft 6in.)
Width	152cm	(5ft)
Depth	76cm	(2ft 6in.)

Environment:
Forced-air cooling: 10°C to 45°C, relative humidity: 90%.

Software:
User Code compiler.
Algol compiler.
Fortran compiler with segmentation facilities.
Coral compiler.
Sub-routine library.
Test routines.

Full details are given in TDL4001

'Myriad III' Digital Computer System

The MYRIAD III system is the latest extension in the MYRIAD range of computers. It is very compact and constructed in a totally modular form which provides flexibility of application, simple installation and ease of expansion. Any programs written for MYRIAD II can be run on a MYRIAD III system of similar peripheral configuration. The input/output interface is similar to that of MYRIADS I and II.

A MYRIAD III computer system works in parallel binary fixed point with single address operation. It has a word length of 24 bits with facilities for double-length working and extensive input/output capability. Storage capacity is up to 262,144 words by a paging system in 16,384 word units. One 16,384 word unit is always associated with the Central Processor (Page '0'). A second unit is 'paged' by program instruction so that the machine behaves as a 32,768 word machine, but has access to 262,144 words.

The machine consists of a number of modular units. These include:
Central Processing Unit.
16K 1·8μsec Store Unit.
16K 0·7μsec Store Unit.
Power Unit for C.P.U.
Power Unit for 1·8μsec Store Unit.
Power Unit for 0·7μsec Store Unit.
Operators Contro Unit.
Programmers/Engineers Control Unit.
Store Extension Unit.
Highway Extension Unit.

Two types of store unit are available. Both are 16,384 × 24 bit word modules but one has a cycle of 1·8μsec and the other has a cycle time of 0·7μsecs.

Because the store timing is controlled from within the store unit and the machine as a whole is asynchronous, it is possible to mix the two types of store unit in a machine configuration so that the cheaper unit can be used to store information which is not critically time-dependant, and so minimise the system costs.

A Master Peripheral Unit designed to accept standard control modules, accommodates the input/output control circuits for the immediate peripheral devices such as the paper tape reader, paper tape punch, teletypewriter, line printer, Watchdog Timer, Real Time Clock, etc. Because any standard module can be plugged into any position, complete flexibility of system design with the minimum of effort is obtained. One of the standard modules is the

Input/Output Extension Module which, in the larger systems, is the link between the main peripheral highway and the Central Processor.

Each unit making up the computer system is engineered to fit into a standard 19-in. rack, but if rack mounting is inconvenient the units can be distributed to make the most efficient use of the space available. This is a particularly important feature in mobile applications.

Because the input/output interface is compatible with MYRIAD I and II, all the peripheral devices that have so far been interfaced with MYRIADS can also be used with MYRIAD III.

Features

Modular unit construction.

High reliability from the use of integrated circuit technology throughout based on Transistor Transistor Logic in Dual-in-Line Packages (D.I.Ps).

Storage up to 262,144 × 24 bit words.

Peripheral device data transfers take place along a single set of cables which form a highway system. More than one highway may be connected to the central processer.

Over 4000 peripheral addresses available.

Eight priority levels of interrupt in hardware. Each level may be multiplexed as many ways as required.

Sophisticated programming facilities include User Code, Algol 60, Fortran, Mini-Coral. Basic software generated for MYRIAD I and II compatible with MYRIAD III.

'Myriad' Peripheral Equipment

All MYRIAD real-time control systems are built up from a comprehensive range of peripheral units, from major items such as a Disc or Display System to small 'building bricks' which can be engineered to give any required configuration of input/output interrupt and addressing. Wherever possible integrated circuits are used on these boards.

The following are some of the major units available at the present time, new peripherals are, however, continually being added to the list.

Disc Store

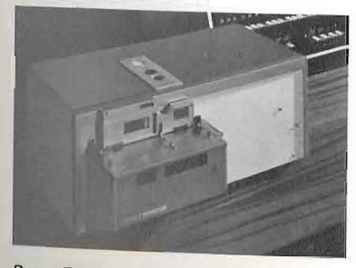
The MYRIAD Disc Controller (see page 329) allows up to eight CDC9460 replaceable disc stores to be connected to the highway. Each disc store has a maximum capacity of 7·25 million bytes (over 2 million MYRIAD words). Variable block length working, seek overlap and parity checking are features of this design.

X2000 Data Displays

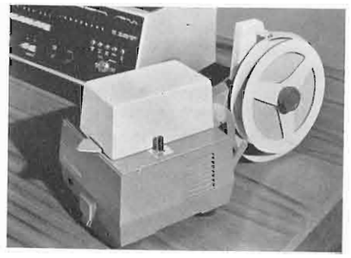
Full graphic and alphanumeric capability on this new range of c.r.t displays and an entirely new Laminar Beam cathode ray tube give higher definition pictures than previously available. A range of units enables widely different system capabilities to be provided, for instance with or without buffer storage, softwave or hardware character generation, vector and circle generators. Touch Wire, Light Pen or Tracker Ball input devices are available (see pages 328 and 329).

Line Printer

The SF400 line printer which operates at 300 lines per minute gives up to 136 columns.



Paper Tape Reader



Paper Tape Punch

Graph Plotter

Computer Instrumentation models 341 and 361 incremental graph plotters may be included in MYRIAD systems.

Typewriters

Teletype ASR33 or 35, Friden Flexowriters, or IBM73 typewriters are available.

Paper Tape Punch and Reader

Facit tape reader (1000 chars/sec) and tape punch (150 chars/sec) are available. A powered tape dispenser is available for use with the reader.

Magnetic Tape Systems

Ampex 7 or 9 track, 36 or 75in/sec, 800 b.p.i tape stations may be used in MYRIAD systems. Four stations can be controlled from one Tape Controller.

Digital and Analogue Inputs

To accommodate the special inputs required in all real-time systems the following units are available.

Highway Connection Units: To tap the highway and provide an internal highway at logic levels within a cabinet, the highway connection unit is required.

Input/output Register: contains a 12 bit register together with a standard address circuit.

Interrupt Gate: contains 6 channels each capable of handling one interrupt signal.

Interrupt Generator (Clock): contains an oscillator and 3 stage counter to provide interrupts into the computer at preset intervals.

Counter Register: provides 5 stages of counter, may also be used as a shift register.

Watchdog Timer: detects failure of the computer.

Power Drive: contains 36 power drive circuits to drive lamps, relays, etc.

Transfer Control Unit: used for transferring data from one MYRIAD computer to another.

Contract Input Gate: used to gate signals into the computer when received over long lines.

Telegraph Input Level Converter

Telegraph Line Driving Unit: for accepting and transmitting data to telegraph circuits.

Digital Scanners: may be built up to accept digital or contact inputs in groups of 120 up to 1024 points.

Analogue Scanners: The full range of English Electric's System M A.D.C's and multiplexers is available.

Digital Output Units: to provide single bit outputs for relays, lamps or control.

Analogue Output Unit: converts digital signals to suitable analogue signals as required.

Mechanical Arrangements

Peripheral Control Boards may be housed in several ways, viz:

(a) *Local Peripheral Unit*—This unit, housed in the MYRIAD II, accommodates up to six boards.

(b) *Disc Controller*—if a disc controller is used in the system, up to 15 boards can be accommodated in the same cabinet, and these use the same highway connection units.

(c) *Cabinet*—for larger systems and where no Disc Controller is used, an Automation Division cabinet is used. These are 191·6cm (6ft 2½in.) high, 65·1cm (2ft 1¼in.) wide, 49·4cm (19½in.) deep.

Boards are mounted on standard 19in. International racking, with plugs and sockets mounted beneath.

Different configurations are available to take 15, 30, 45 or 60 printed circuit boards.

Full details are given in TD 2X.

'Myriad' Software

The standard programming languages supplied with the MYRIAD range are Assembly Language (User Code), Fortran, Coral and Algol. The systems are based on paper tape input-output, and incorporate a range of program-test and diagnostic aids, and automated program-amendment.

Assembly Language

Symbolic addressed and mnemonic functions are used, and a specialized program-amendment system provides print-out in a standard format. Two program-assembly systems are available, of which the simpler is intended for small machine-configurations while the more complex provides for individual 'segments' or 'modules' of program to be compiled independently, prior to loading. This procedure allows program segments to be developed, tested and documented as self-contained units and opens the way to 'modular' software. Variants allow outputs to derive from paper tape punch, character-printer, or line-printer according to choice.

System-support includes dictionary and fault data print-out, post-mortem and a very versatile 'trace' procedure.

Fortran

A compiler for A.S.A Basic Fortran is supplied, and the system adopted allows segmentation as used in relation to the Assembly Language. Complete programs may therefore be built up from 'modules' deriving from Assembly Language and from Fortran.

Coral

Coral is a high-level language sponsored by the Royal Radar Establishment and is designed to meet the needs of on-line automation applications, where efficiency of translation is particularly important. Mini Coral and Coral 66 compilers have been developed for MYRIAD Mini Coral in particular is finding appreciation as a high level programming language for defence and air traffic control systems.

Algol

MYRIAD Algol is an extremely comprehensive implementation of the Algol 60 language, in which only minor deviations have been allowed. Program-recursion is permitted, and most published algorithms can be used with the system. The implementation is designed particularly for rapid and easy program-development; a small sacrifice in speed has allowed excellent run-time diagnostics to be incorporated in addition to the normal syntax checks and reports.

Operating Systems

(1) A 'Real Time Executive' is available which allocates control to one of a range of 'jobs' on a priority basis, and organized communication with input/output packages. The system includes a number of advanced features, and provides a framework within which Automation programs are written.

(2) An 'Off-line Executive' provides batch-processing facilities in which programs and data are drawn automatically from disc storage, and program-execution is carried out concurrently with input and output of job instructions and of data. This arrangement minimizes the loss of processing-time due to input of data, and leads to greatly increased computing capacity.

Standard Sub-Routines

A comprehensive range of sub-routine for single and double length floating-point arithmetic and for trigonometric and hyperbolic functions is provided. Other standard packages include a range designed for peripheral-device control.

Specialist Applications

Projects in Air Traffic Control, Radar Systems, Communications, Computer Graphics and other fields have led to a number of standard applications packages and to experienced programming support. These packages can be drawn on in building up programs for specific applications, but are not normally issued to users.

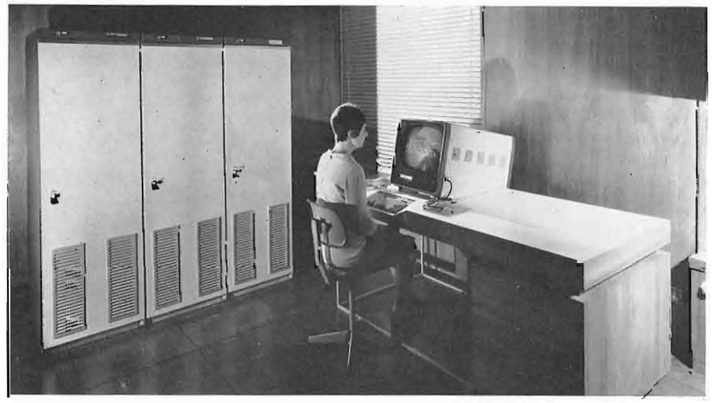
Hardware Test and Diagnostic Routines

Fault-detection and location in the Central Processor and in the peripheral equipment associated with it is facilitated by the use of these routines. A substantial library of well-documented procedures is available.

X2000 Data Display System

The Marconi X2000 series of Data Displays combines tabular and versatile graphical facilities with a choice of input techniques designed primarily to give the operator a means of communicating with the computer using his hands in a natural way.

This system is designed for high-speed data output from MYRIAD or other computers with particular emphasis on picture quality, versatility of operation and flexible input techniques.



X2000 data display system

Typical Applications

The Marconi X2000 Display System provides a positive contribution in the growing use of high speed digital computers. It provides a precise, unambiguous read-out method, and is particularly suitable for use in the following applications.

- Computer Graphics.
- Power Generation and Distribution.
- Steel Mill Operations.
- Message Switching.
- Meteorological Data Handling.
- Banking and Business Data Handling.
- Air Traffic Control.

In order to achieve a wide range of system performance the equipment has been designed in modular form and a number of the facilities available are therefore optional.

The display system consists in its simplest form of a control unit and one cathode ray tube display driven directly from a computer. This allows the presentation of data in the form of dots on a 1024×1024 matrix. The computer will, however, have to send the data and instructions to the control unit so that the displayed picture is refreshed at a rate greater than 16 cycles per second to avoid undesirable flicker.

Where more complex formats are being displayed, the loading on the computer becomes considerable and it is necessary to fit a ferrite core store which buffers the computer from this load.

Where it is required to draw vectors it is necessary to add the vector generator which is a plug-in option to the Control Unit. This allows straight lines to be drawn between points at any angle. By appropriate instructions a picture may be built up from a sequency of vectors. Limited amounts of tabulated data may be dealt with by drawing each character as a sequency of vectors.

The display units are equipped with two deflection systems, a main deflection, and a very high speed auxilliary deflection system. The operation of the position and vector generators, as described above, utilize the slower main deflection system. Three further options are, however, available which use the high speed auxilliary writing channel, these being the symbol, circle and character generators.

To show a very large amount of tabulated data on a number of displays, a character generator may be required since this allows a character to be written in about 10 micro-seconds. Characters are drawn as a preset sequence of small vectors which join adjacent points on a 5×5 matrix.

If the volume of tabulated data is such that a longer character writing time can be tolerated, then software character generation may be used. This allows the program to link to a set of character of symbol writing instructions which are stored in the core store. These instructions consist of the series of vectors required to draw the character of symbol, they are completely under program control.

There are four display units of 8½, 11, 15 and 17in. tube sizes available, these are likely to be augmented by a larger display of 24in. size. The units are of rugged construction and are designed for very high speed of operation.

A comprehensive range of input devices are available for use with X2000 Display systems.

Features

Very high definition using a Laminar Beam tube. This improves clarity and enables more data to be presented.

Tabular operation with alpha-numeric character generation range up to 100,000 per second. The system provides flexibility in number of lines, number of columns and format.

Graphical displays created by vectors drawn between points on a 1024×1024 matrix. Auxiliary deflection channels for rapid drawing of characters and symbols generated either by hardware or software.

Optional 4k buffer store to relieve computer loading.

Sub-routine mode enabling software characters, symbols or subpictures to be called up from store locations by program.

All the modes of operation may be combined to provide tabular and graphical information in the most efficient way.

The choice of Light Pens, Touch Wires and Tracker Balls makes it possible for the operator to communicate with the computer in a direct and convenient way.

Data summary

Display Control Cabinet

Logic elements: Microminiature logic throughout.

Store capacity: 4,096 words, 24 bits.

Store cycle time: 1·8 microseconds (full cycle).

Data code: Marconi Display Code in Sub-routine Mode. ISO 8 in Character Generator.

Display outlets:
6 plug-in for 1 control unit.
12 plug-in for 2 control units.

Number of lines: Flexible, typically 64.

Number of characters: 64.

Ambient temperature range: 0–40°C.

Relative humidity: 90%.

Mains supply: 110 or 230V a.c ±10%. 500 to 1250W according to configuration.

Dimensions:

Height	189·2cm	(6ft 2½in.)
Width	120cm	(3ft 11½in.)
Depth	71·1cm	(2ft 4in.)

Ventilation: The equipment can be operated without air conditioning equipment in the temperature range 0 to 45°C with 90% humidity. Air is drawn in through a filter at the front of the cabinet and is expelled through vents at the top. The cabinet can also be connected to an external forced air blowing system where this is available.

Display Units

Sizes:
8½in. (X2002), 11in. (X2001) 14in. (X2005) and 17in. (X2000).

Front panel controls and indicators: On/off, Focus, Brilliance and mains indicator.

Logic elements: Silicon semi-conductors are used throughout (including e.h.t).

Ambient temperature range: Main and Auxiliary deflection systems 0–45°C.

Relative humidity: 90%.

Power supplies: Integral.

Mains supplies: 110 or 230V ±10% 150–500W per unit.

Ventilation: Self blown.

Dimensions:

X2001 (with covers)

Height	34·3cm	(13·5in.)
Depth	68·6cm	(27in.)
Width	33cm	(13in.)

(without covers)

Height	29·8cm	(11·75in.)
Depth	61cm	(24in.)
Width	30·5cm	(12in.)

X2000 (with covers)

Height	46·9cm	(18·5in.)
Depth	73·7cm	(29in.)
Width	45·7cm	(18in.)

(without covers)

Height	43·2cm	(17in.)
Depth	66cm	(26in.)
Width	43·2cm	(17in.)

Full details are given in TD X2000.

X2000 Data Display Input Devices

A comprehensive range of input devices are available with the X2000 display range together with an auxilliary logic framework capable of accommodating the interface boards. A transmission unit is also available which allows the computer to send and receive data at 600 or 1200 baud rates over telephone lines.

Tracker Ball

The tracker ball is an input device to the computer which is used in conjunction with a display system to give manual control over displayed information.

The operator unit comprises a 3-inch ball which is normally recessed into a desk or control panel, close to the display unit and which may be easily rotated in any direction.

When the ball is rotated, digital signals which indicate motion and direction of motion, are inputted to the computer. Thus, if an associated marker is displayed, it can be arranged that the movement of this marker is directly related to the rotation of the ball in any direction.

It is therefore possible for the computer to calculate the instantaneous position of

Tracker ball

the marker on the display screen. Thus a highly flexible means of communicating with the computer, via the display screen, is established.

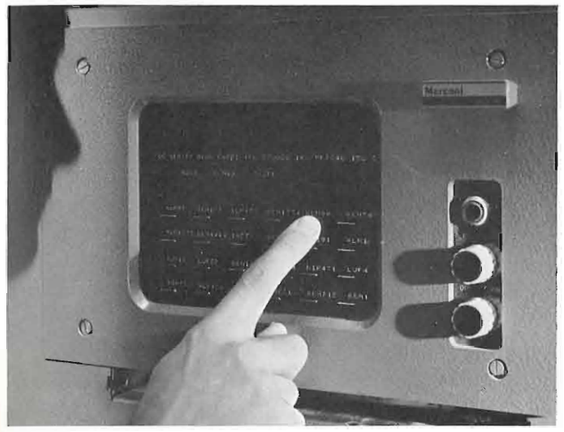
Touch Wire System

The Marconi Touch Wire System is an option to the X2000 series of displays and is a direct input selection device. The system consists of two units: a transparent touch wire mask which fits in front of the screen and provides the man-machine interface, and a decode logic unit which is a board that plugs into a pre-wired socket in the display unit.

There can be up to 32 double wire contacts fitted into the lower part of the mask and the system is so arranged that a finger touch on any one of these contacts results in a unique code being transmitted to the computer. Items of data are written on the screen to serve as labels for each of the contacts and by touching the appropriate contact any of these items can be selected.

As it is possible, by program, to change the labels under the contacts at any time, an unlimited range of selection is provided. Normal information can still be displayed in the upper half of the screen and this will complement the labelling data.

The Touch Wire System has no moving parts and fewer electronic components than a keyboard system and is considerably more reliable. Because it is completely static it is silent and more rapid in operation and results in lower operator fatigue. The direct association of information with the contact also makes a significant contribution to operational efficiency.



Data Display fitted with Touch wires

The Light Pen

The light pen is a hand-held, light-sensitive device which is connected via the display back-up equipment to the computer.

The light pen produces an electrical signal when its field of view is crossed by the spot of the c.r.t. The resultant signal momentarily stops the buffer store output counter and interrupts the computer, thus enabling the computer to identify the picture element to which the light pen was pointing.

By applying suitable software techniques, the light pen can be used for drawing, pointing etc, and offers many advantages in system where a high degree of man-machine interaction is required.

Light pen

Keyboard

The keyboard has self-contained encoding circuitry and is equipped with up to 96 keys. Sixty-four of these electro-magnet keys are in an alphanumeric set and there are up to 32 control function keys which determine for example, the orientation of the graphic display. A feature of the keyboard is the constant duration output irrespective of key pressure variations.

The keyboard may be set into the console in front of the display or may be free-standing.

Auxiliary Logic Frame

The auxiliary logic frame, located in the Display Control Cabinet, provides system interfaces for the input devices described above. One auxiliary logic frame enables the following input devices to be used:

2 light pens.
2 tracker balls.
2 keyboards.
2 touchwires.

If more input devices are required, additional auxiliary logic frames may be specified. If two graphical/Tabular Control Units are specified in the system or the transmission interface is required this unit will be accommodated in an additional cabinet.

Transmission Frame

A framework is available which will interface the MYRIAD Computer to a modem. It provides hardware serialization and deserialization and allows transfers to be made at 600 or 1200 bauds. The unit would, in a graphic system, share the highway tapping elements with the auxiliary logic framework, both being accommodated in a peripheral cabinet.

Disc Store System

A replaceable disc store unit is available as a bulk store medium for MYRIAD Systems. The System comprises a disc store controller and up to 8 disc drive units. The latter units are manufactured by Control Data Corporation and have a data capacity of over 2 million words. The disc pack itself is replaceable enabling long term data to be stored. Data storage is IBM compatible.

The disc controller allows up to 8 disc drive units to be driven from one computer highway and features variable block length working, seek overlap and parity checking on transfers. Integrated circuits are used throughout.

Standard MYRIAD software includes a very comprehensive core disc operating system and routines which facilitate the effective use of the back-up storage.

In the design of the disc controller, provision has been made for housing up to 13 peripheral control boards which may share the same highway tapping unit.

Data summary

Disc Controller Cabinet

Normal access from 2 doors in front, but rear doors also fitted.

Dimensions:

Height	1·89m	(6ft 2½in.)
Depth	52cm	(1ft 8½in.)
Width	120cm	(3ft 11½in.)
Weight	350kg	(650lb)

Disc Drive Unit

Approx. storage capacity: 7¼ million bytes each of 8 bits.

Maximum access time: 165ms.

Track to track access time: 24ms max.

Latency time: 25ms (2400 r.p.m disc speed).

Recording density:
765 b.p.i inner track (track no. 0).
1105 b.p.i outer track (track no. 202).

Total number of tracks: 200 +3 spare.

Max. number of units per system: 8.

Operating temperature: 15·5 to 32°C (60°F–90°F).

Humidity, operating: 10–80% relative.

Vibration operating: 0·15g in range 15–300Hz indefinitely.

Power requirements- 415V a.c ±10%. (line to line) 3ph. Frequency: 46–52Hz. Loading: 0.86kW. Surge current: 8A max.

Dimensions:

Height	103·5cm	(40¾in.)
Length	91·5cm	(36in.)
Width	61cm	(24in.)
Weight	218kg	(480lb)

Discpack: Type IBM1316 or equivalent, removable and inter-changeable between units.

Discs per pack: 6.

Surfaces available: 10.

Diameter: 14in. nominal.

Weight: 10lb.

Full details are given in TD3X.

Disc Store

X4000 Video Data Terminal

The Marconi video terminal system represents a significant advance in peripheral equipment for real time multi-access computer operations. Providing a means of direct computer interrogation and bulk information transfer, without intermediate card or tape preparation, the video terminal is capable of presenting data in an immediately readable form. The inherently high speed operation of the equipment permits interrogation to take place efficently via local or remote transmission links, thus offering a long distance time sharing capability.

The main equipment consists of a type-writer keyboard linked to a cathode ray tube display unit, providing facilities for the composition, editing, transmission and reception of alphanumeric messages of predetermined length. The terminal displays data entered by the keyboard on the tube face, and contains integral dynamic storage and stroke writing character generation, enabling this data to be refreshed at a sufficently high frame repetition rate to maintain a flicker and jitter free display.

Displayed information may be edited and 'formatted' using the keyboard editing controls, which incorporate comprehensive erase, insert and delete facilities for single characters or whole lines. Messages for transmission, which may be placed at any position in the screen, are bracketed by special start of text and end of text symbols, thus permitting a series of questions and answers to be assembled on the screen, without wastefully repetitious transmission.

Data is transmitted under control from the store using ISO/CCITT standard codes, speeds and procedures to a line transmission modem in the remote case, or computer interface in the local case, and replies received from the same medium in a similar manner. Error control includes longitudinal and vertical parity checks, and message format verification before transmission by the terminal is a standard feature.

Similar facilities are provided for the reception of messages, and the computer has complete control over the positioning of data on the screen, by means of special control codes injected at suitable points in the text. The computer may thus choose to erase existing data, or chain the replies immediately after the query. Alternatively the cursor manipulation functions permit the screen to be split, thus allowing two independent sets of information to be serviced, and existing data may be rolled or scrolled from any line up and down the screen at will. Furthermore, the computer may assign certain areas of the display as protected data which cannot be altered by the operator. Since data within protected fields is not retransmitted from the terminal, a considerable reduction in line time is achieved by sending variable data only in these circumstances.

As a means of injecting high priority messages, the processor override function causes the computer to take complete command of the terminal transmission and reception circuits. Thus the processor may, at any time, interrupt the terminal operator where circumstances demand priority access.

A terminal network may be configured as a single terminal dedicated to a line, or as a cluster of up to 32 machines, in any mixture of character capacities, sharing a line. A line expander module acts as the necessary interface between the modem and a terminal cluster.

A range of data adapter units and special computer interfaces complete the system. These units permit a choice of transmission method to suit particular needs, and provision is made for the connection to certain defined commercial computers commonly used in multi access systems.

The System contains three basic video terminal units, with character capacities ranging from 288 to 1152 characters per screen. Each model has a choice of one of three transmission interfaces, parallel, asynchronous or synchronous, each serial interface having two optional operating speeds.

The line expander module for use with remote cluster systems, has a maximum machine capacity of 32 terminals. Cluster sizes may be increased where data traffic conditions permit by multidropping and additional line expanders up to a total of 64 machines.

The data adapter units are provided in three forms suitable for local to computer working, remote asynchronous or synchronous data transmission. In the remote cases, a choice of operating speed is available and the data adapters all have a common input interface.

The computer interface units, similarly, connect to this common interface and can be provided for many commercial machines in common usage. In some cases, these machines offer standard data transmission operating systems, and the compatibility of the Marconi system with ISO/CCITT standards will permit direct connection without the special adaptor and interface units outlined above.

Features

Low cost value engineered design.

Compatibility with ISO/CCITT standards.

Executive styling.

Video Data Terminal

Advanced microcircuit technology.

High reliability and maintainability standards.

High definition display tube.

Sophisticated Editing Facilities.

Comprehensive remote text manipulation.

Wide equipment range.

Data summary

Function	*4020*	*4050*	*4090*
Display features			
Character capacity	288	576	1152
Display format:			
(a) Lines	8	16	16
(b) Chars/line	36	36	72
Character set:			
(a) Alpha A–Z	26—All models		
(b) Numeric 0–9	10—All models		
(c) Symbols	4—All models		
(d) Punctuation	10—All models		
(e) Graphic symbols	13—All models		
Tube size (diagonal inches)	8½	11	11
Phosphor P.31 Green	All models		
Frame repetition rate			
30 frames/sec. minimum	All models		
Keyboard features			
Composing:			
(a) Alpha A–Z (U/C)	26—All models		
(b) Numeric 0–9	10—All models		
(c) Symbols	2—All models		
(d) Punctuation (10)	10—All models		
(e) Graphic symbols (14)	13—All models		
(f) Space	All models		
Editing:			
(a) Cursor movement (7)	7—All models		
(b) Erase (2)	2—All models		
(c) Delete	3—All models		
(d) Insert	3—All models		
Layout:			
ECMA standard alphanumeric	All models		
Interlocking: Electronic	All models		

Transmission/Reception features (all Models)

Keyboard:
- (a) Controls 3
- (b) Indication 4

Transmission methods:
- (a) Local parallel 10–50K bytes/second
- (b) Remote asynchronous 600–1200 baud
- (c) Remote synchronous 2400–4800 bits/second

Error control:
- (a) Character parity
- (b) Block Parity
- (c) Auto retransmit
- (d) Format verification

Transmission procedures (LS)/TC97/SC96

Modem interface (serial transmission only) CCITT V24

Equipment Configuration

Local installations: 32 terminals per parallel data adapter.

Remote installations: 32 terminals per line expander module.

Distance limitations:
- (a) Terminal to PDA—2000ft.
- (b) Terminal to LEM—2000ft.

General

Safety: BS 3861

Environment:
- (a) Temp 0–40°C
- (b) Humidity 90%

Power supplies:
- 100–125V a.c
- 200–250V a.c
- 45–65Hz