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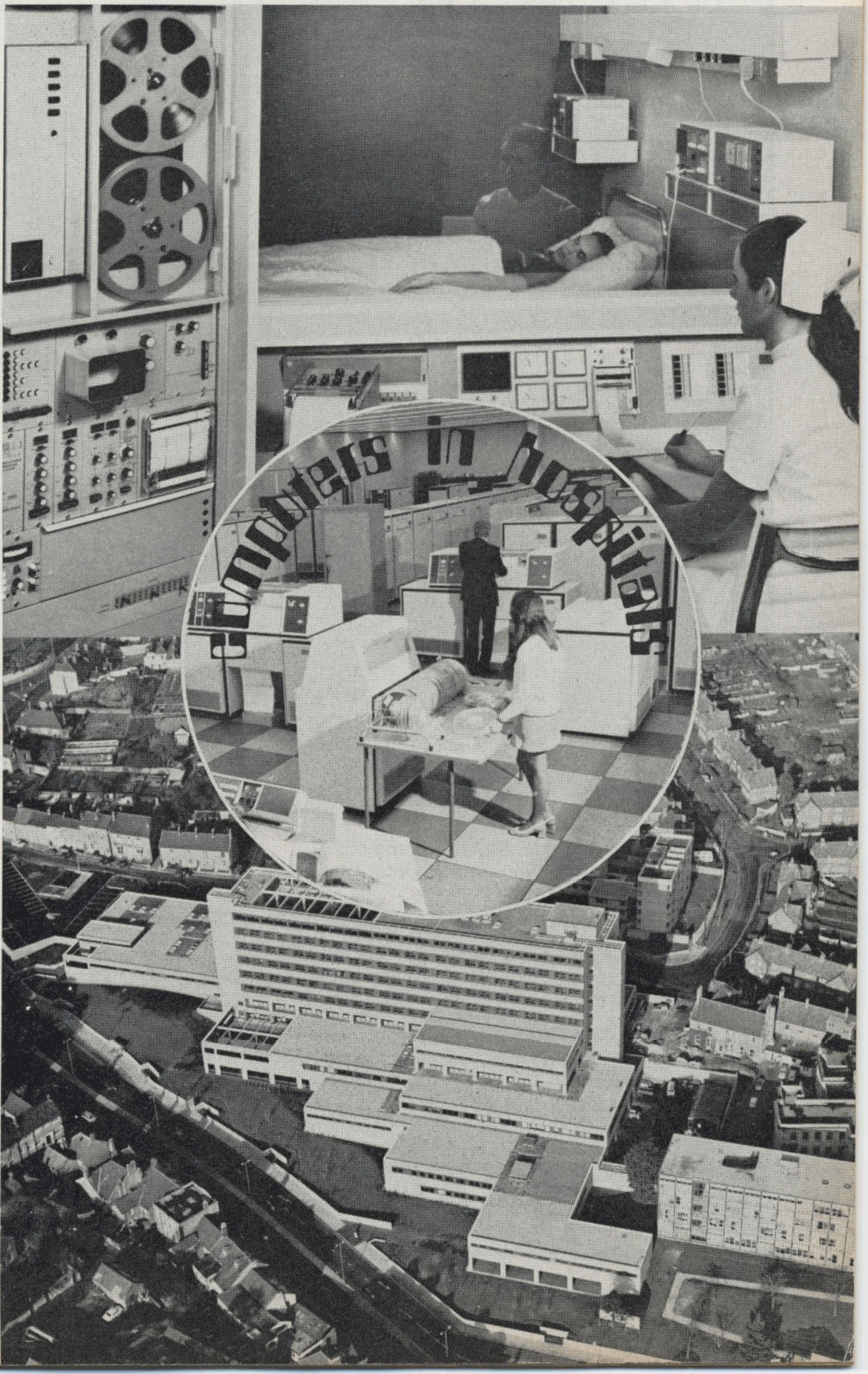

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Contents

Special features

News features

Departments

Front cover: Photos from Siemens AG, International Computers Ltd., Dudley Coles Ltd.

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Hospital Engineering
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An introduction to computers

R. G. KENSETT C.Eng., M.I.Mech.E., M.I.H.V.E., M.Inst.F., A.M.B.I.M., F.I.H.E.,

Although large computers have been in use with the UK Health Service for several years, they have had little use in the engineering field. This article, which provides an introduction to computers and traces their development from the early days, discusses current applications of particular interest to hospital engineers.

Computers are playing an ever increasing role in modern technology and industrial-engineering applications are already numerous. This is particularly so in the repetitive manufacturing industries where many automatic machines are computer controlled. Within the Health Service, the large computer or 'main-frame' machine has been in use for several years, but primarily for financially orientated work such as payroll calculations. It is becoming increasingly used in medical work such as the control of appointments systems and patient waiting lists and for many biomedical applications. Examples of the true medical applications are diagnostic work and biochemistry. Some use is also made in the more sophisticated intensive-care units where the computer monitors physiological functions and controls life-support systems.

It does appear, however, that health-service engineering is far from being in the forefront as regards computer applications. Regretfully much of the blame must rest with ourselves, as engineers, for our failure in many cases to appreciate the potential, and also to take action to understand the machines.

Mr. Kensett is with the Welsh Health Technical Services Organisation, Heron House, 35–43 Newport Road, Cardiff CF2 1SB, Wales.

History

The modern computer has evolved from extensive research and development over the past 25 years or so. The ability to make a machine to solve mathematical problems has, however, been known for many centuries.

Basically there are two types of computer, the analogue and the digital machine. Most of the early work was done using the digital machine, the forerunner of which was the Chinese abacus or counting frame, which came into use during the fifth century B.C.

The first mechanical machine was constructed by Pascal in 1642. Other digital machines were also constructed about this period, including those built by Odhner and Leibnitz, although none of these machines was very reliable. During the later part of the seventeenth century, Napier was developing his system of logorithms and around 1640–1650 the slide-rule concept came into being, which uses the measuring or analogue principle.

During the 1850s, the planimeter was introduced which has, as its main function, the ability to measure areas bounded by a curve and there followed the Thomson 'ball-and-disc' integrator. From these early designs the modern analogue computer was developed.

To differentiate between these two basic types of computer, the principles must be stated. In the analogue machine a physical system is constructed that is a mathematical model of the particular item of interest. Measurements are taken of physical variables in the analogue which are given the effect of certain stimuli to provide numerical information about the response of the original system to modification of its variables. There are many electrical analogues of this kind which can be constructed to represent structures, dynamical systems or fields of fluid flow. One of the first uses of the analogue machine was in the field of nuclear physics and an early form of analogue computer was constructed to predict likely effects of nuclear explosions. The analogue system is now used extensively in the US space programme, primarily as a form of control system.

However, the digital computer is the unit with which we, as practical engineers rather than research specialists, are concerned. As the name implies, this machine works with figures or digits: symbols to represent numbers or sometimes specific nonnumeric information. In this respect it operates as one does when calculating with a pencil and paper or desk calculator.

The father of the modern digital computer was Charles Babbage. In about 1812 he conceived the idea of what he called a 'difference engine', the purpose of which was to compute a new series of astronomical tables from existing data and then construct, using the calculated astronomical tables, navigational tables. Babbage never constructed a full-sized difference engine but using his experience with a model developed his theories and some 5 years later constructed a more advanced machine. This machine was known as 'Babbage's analytical engine' which proved to be far more versatile. To control the machine Babbage used the system of punched cards developed by the Frenchman Jacquard.

The Jacquard system was originally used to control looms weaving intricate tapestries. The method of control is by a series of rods, each rod connected to a warp thread. Each rod was pressed against a card and if there was a corresponding punched hole in the card the rod naturally passed through, which caused the warp thread it controlled to be lifted.

Jacquard's loom was first exhibited in 1801 and in the early years of the nineteenth century when Babbage adopted the system there were over 10 000 punched-card-controlled looms in France. Babbage was fortunate in obtaining a Government grant to develop the system which, of course, had to be entirely mechanical. This and the general limited engineering ability prevented any real development.

The principles used by Babbage were developed into the Burroughs Accounting machine in the 1920s. At this time, IBM began work on their a.s.c.c. system (automatic sequential controlled calculator) which could add, subtract, multiply and divide, and also refer to tables which it had previously generated within the machine. Thus was developed the first machine with a memory. The US government soon realised the potential of this development and financed an ambitious development programme at Penn University which resulted in 1946 in the completed e.n.i.a.c. system (electronic numeric integrator and calculator). This was the first of the high-speed machines and could add 5000 7-digit numbers in a second.

A major breakthrough in the computer field occurred in the 1950s with the development of transistors. Previously, valves and semiconductor diodes were the main components, connected together by a maze of wiring. Other companies such as Honeywell quickly realised the potential that the transistor offered and by 1964–65 the present-day concept of a family of computers had arrived. (A 'family' is computer terminology for a complete range of systems developed by one manufacturer.)

After the 1939–45 war computer development com-

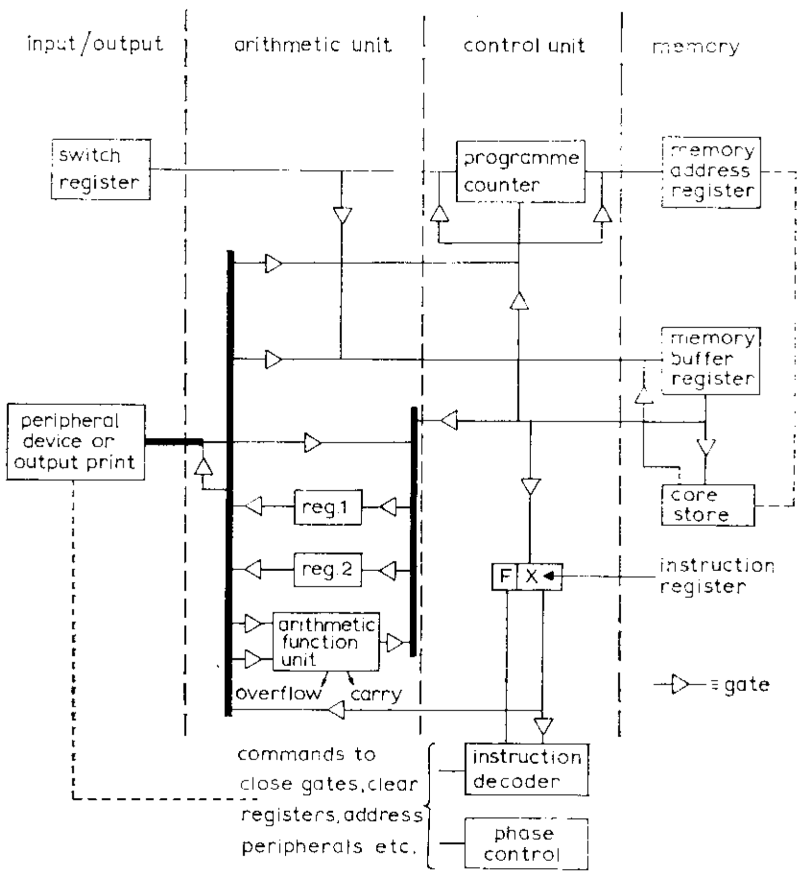


Fig. 1. Simplified computer layout

menced in UK, with the Universities again playing a major role. Cambridge developed the e.d.s.a.c. (electronic delay storage automatic computer) and Birkbeck College a.r.c. (automatic relay calculator). The a.r.c. was the first computer to use magnetic storage drums. By 1953 the Cambridge machine had been developed into a commercial system which was adopted by J. Lyons & Co. as LEO. Once this system was in use major industrial organisations such as EMI Ltd., Ferranti Ltd. and The English Electric Co. Ltd. continued the development. In 1962 EMI's interests were taken over by International Computers and Tabulators Ltd. The company gradually absorbed other commercial interests and in 1964–65 became government sponsored and changed its name to International Computers Limited. (ICL). The machine range has been adopted as the preferred unit for the Health Service with the majority of machines being of the ICL 1900 series. The DHSS is supporting their use and it is almost certain that any computer work with which the UK engineer is involved will, as far as mainframe machines are concerned, utilise these machines.

Functioning of the computer

Fig. 1 illustrates the interrelationship of the five basic elements of any computer system.

These elements are:

Items 1 and 2	input–output devices
Item 3	arithmetic unit
Item 4	memory
Item 5	control unit

It will be apparent that, irrespective of the unit, one has to feed into it the information and also get out the results in an understandable form.

The input can be entered in various ways: punched cards similar to those invented by Jacquard, magnetic cards, paper tape, magnetic tape and magnetic discs. Some very small machines have the input direct from a keyboard which is used as one would use a typewriter. This is, however, very slow indeed in computer terms and is limited to desktop or minicomputers.

The computer requires to translate the data into its own (or machine) language and thus the input devices require a 'reader'.

The output may be in the form of a 'plain-language' printout, which can be immediately understood, or in the form of either a magnetic or paper tape, which can be fed into another processor to produce the eventual plain language printout. In some machines that are used to control automatic processes the tape can be used directly as the method of entering the control instructions. In this case the control device will translate the instructions.

The arithmetic unit is the device that actually does the calculating or, to use the analogy, it corresponds to the slide rule in manual calculations.

The computer will only deal with either 0 or 1 and so an input of standard numeric annotation must be translated into binary code. This is because the arithmetic instructions operate through a series of electronic gates and the 0 or 1 will cause the gate to either open or close, to transmit or not transmit, as the case may be, the electrical impulse generated by the machine receiving the 0 or1. This is illustrated in a simplified form in Fig. 2.

As an example of binary code, 13 may be written in binary form as 1101. This indicates 1×1, 0×2, 1×4 and 1×8. As an example of a simple calculation in binary consider $20 - 9 = 11$:

minuend (20) = 10100 (1×16, 0×8, 1×4, 0×2 and 0×1)

Subtrahend (9) = 01001 (0×16, 1×8, 0×4, 0×2 and 1×1)

Subtracting (11) = 01011 (0×16, 1×8, 0×4, 1×2 and 1×1)

Results of these operations, together with the instructions given to the computer, or in computer terminology its program, are stored in the memory bank (item 4). The programs on the large machines, which accept what is termed high-level language, are written in more or less standard English. To illustrate this better a section of a simple program is given in Fig. 3. This program will be translated in a part of the input device into machine language.

The final section (item 5) is the control unit, which as the name implies controls the input, output and issuing instructions. Each elementary operation is specified by an instruction consisting of a coded set of numbers very similar to a telephone number. These are routed to the control unit from the memory or store.

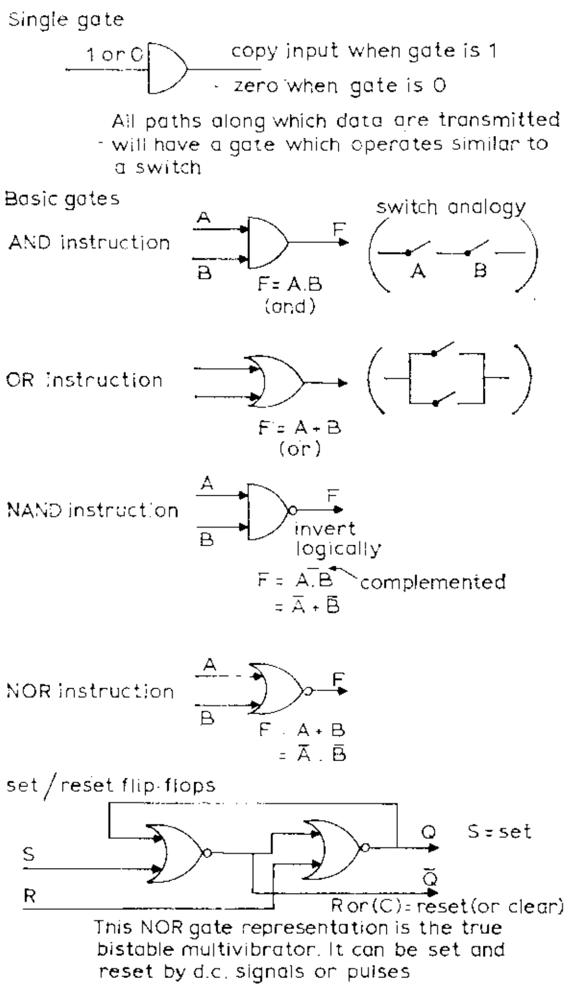


Fig. 2. Electronic hardware

The message is decoded within the control unit to set up the appropriate circuit and control the execution of the operation.

This operates almost like an automatic telephone exchange where, when you dial a number, this opens the correct line to the appropriate section of the network and then rings the bell so the number is aware that it is required.

It will be understood that the explanation given is very simplified and the computer is, in fact, a very complex machine with hundreds of thousands of small networks of the type described, but it is hoped that the explanation given will illustrate the principle of its operation.

Engineering applications

Many regional health authorities are using minicomputers for assisting in design offices with the rapid calculation of standard formulas such as computing heat losses, pipe sizing and calculating system balancing factors. Very little use is made as yet of the larger machines. It is generally agreed, however, that future applications in this field will include the calculation of heat losses, pipe sizing and radiator sizing for a complete district general hospital within a matter of a few hours rather than weeks as at present. Many engineers have expressed fears that such design applications will lead to redundancy and staff reduction. It is not considered that this is so but rather that it will allow the engineer to spend more time on creative thought and reduce the time now spent on repetitive, routine, and often very boring calculations. After all if one considers the present who would be happy to have to operate without his slide rule?

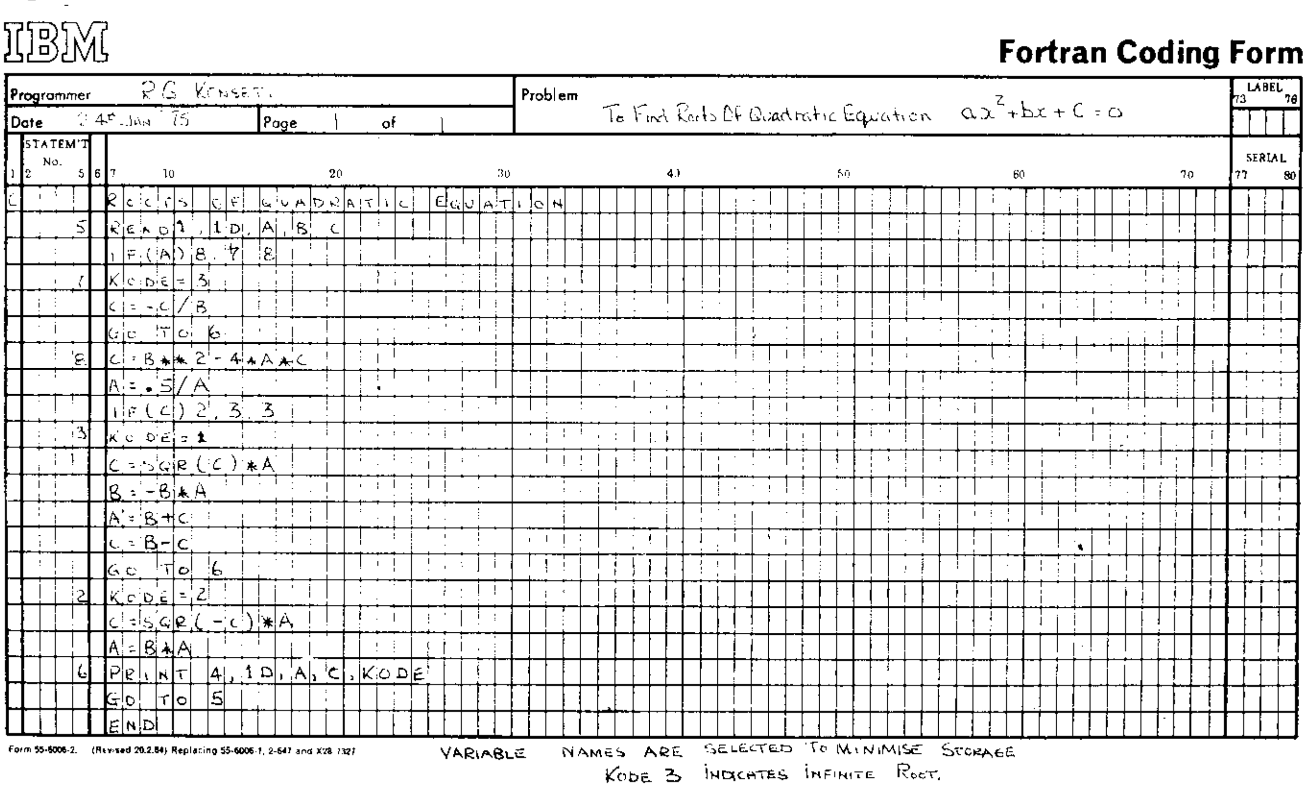
Amongst applications for which programs exist at present, and which are applicable to all hospitals are computerised p.p.m. systems. Group and hospital engineers will readily appreciate the time-saving possibilities if the required work dockets are prepared by a machine, appear at exactly the right time and are always accurate as regards the task to be completed. Present programs are so written that the docket will reappear repeatedly until the instruction is withdrawn by entry of the completed work docket. The program can also be extended to cost the system accurately so that the engineer will know exactly what each task costs and the average time to complete it.

The main advantage is the amount of data relating to the maintenance system which can be stored and held within the computer complex. Normally this information is stored on either magnetic tape or discs and all the information relating to an authority could be stored easily on an average sized cupboard shelf, available at short notice as and when required.

Unfortunately, accurate and swift as the computer may be, it can never complete the scheduling! A program prepared for use within the Welsh region, and with which the author was associated, is the Engineering Information Retrieval Program (EIRP).

The program is intended to store all the data relating to engineering services, plant and equipment and to provide on demand printouts of any specified data. For example, if one receives a typical query from the DHSS requesting, say, numbers of boilers, coal-fired and of the 3-pass economic type installed prior to 1960 this information could be provided within, say, 1 h if one has immediate access to the computer and easily within 24 h even if it is necessary to request the Regional

Fig. 3.



IBM **Fortran Coding Form**

Programmer: R G Kinsey. Problem: To Find Roots Of Quadratic Equation $ax^2+bx+c=0$

Date: 24th Jan 75 Page 1 of 1

```
C     ROOTS OF QUADRATIC EQUATION
    5 READ 1, 1D, A, B, C
      IF (A) 8, 7, 8
    7 KODE = 3
      C = -C/B
      GO TO 6
    8 C = B**2 - 4*A*C
      A = .5/A
      IF (C) 2, 3, 3
    3 KODE = 1
      C = SQR (C) *A
      B = -B*A
      A = B+C
      C = B-C
      GO TO 6
    2 KODE = 2
      C = SQR (-C) *A
      A = B*A
    6 PRINT 4, 1D, A, C, KODE
      GO TO 5
      END
```

Form 55-6006-2. (Revised 20.2.84) Replacing 55-6006-1, 2-647 and X28 7327

VARIABLE NAMES ARE SELECTED TO MINIMISE STORAGE

KODE 3 INDICATES INFINITE ROOT.

Computer Centre to carry out the search and provide the data. No doubt, group and hospital engineers who have been harrassed by their authority to provide such information will readily appreciate the advantages of the system.

Another application of this program is within the regional health authority to assist in forward planning, or in the preparation of a capital programme. In this instance the information could be requested on all plant which had exceeded the life factors stated in HTM 24 'Present Value Techniques' by more than 20%, or again, of boilers that are due for replacement within the next 5 years.

Future developments of mainframe computer programs will be associated with the Harness system, CUBITH and, in Scotland, CLASP. The future will probably lead to an increase in central purchasing and the use of 'call-off' listing, and here again the use of the computer will be invaluable.

There should be no reason for concern with these developments but rather the opportunity for us all to fulfil our real function as engineers, to manage more efficiently and to operate the engineering services entrusted to us more efficiently.

The thing to remember is that, however useful the computer may be and however efficiently it may operate, it cannot make value judgements based on experience and the knowledge we have obtained: for that we, as engineers, will always be required.

Introduction aux ordinateurs

Bien que de grands ordinateurs aient été utilisés par les Services Sanitaires du Royaume-Uni depuis plusieurs années, leur utilisation dans le domaine de l'ingénieur n'a été que très minime. Cet article, qui donne une introduction aux ordinateurs et retrace leur développement depuis leur début, discute des applications courantes d'un intérêt particulier aux ingénieurs des hôpitaux.

Eine Einführung in die Computertechnik

Das britische Gesundheitswesen macht zwar schon seit mehreren Jahren von großen Computern Gebrauch, aber auf ingenieurtechnischem Gebiet wurden sie bisher nur wenig eingesetzt. In diesem Artikel, der eine Einführung in die Computertechnik darstellt und die Entwicklung der Computer von ihren Anfängen bis zum heutigen Tag verfolgt, werden die gegenwärtigen Einsatzmöglichkeiten erörtert, die für Krankenhausingenieure von besonderem Interesse sein dürften.

Una breve introduzione ai computers

Sebbene il servizio sanitario del Regno Unito abbia fatto uso di computer grandi per parecchi anni, questi coadiuvatori elettronici sono stati peraltro poco sfruttati nel settore dell'ingegneria. Il presente articolo, il quale offre un'introduzione pratica ai computer e ne traccia il loro sviluppo dalla nascita, esamina in dettaglio le correnti applicazioni di interesse particolare per i construttori di ospedali.

BSI News – Hospital sterilisers

J. C. SHELTON

During the meeting of the BSI Technical Committee SGMH/14—Hospital Sterilisers held on the 22nd January 1975 under the chairmanship of J. H. Bowie a discussion took place on the best method of organising the April 1975 conference on containers for sterile fluids. The proposed topics to be discussed at the conference were containers for:

(*a*) intravenous fluids
(*b*) eye drops
(*c*) parenteral injection fluids

and it is hoped that arising from this conference means may be found to solve at least some of the many problems encountered in this branch of sterilisation. It was during the discussion on the arrangements for the conference that certain shortcomings of the present containers were expressed, and this led Dr. Bowie to pose the question: 'Is there such a thing or ever likely to be as a perfect container'.

H. E. Roberts, with the aid of time–temperature graphs on the blackboard and copies of recorder printouts handed round to the committee, reviewed the conditions of the buildup of temperature within the bottles of a fluids steriliser, this being all part of general discussions on sterilisers for bottled fluids preparatory to work on the revision of BS3970 Pt. 2. Dr. Roberts demonstrated the point that, although there were definite advantages in elevating the steam pressure above the level that is normally required during the warm-up period, there is a constant danger of overshoot occurring which may have adverse effects on some fluids being sterilised if this condition prevailed for any length of time.

In fact the printout showed that this excess of temperature was difficult to correct and that the actual higher temperature limit and the point of cutoff in time were critical if this temperature overshoot were to be avoided. Many other aids and adaptions, some already incorporated on certain sterilisers, were put forward as having a greater effect on reducing the time at elevated temperature. These included steam-trap bypasses to maintain turbulent flow of steam and thus promoting even temperature distribution through out the load.

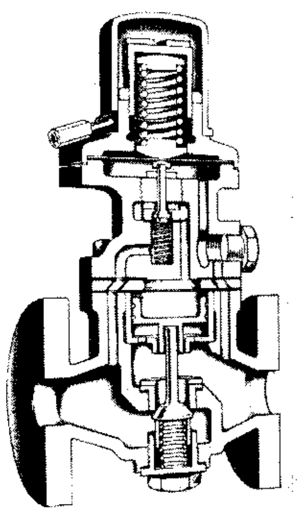
It occurred to the writer, as a hospital maintenance engineer, that although these embellishments would no doubt shorten the process time by varying amounts, they would in relation to their complexity also add to the maintenance and the machine's downtime, due either to maintenance or breakdown.

The subject was eventually referred to a subsequen meeting.

Product news

Steam-pressure-reducing valve

The B type relay-operated pressure-reducing valve is designed for inlet pressures up to 28 bar and a reduced pressure range of 0.35–17.5 bar is available. Constructed from spheroidal graphite iron, the valve can be supplied with the following end connections: 0.5 in to 2 in BSP, flanged 0.5 in to 2.5 in BST 'H', or DIN ND 25/40.



William Broady & Son Ltd., English Street, Hull HU3 2DU, England.

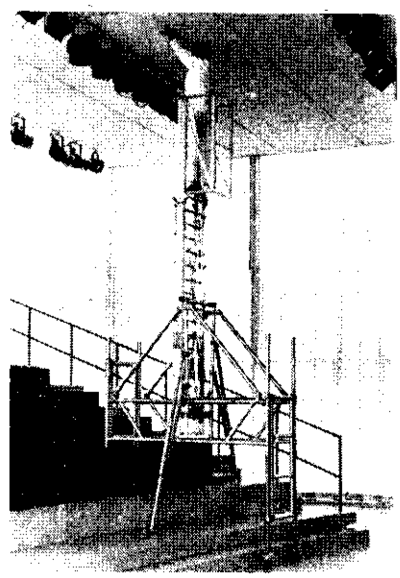
Portable chart recorder

The M230 voltage/current recorder is a portable self-contained unit housed in a lockable carrying case. Included in the package is a 6-range switchable c.t. and two voltage test leads, to give three ranges of voltage and three ranges of current, up to 600 V and 300 A. The recorder will record continuously for one month on one pressure-sensitive chart roll.

Channel Electronics (Sussex) Ltd., Cradle Hill Industrial Estate, Seaford, Sussex BN25 3JE, England

Work platform

The Topek telescopic aluminium platform extends up to a working height of 900 cm for ceiling work. The platform is mounted on wheels



and can be carried up stairways for split-level areas, or used for outdoor maintenance.

John Rusling Ltd., Springfields, Newport, Salop TF10 7HU, England

Water-purity monitor

The Datronix solid-state water-purity monitor has automatic temperature compensation and a variable-delay alarm-initiation circuit. The controller is designed for automatic and continuous monitoring of demineralising and distillation plant, boiler feed water, return steam condensate, desalination systems, cooling towers, rinse and cooling water, fresh-water pollution etc. The set-point control is calibrated in microsiemens as standard, but calibration in parts per million of total dissolved solids is also available. Temperature compensation is automatic in the range 10–80°C at a coefficient of 2% per deg C but other coefficients can be supplied for specific applications.

LG International, PO Box 19, Letchworth, Herts. SG6 3PS, England

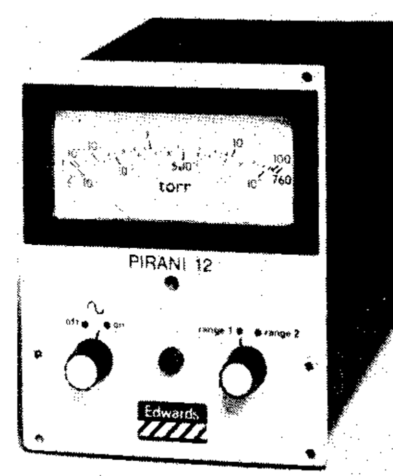
Leak-location gas detector

The BZ-LL gas detector acts as a combined flammable-gas detector and leak locator. The hand-held monitor is available in a purpose made carrying case and acts as a spot check or continuous automatic monitor for most hydrocarbon gases including natural gas, propane, butane, acetylene, hydrogen, etc. Detection is by a pulse-operated Pellistor catalytic sensor and when the level of gas in air rises above a preset limit an audible and visual warning is given. The detection point is well below the lower explosive limit of the atmosphere. When the presence of a potentially dangerous level of gas is signalled, the monitor may be switched to a continuous search mode for leak location. As the volume of gas in air sensed by the monitor increases the frequency of oscillation of the 2-tone audible warning increases.

Neotronics Ltd., Building 10Z, FSTS Site, Stansted Airport, Stansted, Essex CM24 8QX, England

Vacuum gauge

The Pirani 12 vacuum gauge has a pressure range of $100–10^{-3}$ torr, an accuracy of better than 10% of indicated pressure between 10 and 10^{-2} torr, and facilities for process control. The instrument is designed to be used with the Edwards M12 gauge head. The gauge has a response time of 50 ms and has



two meter scales with a total scale length of nearly 140 mm. It is designed to the Post Office 19 in (48 cm) rack module.

Edwards High Vacuum, Manor Royal, Crawley, West Sussex RH10 2LW, England

Computer-aided planning and design of hospitals

The state of the art

by S. K. GHOSH and V. K. HANDA

The rapidly rising costs of health-care necessitate a careful assessment of possibilities in the planning and design of a hospital. This is particularly important since the ratio of operating cost to construction cost is significantly higher for hospitals than for other buildings, and since hospital operating costs are directly related to the design of the hospital. Computer-aided planning and design of hospitals permits the study of design possibilities without paying the price of erroneous decisions in the actual situation. This article reviews the four major stages of computer-aided planning and design of hospitals:

(a) regional planning
(b) institutional planning
(c) functional design
(d) engineering design.

It is pointed out that spatial layout or functional design is perhaps the most important aspect of the planning and design of hospitals. The commerce subsystem, which handles all movements within a hospital, holds the key to efficient functional design.

The health-care services industry of any nation can be characterised as a system of individuals and organisations seeking to provide services to people that will restore or maintain their personal health.[1]

One growing area of concern in the health-care industries of nations around the world is the rapidly rising cost of health care to the patient. As shown[1] in Table 1, the cost of medical care in the United States has been rising at a faster rate than that of all consumer goods for the past 25 years. The apparently narrowing gap in the two rates of increase is due as much to the overall inflation currently being experienced as to any success in slowing health-care inflation.

While the reasons behind the rising health-care costs are many and varied, there is one area that is of particular concern to the engineer, and forms the basis of discussion in this paper.

The hospital

The hospital provides the personnel involved in health care with the opportunity to interact and complement each other's expertise. In general, hospital care can be classified into four major categories: short-term care, long-term care, psychiatric care and tuberculosis care. Hospitals providing short-term care dominate the industry and also have the majority of hospital beds. The scope of the present study is confined to hospitals providing short-term care only.

A hospital, irrespective of its type, can be looked upon as a system in the sense that the word is known in normal systems-research usage. In such usage, a system is described as a mechanism that has identifiable inputs and outputs. Depending on the system's purpose, various influences or resources of the system are brought to bear on the input in order to change it to an output item.

The hospital may be described as a system whose input is sick people and whose desired output is people who are well. The hospital's resources for this production effort are medical care, nursing care, psychological and physical support, and the aids of shelter and supplies that make these things possible. The goal of hospital planning is the design of a system environment that is safe, comfortable, efficient and pleasant.

It is well known that the ratio of operating cost to construction cost of hospitals is much higher than that for any other type of building. Hospital operating costs are greatly influenced by the design of the hospital, which cannot be corrected once the building is con-

Dr. Ghosh was formerly, and Prof. Handa is, with the Department of Civil Engineering, University of Waterloo, Waterloo, Ont., Canada. Dr. Ghosh is now with the Portland Cement Association, Skokie, Ill. 60076, USA.

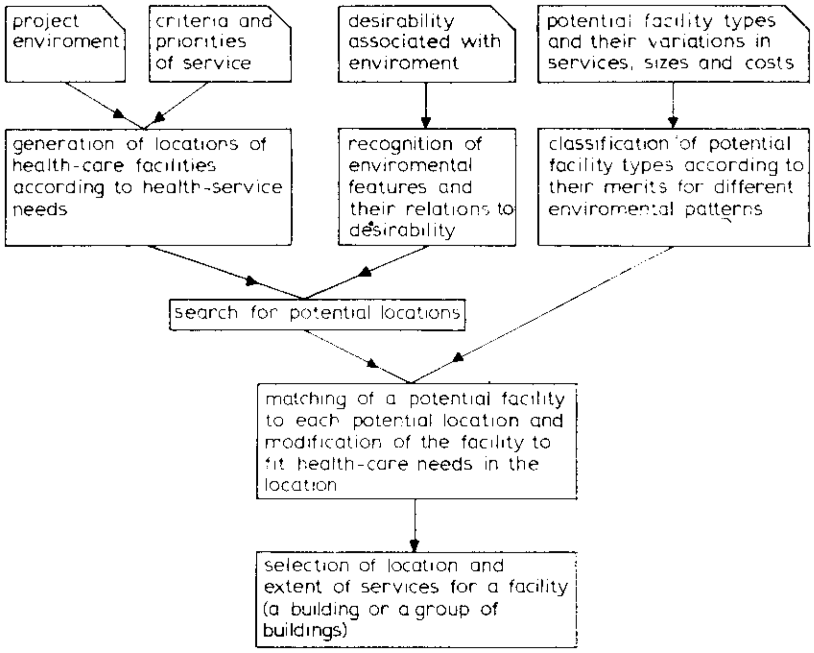


Fig. 1 Regional planning of health care facilities—a schematic representation[3]

structed. This is where the engineer can play a significant role in trying to combat the rising cost of health care.

Computer-aided planning and design of hospitals permits the study of design alternatives and their influences on subsequent operations without paying the price of erroneous decisions in the actual situation. The purpose of this article is to review, systematise and draw some useful conclusions from the body of information currently available on all phases of computerised planning and design of hospitals.

The overall hospital planning and design process may conveniently be subdivided into four major stages:[2]

(*a*) regional planning of health-care facilities for determining the location and the extent of services to be provided by a hospital
(*b*) institutional planning in meeting the performance requirements for patient care in accordance with current and anticipated medical practices
(*c*) functional design with respect to space organisation and allocation
(*d*) engineering design, including construction planning.

Here we will review each of these stages separately.

Regional planning

The main objective of regional planning for health-care facilities is to conceive a master plan of physical facilities through which a health-care system can be efficiently implemented.[2] The conceptual framework in determining the location and the extent of services to be provided by a health-care facility is shown schematically in Fig. 1, which is reproduced from a paper by Au *et al.*[3] who have proposed the only computerised model available so far for the regional planning of health-care facilities.[3,4]

The basic types of information required for planning include:

(*a*) an extensive knowledge of the physical and socio-economic environment of the project, including comprehensive health-care data.

The project environment can be conveniently described by a set of maps. The maps used by Au included a topographic map, a land-use map, and a demographic map. Internally in the computer storage, the information on these maps was discretised into a grid system and stored in a set of arrays known as feature maps. Each feature on a map was represented by a prime number, the product of two or more prime numbers representing the joint occurrence of two or more features at the same point.

In addition to the above, three categories of health-care demands and services were considered by Au: outpatients per day, general beds and obstetric beds. Four types of data for each of these services had to be provided to the Au model: average demand rate, the factors that might cause variations in the demand rate, variations from average demand rates, and service capacities and locations of existing health-care facilities and their patterns of services.

(*b*) An administrative policy defining the criteria and priorities of services to be provided.

When the demands in all categories that cannot be satisfied by the existing health-care facilities are determined, criteria must be developed for selecting the location of a new facility which can provide the best services to a neighbourhood within the budgetry constraints. In search of a site for a new facility, a plan showing the health-care services that should be located at each grid point location in order to satisfy each category of demand in its vicinity was first generated. In screening for peak demand in each category, it was clear that the demand for outpatient services, general beds and obstetric beds generally did not have peak values at the same location. Consequently, an index involving the linear combination of all these demands was used as a basic criterion for selection. For example, a planner might prefer to select a location with peak demand on general beds, and ignore the other two demands.

Since not all health-care demands in an area-wide system can be met by a new facility, priorities of services in meeting the demands must be established. In general, in planning a new facility, various types of services should be provided to certain levels such that the totals of these services in the comprehensive system will equal and possibly exceed the respectively critical minimum levels that are deemed necessary to maintain the health-care standards of the society. After these minimum requirements are satisfied, selective improvements may be made by increasing the types and/or levels of services within the budgetry constraints. When the demands cannot be completely satisfied, priorities may be specified as to which category should be increased from the minimum standard first.

(*c*) A scale of values expressing the desirability, including cost, associated with specific features or characteristics of the environment.

One location may be preferable for the project than another because of the cost of land use or for reasons other than cost, such as the disruption of a coherent neighbourhood or aesthetic considerations. Hence, for some features in the set of maps representing the project environment, a desirability index and/or a cost may be assigned.

(*d*) Information from previous experiences on the types of health-care facilities that have been used to provide the envisioned services.

The essential items of information include the variations of services, sizes and costs of various potential facility types. On the basis of such information, the merits of various potential facilities for different environmental feature patterns can be classified for consideration while planning potential locations for the proposed facility.

Au developed a computer programme written in APL to implement the regional planning of health-care facilities. The programme consisted of seven major subroutines, the functions of which give a fair indication as to how the programme works (Table 2).

While the programme given in Table 2 is experimental in nature and represents only the first step in computerising the complex process of regional planning of health-care facilities, it can be used with little modification in a real-life situation, provided that a sufficient amount of real-life data are available.

Institutional planning

A systematic procedure for determining performance requirements of hospital services from the expected levels of patient demands and for estimating proposed capacities of service groups, which are the primary aims of institutional planning, is useful for generating the data necessary for detailed functional design.

Significant studies of relevance to this area are few in number. Howland[5] and associates demonstrated the interdisciplinary nature of the hospital system and the importance of finding system performance measures which could be regarded as common. Their search for a methodology for evaluating the quality of patient care is a pertinent and basic study.

Table 1 Annual rate of increase of US health-care prices

Period	Annual rate of increase	
	All consumer items	Health-care prices
	%	%
1946–60	3·0	4·2
1960–66	1·5	2·8
1966–69	4·1	6·7
1969–70	5·9	6·3

Flagle *et al.*[6] have studied both the inpatient input to the hospital and the potential ability of the hospital to cope with the stochastic inputs which they found to be characteristic of hospitals. Their uses of queuing theory and systems-analysis techniques for anticipating patient loads and adjusting organisation to meet these loads are valuable guides.

Thompson and Pelletier[7] have demonstrated, like Flagle, the random nature of the hospital input and described ways for predicting a number of inputs. Their studies of the inpatient nursing unit, the delivery site operation, oxygen utilisation etc., demonstrate methods for producing information prerequisite to decision-making.

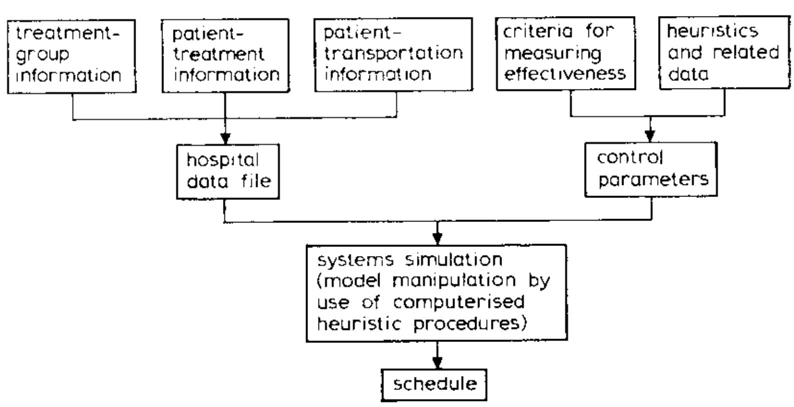


Fig. 2 Planning patient care in a hospital—a conceptual model[9]

Later Yale studies[8] were carried out with the objective of providing hospital administrators with tools that would give them the ability to predict the operational consequences of alternative design and, given any set of facilities, the results of the application of alternative policies for guiding the operation of these facilities. To this end, major effort was devoted toward the construction of a set of simulation models that were descriptive of the essential features of various subsystems in a hospital. Fetter and Thompson[8] reported on three fully developed models:

(*a*) a maternity suite
(*b*) an outpatient clinic
(*c*) a surgical pavilion

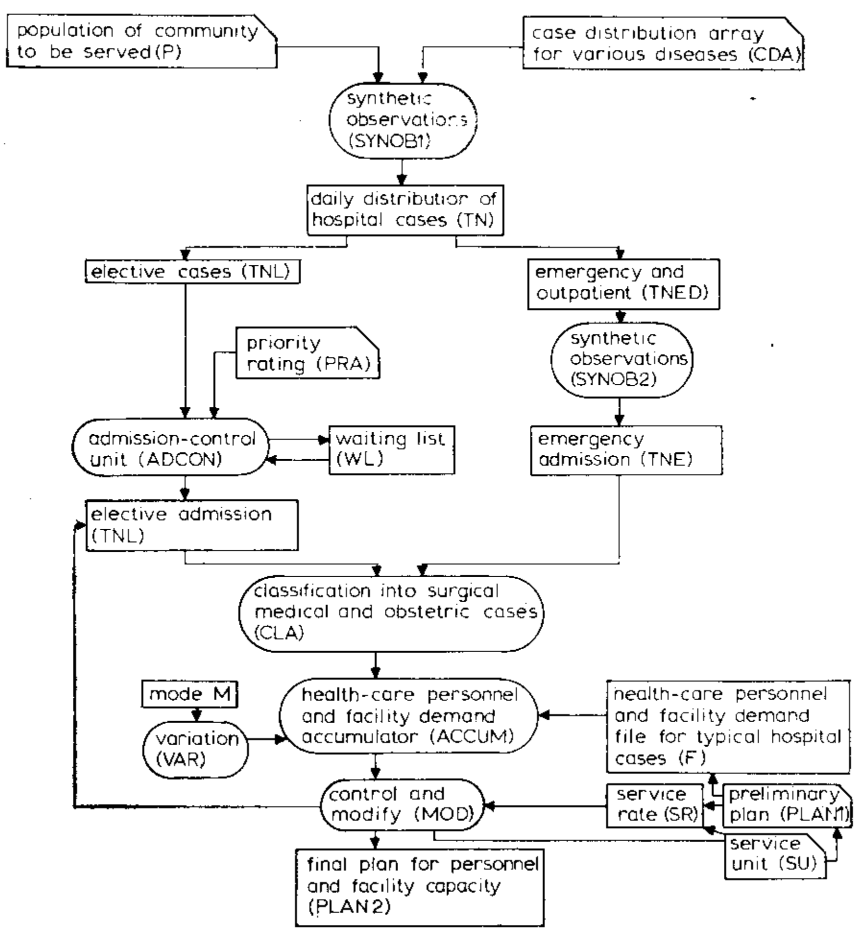
and on three other models in various stages of development: one of a clinical chemistry laboratory, a second one to predict the effect of various room arrangements on economy of operations, and a third one to predict the economic and technical consequences of any scheme of patient organisation based on care requirements. Various experiments performed with the maternity suite model were also reported on: the effects were studied of:

(*a*) increases in admissions rate
(*b*) admission of elective inductions
(*c*) changes in lengths of stay.

Table 2

Subroutine	Function
1	To extract desired features from the compressed data in one of the feature maps and to print them on a specific feature plan.
2	To estimate the existing health-care facilities in the region and to present such data on the basis of the regional comprehensive health-care data.
3	To generate a health-care-demand plan showing the units of demand per square mile for each of the three specified demand categories on the basis of the information on feature plans and the health-care-facility plan.
4	To compress the desirability indices associated with various features into a desirability index plan.
5	To compress the unit costs of land use corresponding to various features into a unit-cost plan.
6	To search satisfactory and desirable potential locations that can best satisfy the three demand categories according to specified criteria and priorities of providing services.
7	To match the feasible health-care-facility types and the potential locations, and to propose a number of facility types together with their corresponding locations in the ascending order of unit cost per square foot of usable floor area for each facility type.

Fig. 3 A dynamic model for planning patient care in a hospital[10,11]



While the above studies were concerned with hospital subsystems, simulation models of the entire patient-treatment systems in general hospitals were proposed by Grooms and Au,[9] and Wong and Au.[10,11] It was pointed out[10] that the objectives of developing a comprehensive and systematic procedure for planning patient care in hospitals are two-fold. First such a procedure would yield a more accurate prediction of the personnel and facility capacities required to provide the envisioned health services in planning a new hospital. Secondly, the procedure could also be used to make more efficient use of fixed health-care personnel and facility capacities by experimenting with various administrative policies in levelling offpeak service demands when such rescheduling would not affect the quality of health care.

The patient-treatment system of a general hospital is characterised by a decision process of scheduling treatment groups for patient treatments, including the transportation of patients from one group to another. The information on the treatment groups, patient-treatment files and patient transportation at any specified time is contained in the hospital-data file which constitutes the input to the system. A feasible schedule, which has been improved upon by using a number of heuristics to search for better solutions, constitutes the output. An objective function selected by the hospital management should be used as a measure of effectiveness of the system. The basic structure of the conceptual model is shown[9] in Fig. 2.

To implement the simulation process a computer program was written in FORTRAN V for operation on a Univac 1108 computer. The choice of the computer language was influenced by the consideration of possibly combining the use of the program with other existing program for allocation of facilities.

A model, more comprehensive than the one above, was later proposed by Wong and Au[10,11] for planning health-care services in a proposed hospital by actually simulating the envisioned service demands on the basis of the health-care needs of the community and the hospital administrative policies for providing services. This simulation model was dynamic in the sense that new information could be input into the model at various time periods and that admissions and service rates could be adjusted through feedbacks from preliminary plans. The simulation procedure and the APL program written to implement it are best explained through Fig. 3 and Table 3. [10,11]

The author of a more recent investigation[12] started from the postulate that patients are central to the activity patterns in a hospital and that the natural place to begin was with a study of the daily activities at ward level. A model for predicting the daily routine in each ward, under any set of operational policies, was described. The model was actually developed in terms of an acute surgical ward.

It was envisaged that the ward model would be run on two levels: first on a steady-state level to show the typical daily routine over a long period of time, and secondly on a short-term level to show how the actual ward routine changed from one day to the next as the patient population changed. The output from the model was a set of timetables for nurses and other personnel.

It was envisaged that, as the study progressed, the ward model would be extended to cover other departments of the hospital, the outputs resulting from operational policies in one department forming inputs to the other departments.

Table 3 A simulation model for planning patient care in hospitals—operations of special APL functions[10,11]

Special APL Functions	Operations
SYNOB1	For generating occurrences of various hospital cases (elective, emergency and outpatient) based on statistical records by synthetic observations with the aid of a pseudorandom-number generator provided by the APL system
SYNOB2	For including some outpatient cases for admission to hospital and for discharging some emergency cases based upon synthetic observations of pseudorandom numbers of certain probability distributions
CLA	For breaking down hospital cases into *surgical, medical and obstetrics cases* according to the case percentages based upon statistical record
ACCUM	For generating health-care personnel and facility daily demand for all cases from synthetic observations over any specified period
PP	For generating the average demand rate for all cases and peak demand rate for emergency and critical cases; and from these rates and the service unit file, generating the average and minimum demand units for the hospital over any period
ADCON	For placing certain elective cases on the waiting list according to some prescribed priority rating when the predicted demand exceeds service capacity over a certain period of time
MOD	For controlling admission of elective cases when certain predicted demand exceeds service capacity, for modifying *service capacity or service units when the* difference between the two exceeds certain specified criteria, and for generating detailed information for case treatments according to specified service rates
VAR	For changing the demands for certain cases over a short period of time according to certain mode of case variation

Functional design

'In recent years, the rising costs of hospital operations have focused the attention of hospital planners on better utilisation of health-care personnel in hospitals. One of the most important factors concerning hospital-personnel utilisation that has been singled out in practically all hospital-management studies is the large amount of travel time spent by nursing and other supporting service staff in the performance of their services. As a result, various methods have been sought to reduce travel times of various hospital personnel. One obvious method is to design a hospital in such a way that the frequencies and distances of travel by staff between various operational units within the hospital can be minimised. Consequently, the spatial layout is generally regarded as the most significant aspect of functional design of hospitals.'[13]

Historically, the hospital building has been a reflection of the intuitions, traditions and temperaments of the many disciplines involved in caring for the sick. Since the early thirties, however, there have been a number of attempts to establish qualitative and quantitative criteria to guide hospital planning. J. J. Souder[14] has published succinct reviews of the earliest studies in this direction. Here are two excerpts from Souder:[14]

'The Army medical corps, following World War I, attempted to summarise its wartime experiences with space requirements for patient care. Drawings were prepared for buildings of a given module which could be assembled in appropriate groupings to provide hospitalisation for any given number of men. These drawings, finally put in working form under a Works Progress Administration project in the 1930s, formed the basis for Army and Air Force hospital construction in the 1940 mobilisation. They were refined continually during World War II, but only in terms of modules capable of quick construction by field forces at home or overseas. The navy had similar plans.'

'The United States Public Health Service first offered sophisticated help to the civilian community after World War II with its publication of *The elements of the general hospital*[15] and accompanying documents which spelled out minimum space and equipment requirements for acute general hospitals of varying sizes, from 50 beds to 200 beds. These too were empirical formulations based on experience, but they went further in attempting a space-requirement breakdown by departments without reference to the form of the building. In retrospect they appear remarkably reasonable, and in practice they contributed a useful body of measures for evaluating plans for new hospitals in communities that had no experience in planning hospitals. They were outgrown as experience proved that in a community-supported hospital enterprise the minimum published standard tended to become the only standard and therefore inadequate to meet growing needs.'

The Nuffield Foundation Studies[16] of task performance in relation to physical and organisation arrangement for patient care are also of interest. The planning conclusions of this study were based on practical experimentation which assumed the acceptability of then current patient-care practices in the UK. They suggested impicitly that the testing of other procedures would be appropriate.

The Committee on Hospitals and Health of the American Institute of Architects in 1954–57 undertook to document current nationwide experience in hospital space planning. It adopted and carefully described specific rules for measuring space allocation. It then solicited space-assignment data from 70 acute general hospitals built between 1948 and 1956 thoughout the US. The data were assembled by the architects of the individual hospitals and were collated and reported by the Committee.[17] These data showed remarkable and dramatic differences in total space requirements and departmental space allocations among hospitals of equivalent size performing services of equivalent scope.

J. J. Souder[14] subsequently suggested a method for predicting gross space demands for acute general hospitals, but produced no means for evaluating the merits of these demands.

Other important contributions to the understanding of hospital space planning have been made by a number of investigators.[18,19] Topical papers have appeared regularly in the professional journals and may be found in the US *Hospital literature index*[20] and the *Architectural index*.[21] Among the latter, a study published in 1972[22] deserves to be mentioned separately.

The earliest significant study in the computer-aided functional design of hospitals is perhaps the one by Souder *et al.*[23] The study was directed toward simplifying the statement of architectural problems in hospital planning and toward finding new and stronger aids for solving them. It presented observed data, some conclusions derived from the data, and a methodology for handling hospital planning problems which reduced the area previously governed only by intuition. It examined the similarity between hospital planning and other contemporary problems and pointed out ways of adapting modern computer techniques to the hospital planning process.

Souder *et al.* described the concept of the hospital as a system containing four principal subsystems of medical care, nursing care, supply and administration. This concept was not unlike the one suggested earlier by Howland.[5] It was noted that, in a hospital, each of the above subsystems is constantly demanding deliveries of patients, personnel, goods, equipment and information without which it cannot operate effectively. At the same time, the patients themselves and their visitors are constantly requiring movement from one place to another. There is thus another subsystem of the hospital whose responsibility it is to handle all of these movements at a rate and at a level of satisfaction acceptable to all. This subsystem was called the commerce subsystem. The architect's dilemma in devising the framework of a hospital plan is one of so relating the many departments that commerce tasks may be performed efficiently and to the satisfaction of the departments concerned. His greatest problem in basic planning revolves around the interdepartmental relationships which are seen in the commerce subsystem. This latter hypothesis is central to the work reported by Souder. The hypothesis was confirmed through a detailed sampling of the views and experiences of a number of hospital architects, administrators and consultants.

Souder *et al.* felt that an objective of the search for planning method is the development of a relatively complete inventory of commerce tasks in hospitals. The compilation of such an inventory would permit the development of methods of simulating these occurrences and of predicting them for other hospitals. In addition, the quantitative and qualitative information in the inventory would be useful to practitioners concerned with planning and administration. The authors made systematic observations of the interdepartmental traffic patterns in two medium-size acute general hospitals in Massachusetts and California. The departments selected for study in each hospital were two inpatient nursing units, the radiology department, the central supply room, and the pharmacy. The detailed observation of all traffic entering and leaving the four hospital units automatically offered some insight into similar activities for other departments in each hospital since the origins and destinations of all traffic were recorded, as was the purpose of the traffic. Consistencies in the observed commerce patterns were identified and a number of simple rules and relations useful for describing and predicting commerce activity were presented. The reported observations pointed to interesting differences in details of daily operation but a high degree of consistency in operating goals and operating patterns of the study hospitals.

Souder also described a methodology, named Coplanner, which employed a digital computer equipped with an oscilloscope. Coplanner drew on the body of observed data to elicit ordered patterns of task volumes, task-performance coincidence, and task demands on people.

The next capability of Coplanner permitted the operator and conferees to adjust the observed data for conformance with judgmental projection of what the similar data components might be in a proposed hospital. The third capability permitted the drawing of proposed planning frameworks on the oscilloscope, and then the one-by-one simulations of task performance in the plan presented and the measurement of performance against known scales of values. The fourth capability was that of storing and then re-presenting on demand any set of data or any set of plans that had been developed. It was hoped that planners using the above methodology at the conference table could elicit recorded performance data, adjust them to projected performance demands, and test plans, one by one, against experience and against increasingly good value scales until satisfactory planning solutions could be reached.

According to Souder, the results of the study were more positive than negative. On the positive side, the results presented the possibility of employing a body of data and, with computer assistance, of developing and comparing proposed commerce task performance with that observed in existing hospitals. On the negative side, the useful measures developed were insufficient for complete evaluation of plans. The resulting methods, nevertheless, offered some positive assistance to the development of hospital programmes and hospital plans.

An integrated approach to computer-aided functional design of hospitals has recently been proposed by Parti *et al.*[24,25,13] The major considerations in this approach include:

(*a*) organisation of hospital functions[24]

(*b*) specification of environmental conditions inside the building[25]

(*c*) arrangement of spaces.[13]

Parti *et al.*[24] listed seven levels of responsibilities in a hospital with the objectives of each in fulfilling various health-care services (Table 4). All functions in existing and proposed hospitals can be decomposed into a hierarchy of these seven levels. The use of a hierarchy of functions was motivated by the fact that different levels of responsibilities exist within the hospital administration. Corresponding to each is a set of decisions that would affect the grouping of functions at that level.

To specify the hierarchy of functions for a hospital, three types of information are needed for each functional element:

(*a*) the position of the element in the hierarchy

(*b*) the symbolic name of the function

(*c*) physical attributes such as size, shape, etc. of the space which supports the activities for that function.

Once these three types of information for each element in the hierarchy are specified, the functional relations can be recorded in a logically arranged multilink list. A computerised model for the organisation of hospital functions into the above hierarchy was proposed by Parti.[24] After initiation, interrogation, evaluation and modification of the state of the model were permitted.

Parti and Au[25] examined various environmental conditions affecting the comfort and safety of patients in a hospital. Some criteria were suggested for design purposes concerning atmospheric conditions, such as pressure, temperature, relative humidity, odour and particle pollution, and other environmental conditions, such as sound, light and fire protection. These criteria could be used as the basis for the investigation of the desirability of adjacency between spaces inside a hospital building.

It was pointed out that the decision as to whether or not to locate spaces adjacent to each other ultimately reduces to the choice of either yes or no. Hence the

Table 4 Hierarchy of health-care functions in a hospital

Level		Objectives	Functions or Activities
1	Hospital	comprehensive health care	conglomerate of all services resulting from top policy decisions
2	Division	efficient management of the facility	total amount of broadly related activities assigned to the same general area
3	Department	Integrated services to the primary consumers or users	combination of services delivered by a service or treatment group
4	Suite	convenient conditions for the principal provider	specific type of common services or treatments performed in the same suite of rooms
5	Room	good local environment for users and/or providers	all activities that can be carried out in the same local environment surrounded by physical barrier
6	Zone	integration of the main service rendered	several closely related activities that are undertaken by individuals
7	Object	support of a single activity performed	a single activity associated with an individual

simplest form in which the effects of environmental factors on possible organisation of a hospital can be recorded is a logic matrix. Each entry in the matrix is then either a one or a zero, indicating, respectively, that two particular spaces within the hospital can be either adjacent or not adjacent. In deriving the logic matrix, if one factor is very dominant, the influence of other factors may be neglected. If all factors are of approximately equal importance, then the constraints pertaining to all factors must be satisfied. Since the definition of the hospital environment involves the complex interaction of many environmental factors, it is inconceivable that every factor would be immediately satisfied as it is initially specified. If attempts to arrange spaces within a hospital are constantly interrupted by constraints, then a procedure for releasing constraints in a logical manner is needed.

It may be worthwhile to mention here in passing that the problem of desirability of adjacency of spaces was encountered in a different context by Nwachuku[26] and the authors. A solution slightly different from that of Parti and Au[25] was proposed.[26,28] The concept of a closeness index was crucial to the latter solution.

Parti *et al.*[13] also developed a computerised procedure for generating acceptable hospital spatial layouts on the basis of operational characteristics and environmental conditions. Although the procedure was essentially automatic, manual manipulation by the designer was permitted in order to implement aesthetic or other considerations that were not included in the computer programmed design criteria.

The health-care functions in a hospital were organised in a hierarchy of seven levels, as mentioned earlier. Data depicting the desired hierarchial structure, together with the information concerning commerce patterns and environmental conditions that had been compiled and expressed in convenient form, were used as the bases for deriving the spatial arrangement of the functional elements. The process was to be started at the lowest level of the hierarchy that might be considered stable by the designer. The connection between functional elements and physical spaces can most easily be made at the lowest level of the hierarchy, since the functions of various objects are usually quite apparent.

The methodology for generating the spatial arrangement consisted of three phases. The initial phase was devoted to the assignment of initial relative positions of elements within a functional group based on the commerce patterns and environmental conditions. This was accomplished by first ranking the spaces according to the frequencies of travels between spaces and then positioning the spaces in an effort to minimise the total frequencies of travel for all spaces in the group. In the next phase, dimensions that represented approximately the desired size (area) and shape (length and width) of each space were assigned to the corresponding sides of the unit square representing that space. In the third phase, sizes of spaces were selectively modified by trading areas among spaces that were adjacent to each other so that a proper ratio of sizes was maintained between adjacent spaces while maintaining the adjacency constraints and the shape requirements within the specified tolerances. Following the completion of this process the designer could elect to manipulate the results manually if the outcome generated by the automated procedure turned out to be less than satisfactory to him.

The above works signify only a beginning in the field of planning research. There are many needs for identifying problems, finding formats for their solutions, and developing methodologies which are understandable and usable by a variety of planners who may be expected to work more and more in an interdisciplinary framework.

Engineering design

The interfaces between spaces in the layout of a hospital must be clearly defined to provide the necessary physical boundaries to ensure the desirable environmental conditions within each enclosed space. Although the partitions in a hospital building may or may not be a part of the structural frame, the selection of partitions needs to be considered in connection with the structural engineering aspect of hospital design.

'In general, shapes and dimensions of many features in the spatial layout of a hospital may influence the design of the building frame. Consequently, tradeoffs between functional design of spaces and engineering design of physical components are major considerations in the overall hospital design process. As both the spatial layout procedure and structural design methods can be computerised, meaningful tradeoffs can be made when the preference among a set of spatial layout alternatives are in conflict with the preference among the corresponding set of structural framing alternatives. In some cases, the conflicting situation ... can be examined according to the principles of decision theory. For example, frequently, a choice must be made between a more flexible scheme with higher initial cost and a less flexible scheme with lower initial construction cost. As the projected remodelling may or may not occur as envisioned at the time of construction, the consequence of a choice is affected by the turn of unpredictable future events. In effect, the designer must be content with the idea of making the optimal or best bet based on whatever information is available. Attempts should be made to quantify this probabilistic decision problem so that an optimal bet can be derived in a rational manner'.[2] To the authors' knowledge, only a very rudimentary attempt[29] has so far been made in this direction.

As the basic principles of structural engineering and building construction are applicable to most building types, an extensive volume of knowledge already exists for evaluating some kinds of tradeoffs in hospital building design. In the field of structural engineering, computer programs are available for the analysis of structural systems and the selection of component members, and to some extent for optimisation and design. However, to realise the maximum possible benefit with respect to the particular type of hospital building, features peculiar to this type must be identified into the integrated conceptual framework for the overall planning design process. Some of the difficulties in the realisation of this goal must yet be overcome.[30]

Summary and conclusions

The ratio of operating cost to construction cost is much higher for hospitals than for any other normal type of building. Hospital operating costs are directly influenced by the design of the hospital which is almost impossible to correct once the building is constructed. Computer-aided planning and design of hospitals permits the study of design alternatives and their influences on subsequent operations without paying the price of erroneous decisions in the actual situation.

The rising costs of health care make a better utilisation of health-care personnel in hospitals almost imperative. One of the most important factors concerning hospital-personnel utilisation is the large amount of travel time spent by nursing and other supporting service staff in the performance of their services. One obvious way of reducing travel times is to design a hospital in such a way that the frequencies and distances of travel by the staff between various operational units within the hospital can be minimised. Consequently, the spatial layout or functional design is perhaps the most important aspect of the planning and design of a hospital. And the commerce subsystem, whose responsibility it is to handle all the movements within a hospital, holds the key to efficient functional design.

It should be appreciated that the various methodologies reviewed herein can be applied in real-life situations only if a sufficient amount of real-life data is available. The collection of such data is usually a formidable task to which relatively little research attention has been directed in the past, and more should certainly be devoted in the future. The type and amount of data to be collected would of course depend upon the complexity and structure of the conceptual framework that may be adopted for the planning and design process. The scope of this paper has been limited to the exploration of a number of feasible and desirable frameworks.

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Etude de la planification et de la conception des hôspitaux à l'aide d'ordinateurs—la condition de l'art

La croissance rapide des coûts des soins et traitement impose une évaluation approfondie des possibilités offertes dans le domaine de la planification et de la conception des hôpitaux. Ceci est d'une importance particulière du fait que le rapport des coûts d'administration à ceux de la construction est relativement plus élevé pour les hôpitaux que pour d'autres constructions et parce que les coûts d'administration d'un hôpital sont en fonction directe de la conception de celui-ci. L'emploi d'ordinateurs pour aider à l'étude de la planification et de la conception des hôpitaux permet que les possibilités de leur conception soient étudiées sans que les conséquences de décisions erronées dans la conjoncture actuelle soient a subir. Cet article présente une revue des quatre étapes principales de l'étude de la planification et de la conception des hôpitaux à l'aide d'ordinateurs: (*a*) Planification régionale, (*b*) planification de l'institution, (*c*) conception fonctionelle et (*d*) conception technique. On fait remarquer que l'aménagement de l'espace ou conception fonctionnelle est peut-être l'aspect le plus important de la planification et de la conception des hôpitaux. Le sous-système commercial qui s'occupe de tous les mouvements à l'intérieur d'un hôpital, détient la clé d'une conception fonctionnelle efficace.

Computerunterstützte Krankenhausplanung und -gestaltung—gegenwärtige Sachlage

Die schnell steigenden Kosten auf dem Gebiet der Gesundheitspflege erfordern eine sorgfältige Beurteilung der sich für die Planung und Gestaltung eines Krankenhauses bietenden Möglichkeiten. Das ist besonders wichtig, weil das Verhältnis zwischen Betriebskosten und Baukosten bei Krankenhäusern erheblich höher ist als bei anderen Gebäudearten und weil die in einem Krankenhaus anfallenden Betriebskosten in direktem Zusammenhang mit der Gestaltung des Krankenhauses stehen. Wenn die Planung und Gestaltung von Krankenhäusern durch Computer unterstützt wird, kann man die verschiedenen Ausführungsmöglichkeiten untersuchen, ohne im wirlichen Einsatz den Preis für falsche Entscheidungen zahlen zu müssen. Dieser Artikel geht auf die vier Hauptstufen in der computerunterstützten Planung und Gestaltung von Krankenhäusern ein: (*a*) regionale Planung, (*b*) institutionelle Planung, (*c*) zweckmäßige Gestaltung und (*d*) technische Gestaltung. Es wird darauf hingewiesen, daß die räumliche Anordnung oder zweckmäßige Gestaltung vielleicht der wichtigste Aspekt in der Planung und Gestaltung von Krankenhäusern ist. Das kommerzielle Untersystem, das für alle Abläufe innerhalb eines Krankenhauses zuständig ist, bietet den Schlüssel für eine leistungsfähige zweckmäyige Gestaltung.

Progettazione e strutturazione di ospedali con l'aiuto di computer—posizione attuael

Il costo in continuo e rapido aumento registrato nel settore igienicosanitario richiede per forza di cose una scrupolosa valutazione delle varie possibilità disponibili in fase di progettazione e strutturazione di un ospedale. Si tratta di un fattore particolarmente importante, in quanto il rapporto costo d'esercizio/spesa di installazione risulta di molto superiore per il settore ospedali di quanto sia effettivamente per altri stabili; inoltre, il costo d'esercizio per un ospedale è in diretta relazione alla struttura dell'ospedale stesso. La pianificazione e strutturazione di ospedali, con il valido aiuto di computers, permette lo studio delle varie possibilità progettistiche, senza implicare il costo effettivo derivante da decisioni errate. Il presente articolo è in effetti un riesame delle quattro fasi principali in seno alla strutturazione e progettazione di ospedali, avvalendosi di computers: (*a*) pianificazione regionale; (*b*) pianificazione istutizionale; (*c*) progettazione strutturale a carattere funzionale e (*d*) progettazione strutturale in termini di ingegneria pura. Si fa notare che la planimetria—dal punto di vista disegno d'ingombro—(oppure la strutturazione funzionale) è forse l' aspetto più saliente in seno alla programmazione e strutturazione di un ospedale. Il sottogruppo commerciale che tratta tutti i servizi in transito all' interno di un ospedale rappresenta la chiave reale per un design funzionale veramente efficiente.

Appointments

Area maintenance managers

The following have been appointed area maintenance managers in Scotland:

AHA	*Name*	*Previous post*
Argyle and Clyde	Mr. Peters	(ex Group Engineer)
Ayrshire and Arran	Mr. McDonald	(ex Hospital Engineer)
Fife	Mr. Millican	(ex Group Engineer)
Forth valley	Mr. Duncan	(Ex Architect from CSA)
Glasgow	No appointment	(to re-advertise)
Grampian	No appointment	(to re-advertise)
Lanarkshire	Mr. Terry	[ex Deputy Regional Engineer (Glasgow)]
Lothians	Mr. F. Potter	(ex Group Engineer)
Shetlands	No appointment	
Tayside	Mr. Keddy	(ex Regional Architect)
Western Isles	No appointment	(to readvertise)
The Sarders	No appointment	(to readvertise)
Dumfries	No appointment	(to readvertise)
Highlands	Mr. Short	(ex Building Supervisor)

Area works officers in Wessex

The following have been appointed area works officers to the Wessex Regional Health Authority:

AHA	*Name*	*Previous post*
Hampshire AHA	R. Walker	(previously Assistant Regional Architect, WRHA)
Dorset AHA	A. H. Hawthorne	(previously Assistant Regional Architect, WRHA)
Isle of Wight AHA	P. F. Brown	(previously Assistant Quantity Surveyor, WRHA)

Institute news

New president

The new President of the Institute is F. Hugh Howorth, F.R.S.A., F.Inst.P.I., F.I.I.C., Chairman and Managing Director of the Howorth Group of Companies.

Mr. Howorth was educated at King William's College, Isle of Man, and Manchester University. He was Managing Director of the Howorth Group from 1949 to 1960, when he became Chairman as well as Managing Director, which offices he continues to hold.

Among Mr. Howorth's many interests he is a Fellow of the Royal Society of Arts and has been North West Regional Chairman since 1966. He is also a Fellow of the International Institute of Conservation (of Works of Art), a Fellow of the Institute of Patentees & Inventors, a Member of the New York Academy of Sciences, a Member of the Society of Environmental Engineers, a Member of the Biomedical Engineering Society and an Honorary Member of the Low Friction Arthroplasty Society.

Mr. Howorth assumed the Presidency at the Annual General Meeting of the Institute which was held at the Postgraduate Medical Centre, Royal Victoria Hospital, Bournemouth on the 25th April.

Library

As members may know, the Library in its present form first started in 1973 when many books which had been donated by various members, were brought together by the Honorary Librarian. All of the books were catalogued, either by author's name or subject, and cards made out for each book/catalogue: one index card and one which details the name and address of the borrower, the date the book was borrowed and returned.

The length of time normally allowed for books to be out on loan is one month, but this can be extended if the book is required by students for study purposes. When money was made available by Council for the purchase of new books, details were obtained from various publishers: Hudsons Books in Birmingham were the successful tenders. Hudsons are the main suppliers to the two universities in Birmingham, and we are therefore sure that we will receive details of any new publications that will be of use to members.

We have recently entered into an insurance agreement, to ensure that if anything such as fire or loss should happen to the books, we are adequately covered.

Since the beginning of the year, we have been in touch with our colleagues in New Zealand, advising them of the best way in which to start their own institute library, and also sending them a regular copy of the new technical publications that may be of interest to them.

R. G. Smith
Honorary Librarian

Northcroft Silver Medal

Council of the Institute has approved that the Northcroft Silver Medal for 1974 be awarded to George Tuson, Assistant Regional Engineer, Wessex Regional Health Authority, for his paper entitled 'Interdisciplinary relationships between professions in building services engineering', which appeared in the July 1974 issue of '*Hospital Engineering*'.

Mr. Tuson will be remembered by many for the contributions he has made in recent years to the Keele Courses, both as a lecturer and as a course tutor.

The award of the Silver Medal was made during the Annual Conference Dinner at the Palace Court Hotel, Bournemouth, on the 25th April.

Retirement

E. Dyer a member of the Institute from its early days retired from the Health Service on the 21st February his 65th birthday. Mr. Dyer, who was a group engineer in South Wales, has always been active in the affairs of the Institute and intends to continue his membership.

South Western Branch

The following members of the Branch have been appointed district works officers:

K. Lucas Southmead (T) District,
M. Lees, Bristol (T) District,
D. Nicholson, Frenchay (T) District.

East Anglian Branch

The January meeting of the branch was held at the West Suffolk Hospital, Bury St. Edmunds, the recently completed Best Buy hospital, where members toured the boilerhouse, plant rooms and engineering services.

Various problems were discussed and it was obvious that the most serious problem for the engineer in the Best Buy hospitals is that of access to services, this being extremely difficult and almost impossible in some circumstances. Improvements were being carried out to the fire-alarm system, as the original installation relied almost entirely on the telephone system. The work of installing break-glass contacts and a complete new system was in progress. Amongst other difficulties met with during the commissioning exercises was the instrumentation associated with the heating system.

The visit proved of great interest to members, and Mr. Parker, the Vice Chairman, expressed his thanks to Mr. R. G. Kidsley for an interesting insight into the Best Buy hospital and the problems of commissioning, and for the facilities he had laid on that afternoon for the benefit of the branch.

Following the inspection of the hospital a discussion took place on the problems of subsidence at St. Mary's Hospital and members were interested to examine a map of the old lime workings and the efforts which had been made over a number of years to fill them up and prevent further subsidence.

Erratum

We apologise for an error in one of the captions to the recent article on the Keele Courses (March 1975). The caption to the photograph on p. 12 entitled 'Tutors at the 1965 Assistant Engineers Course' should read: 'Tutors at the 1964 First National Post-Experience Course for Engineers'. Left to right: P. H. Beahan, M. B. Saunders, R. Forrester, V. Ellis (front), J. Ogston (back), C. N. Anderson, T. Shaw, G. E. Tivells, J. A. Sutherland, C. J. King, A. A. H. Philips, I. Crofts.

It's your last chance

The Keele Courses

1975 will be the last year that the Institute will hold the engineering-management courses at the University of Keele.

Many of those who have savoured the joys of the 'Keele Courses' over the last 11 years may wish to take the opportunity to return this year, and those who have not visited Keele may wish to attend in this final year.

In future years, the DHSS intends to stage 'Keele-type' courses at the Training Centre at Falfield.

Meanwhile, Council of the Institute is actively considering what additional education and training can be undertaken to replace this activity and to continue to extend the service offered to members.

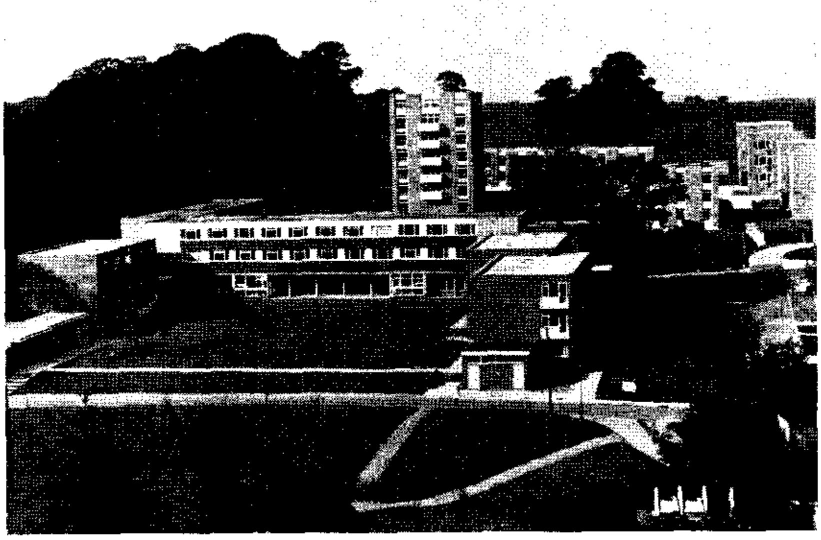


photo: The University of Keele

Fire-prevention conference

The Northumberland Area Health Authority, the British Fire Services Association and the St. George's Hospital Fire Service have arranged a 2-day fire prevention and precautions conference and appliance display to be held at St. George's Hospital, Morpeth, Northumberland, on the 3rd and 4th June 1975.

The conference will cover the following subjects:

3rd June

'Compressed gases' by S. Taylor
'The burning question' by J. Maxwell
'Fire safety in perspective' by A. Clayton
'Polyurethane foam and fire hazard: a hospital perspective' by P. J. Smith

4th June

'Fire safety in fibre building boards' by E. A. Rayham
'Hospital fire safety: quo vadis' by A. Leese

Also included will be an appliance demonstration, a visit to the Northumberland County Fire Brigade Headquarters and a session of fire films.

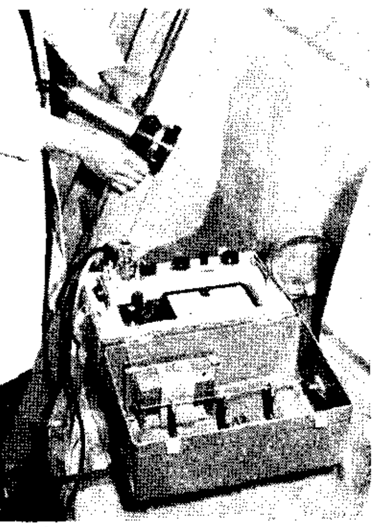
The conference is open to non-members of the British Fire Services Association and health-service representatives are invited to attend. Further information can be obtained from J. F. Leatherbarrow, Area Fire Prevention / Safety Officer, Northumberland Area Health Authority, St. George's Hospital, Morpeth, Northumberland.

HE Technical news

A test for high-alumina cement

A portable system for testing on site whether a concrete building contains high-alumina cement has been developed by John Laing Research & Development Ltd. The system is nondestructive, with the user merely holding an instrument against a beam and taking a reading on the meter.

The technique consists of irradiating the concrete with energy from a plutonium 238 isotope source and measuring the emitted radiation with a portable X ray fluorescence isotope analyser. All high-alumina cements contain a high iron content, in most cases as much as five times that of ordinary Portland cement, and the instrument is able to detect this high iron content. In some rare instances, ordinary Portland cement with a high iron content may be mistaken for high-alumina cement but this would be detected in any following analysis, so the system is fail safe.



Understanding washing-machine problems*

by R. WILLIAMS

The Hospital Service Centre in Cardiff was completed in May 1971. It was built to coincide with the opening of a new 800 bed teaching hospital and was designed to serve the then newly formed University Hospital of Wales (Cardiff) Hospital Management Committee, with a total beddage of approximately 5000.

The laundry installation was designed on the flow line principal, which employs six tunnel washing machines.*

Soon after commissioning the washing machines, numerous problems were experienced but, by the time I joined the staff of the Hospital Service Centre, many of the smaller problems had been resolved, leaving the more troublesome hard-core problems. Two of these were the failure of the drive heads on the hydromachines and the rapid deterioration of the water seals on the paddle shafts of the washing machines.

Drive alignment

The hydromachines are provided with a unique coupling arrangement employing 10 springs, each approximately 120 mm long and 25 mm in diameter, which couple the drive shaft to the hydro drum shaft. The whole assembly is held in its correct position by two large rubber rings on each side of the complete drive system. It will be appreciated that the hydros are driven from an overhead motor, mounted in the vertical plane.

At regular intervals of 4–5 months, the springs would shear, and the implacement holes in the 'head' of the shafts in which the springs were situated would become elongated and the rubber rings suffered severe damage. It soon became obvious that the setting of these 'heads' was critical to ensure maximum machine life, and after communication with the manufacturer, a 'setting-up' procedure was established to obtain the correct tension on the drive springs and rubbers.

This was carried out without success, and the springs continued to shear after a relatively short period.

Paddle shaft seals

The water seals on the shafts caused considerable problems through premature failure. The maintenance staff were involved in considerable dismantling work to replace these seals in accordance with the drawings provided in the original manuals.

Mr. Williams is an assistant engineer with the University Hospital of Wales (Cardiff) Hospital Management Committee

* Englehard & Forster Ltd., Bremen, W. Germany

The persistence of the above faults led the hospital authorities to the belief that a representative should visit West Germany and obtain first-hand knowledge of the machines. During November 1973, I was fortunate enough to be sent on a week's visit to the manufacturer's factory in West Germany.

It was my first visit to Germany and my knowledge of the language was limited to the little I had picked up at school. I was therefore rather apprehensive about the communication problem of the technical explanations that would obviously be necessary if the visit were to be a success. However, my fears were soon dispelled.

On arrival, I was met by the service manager who, realising that my German was even less proficient than his English, took me along to the drawing office.

The first was the mechanical design engineer whose English was quite reasonable and with whom mechanical problems were solved. The second was the electrical design engineer who not only acted as interpreter, because of his excellent English, but with whom I exchanged many interesting views on both engineering and management aspects. I was most impressed by the organisation and attitude to work that all concerned seemed to possess.

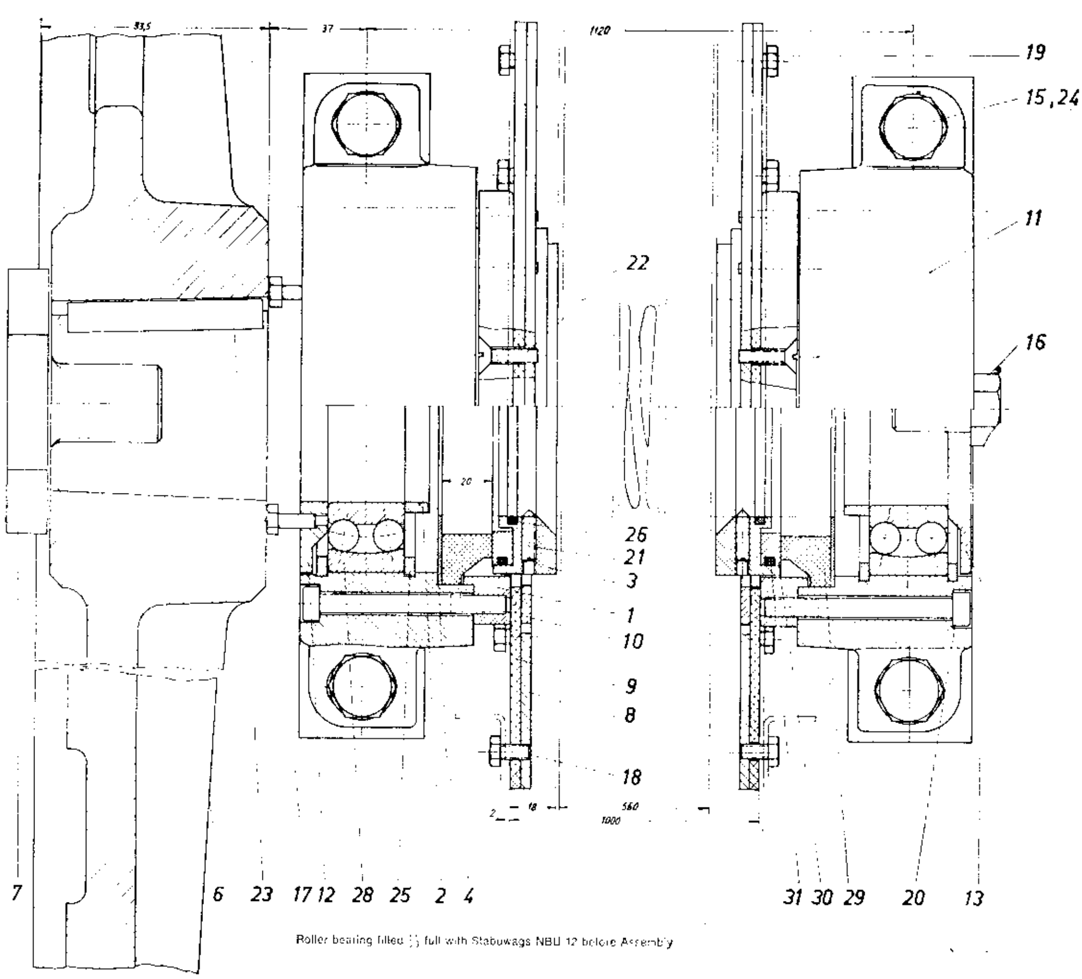
Most of the parts for assembly of the machines are manufactured at the factory, e.g. the stainless-steel drums are cut, pressed and shaped etc., at one side of the factory, together with frames and other mechanical parts, like sprockets, spindles, gearing etc.; on the opposite side, the electrical panels were being assembled.

One most impressive modification to the machine was the conversion of the relay logic and control for the automatic dispensing of bleach, starch and soap injection etc., to solid-state logic. The electronic modules are bought as standard packs, then wired, tested and installed by the electrical staff, who also complete all the other wiring on the machine. They are, therefore, involved with the construction from beginning to end. This probably explains their 'interested' attitude to work since they apparently have the boredom problem cured.

The machine is assembled at the centre of the floor area and, although the whole floor area looks rather congested, the plant seems to operate remarkably smoothly and quite efficiently.

After a tour of the factory, the electrical engineer produced two technical dictionaries, one from English to German, and the other vice versa.

I was then taken to the publications departments, where there were copies of the technical manual for the washing machine in several languages, including



Qty.	Description & Remarks		Part	Drg No Stores No.	Material	Semi Finished Product Raw Measurement Model No
			32			
2	Annular Ring GRR 492 116-124-4		31		S B 675	Goetzewerke
2	Counter Ring 76.20-306-00		30		Dulenil	
2	Slide Ring Gasket 76 60 100-140		29			Goetzewerke
2	Self aligning Ball Bearing 2215	DIN 630	28		STEEL	
			27			
2	O-Ring 85 x 4		26		Perbunan	
4	Safety Ring 130 x 4	DIN 472	25		Spring St.	
4	Spring Washer A 16	DIN 127	24		Spring St.	
1	Key A 20 x 12 x 80	DIN 6885	23		St. 60	
24	Countersunk bolt M 6 x 25	DIN 87	22		Cr Ni	
4	Threaded Pin M 6 x 20	DIN 553	21		5 S galv.	
4	Internal Hex Bolt M 8 x 75	DIN 912	20		8 G galv	
34	Hex. Bolt M 6 x 10	DIN 933	19		Cr Ni	
10	Hex. Bolt M 6 x 12	DIN 933	18		Cr Ni	
2	Hex. Bolt M 6 x 15	DIN 933	17		8 G galv.	
1	Hex. Bolt M 16 x 30	DIN 933	16		8 G galv	
4	Hex. Bolt M 16 x 120	DIN 931	15		8 G galv.	
			14			
1	Shaftend Disc		13	4R10.10-281 8 4		
1	Thrust Washer		12	4R10 10-281 8.3		
2	Drum Bearing		11	3R10.10-281.5.10		
2	Counter Flange		10	4R10.10-281.5.9		
2	Gasket		9	4R10.10-281.5.8		
2	Flange		8	4R10.10-281.5 7		
1	Collar Bolt		7	4R10.10-281.5 3		
1	Drum Wheel		6	2R10.10-281.5.1		
			5			
2	Sealing Ring		4	4R10.10-282.3.4		
2	Labyrinth Bush		3	4R10 10-282.3 3		
2	Distance Ring		2	4R10.10-282.3.2		
2	Intermediate Ring		1	4R10.10-282.3.1		

Fig. 1 Drum bearing complete with slide ring gasket

Russian and Japanese. I obtained an up-to-date English version and then worked through a detailed programme, which I had prepared beforehand, taking each item in turn throughout the manual.

Mechanical design

The two major problems were mechanical, and we therefore discussed these at great length. When necessary or requested by myself, a demonstration was arranged on the factory floor, where the part or section of the machine was being assembled or overhauled.

The water-seal problem was quickly solved as the manufacturers had developed a modification to the seal assembly procedure, which seemed quite logical, although there was a correct replacement procedure of which we were not aware (Fig. 1).

The drive-arrangement problem was of a different nature, and the manufacturer was pleased to learn of a successful experiment that we had carried out in Cardiff, whereby the holes in the shaft 'heads' that accommodated the springs had been case-hardened, thereby eliminating the enlarging of these holes.

The 'set-up' procedure for the drive arrangement is complicated to explain, even with a detailed drawing and the application of a formula that is used to establish

No. off	Description and Notes	Part	Drawing No. Stores No.	Material
			The electric motors as per drawing J 793 251	
			Each motor with 3 cold conductor temperature feelers	
			55 KW 1 RS 2 166 4 AA.9-Z 220 V or 380 V	
1	Electric motor	129	45 KW 1 RS 2 165 4 AA.9-Z 220 V or 380 V	
4	Narrow V-belt	128	SPB x 3150	
		127		
1	Clutch	126	Type 81 502-16 B	Messrs. Binder
1	Geared motor	125	FZ 2 B OBR 0245 0.18 KW 9.8 rpm	
1	Brush	124	Type 31 085-42 B	Messrs. Binder
		123		
		122		
		121		
4	Threaded pin AM 10x20 DIN 914	120		St 10.9
1	Countersunk screw M 4x15 DIN 87	119		Brass
5	Countersunk screw M 4x20 DIN 87	118		Brass
2	Oval-head screw M 5x15 DIN 85	117		Ni-plated brass
12	Threaded pin M 16x17 DIN 915	116		St 10.9
6	Cylindrical pin 10m6x28 DIN 7	115		St 50
2	Adjusting ring A8 DIN 705	114		St
2	Grease nipple AM 10x1 DIN 3402	113		
6	Magnet M2	112		
1	Giga magnetic switch LRU 9	111		
5	Giga magnetic switch GMS 9	110		
1	Roller bearing NU 219	109		
1	Grooved ball bearing 6218	108		
1	Grooved ball bearing 6019	107		
1	Grooved ball bearing 6217 NR	106		
1	Grooved ball bearing 6015 2RS	105		
1	V-ring Type V 100	104		Rubber
		103		
1	Retaining ring 160x4 DIN 472	102		Spring steel
1	Retaining ring 95x3 DIN 471	101		Spring steel
		100		
5	Hexagon nut M 4 DIN 934	99		Brass
5	Hexagon nut M 8 DIN 934	98		St 8.8
11	Hexagon nut M 10 DIN 934	97		St 8.8
		96		
6	Hexagon nut M 20 DIN 934	95		St 8.8
4	Hexagon nut M 16 DIN 934	94		St 8.8
18	Hexagon nut M 16 DIN 936	93		St 8.8
8	Hexagon nut M 20 DIN 936	92		St 8.8
		91		
4	Spring ring A 8 DIN 7980	90		Spring steel
10	Spring ring A 10 DIN 7980	89		Spring steel
8	Spring ring A 12 DIN 7980	88		Spring steel
8	Spring ring A 20 DIN 7980	87		Spring steel
		86		
		85		
8	Washer A 8.4 DIN 125	84		St
11	Washer A 10.5 DIN 125	83		St
		82		
4	Washer A 17 DIN 125	81		St
		80		
3	Hexagon bolt M 8x30 DIN 931	79		St 8.8
4	Hexagon bolt M 10x35 DIN 931	78		St 8.8
7	Hexagon bolt M 10x45 DIN 931	77		St 8.8
5	Hexagon bolt M 12x35 DIN 931	76		St 8.8
1	Hexagon bolt M 12x45 DIN 931	75		St 8.8
4	Hexagon bolt M 16x50 DIN 931	74		St 8.8
4	Hexagon bolt M 8x10 DIN 931	73		St 8.8
4	Hexagon bolt M 8x25 DIN 931	72		St 8.8
		71		
		70		
12	Socket-head hexagon screw M 10x12 DIN 912	69		St 8.8
6	Socket-head hexagon screw M 10x25 DIN 912	68		St 8.8
4	Socket-head hexagon screw M 10x25 DIN 912	67		St 8.8

No. off	Description and Notes	Part	Drawing No. Stores No.	Material
6	Socket-head hexagon screw M 12x40 DIN 912	66		St. 10.9
8	Socket-head hexagon screw M 12x80 DIN 912	65		St. 10.9
2	Socket-head hexagon screw M 20x90 DIN 912	64		St 8.8
6	Socket-head hexagon screw M 20x150 DIN 912	63		St 8.8
		62		
		61		
		60		
		59		
		58		
		57		
		56		
		55		
1	Retaining bolt for clutch	54	4Z100-202.0.24	
1	Driver	53	4Z100-202.0.23	
1	V-belt pulley (motor)	52	3Z100-202.0.14	Grey cast iron (GG)
1	Spacer ring	51	4Z100-202.0.21	
		50		
		49		
1	Washer	48	4Z100-202.0.20	
1	Bush	47	4Z100-202.0.19	
1	Cover for electrical drive	46	2Z100-202.0.2	St 37-2
1	Threaded pin	45	4Z100-202.0.18	
1	Guard plate – right-hand	44	3Z100-202.0.16	
1	Guard plate – left-hand	43	3Z100-202.0.15	
5	Bush 20 dia.	42	4Z100-201.0.12	CrNi
2	Magnet bracket, short	41	4Z100-202.0.10	CrNi
2	Magnet bracket, long	40	4Z100-202.0.9	CrNi
1	Magnet bracket, vertical	39	4Z100-202.0.8	CrNi
1	Bracket for drag switch	38	4Z100-202.0.22	
1	Safety hood	37	2Z100-202.0.12	GFK
1	Cover for electrical drive	36	1Z100-202.0.5	
		35		
1	Bush 35 dia.	34	4Z100-201.0.11	St 37 K
1	Control disc 2	33	4Z100-202.0.4	
1	Spacer sleeve	32	4Z100-202.0.7	St 37 K
1	Control disc 1	31	4Z100-202.0.3	
		30		
1	Shaft for control disc	29	4Z100-202.0.6	St 37
1	Selector ring	28	3A 3123	CrNi
		27		
		26		
1	Upper end plate	25	4A 3122	St 37
1	V-belt pulley (clutch shaft)	24	1Z100-202.0.17	GG-22
1	Cylindrical pin with internal thread	23	4A 3150	St 60
1	Spacer tube, trimmed	22	4A 3175	
1	Bearing pressure ring	21	3A 3120	
1	Clutch shaft	20	2Z100-201.0.4	St 50
1	Upper bearing housing	19	1Z100-202.0.13	GG-22
		18		
		17		
		16		
		15		
1	Bush	14	4A 3147	centrifugal casting
10	Clutch spring	13	4Z100-201.0.3	Spring steel
2	Bearing ring	12	4A-201.0.15	Natural rubber
2	Pressure ring	11	4A 3121	St
1	Clutch flange	10	3Z100-201.0.2	St 50
1	Lower bearing housing	9	2A 3130	GS-38
1	Lubrication ring	8	4Z100-200.0.5	GZ-Rg 7
		7		
		6		
1	Spacer tube, trimmed	5	4A 3022a	St 37
1	Floating sleeve	4	1Z100-201.0.14	GS 38
1	Bearing support ring	3	2A 3033a	GG-22
1	Inner spacer bush	2	4Z100-201.0.5	St 37
1	Drum shaft	1	2Z100-301.0.1	St 60 K

Key to Fig. 2

the correct pressure on the springs and tension on the rubber ring 'dampers', but it would suffice to say that, because one or two words were lost in the translation, the English assembly instructions had a different approach. The correct method of assembly was made absolutely clear by both explanation and a demonstration on the factory floor.

Although a considerable time was spent on mechanical discussions, it was fortunate that there was ample time for electrical explanations also, for this revealed another important aspect regarding the washing-machine drive.

The drive motor has an automatic rotor-resistance starter, the acceleration period for which is variable, and if too short, a greater starting torque is exerted on the springs.

The difficulty with this problem is the fact that, if the acceleration period is extended to obtain minimum stress on the springs, the efficiency of the hydro is reduced and the overall running time has to be increased, which has the effect of reducing the rated output of work from the machine.

Therefore, an optimum has to be reached to obtain reasonable machine life with regard to rated output per hour, and taking into account the size of machine etc.

Communication

The manufacturers were extremely courteous and helpful in providing additional information, e.g. drawings, graphs, circuit diagrams etc.

It is obvious from this exercise that, once again, the problem of communication has contributed a great deal

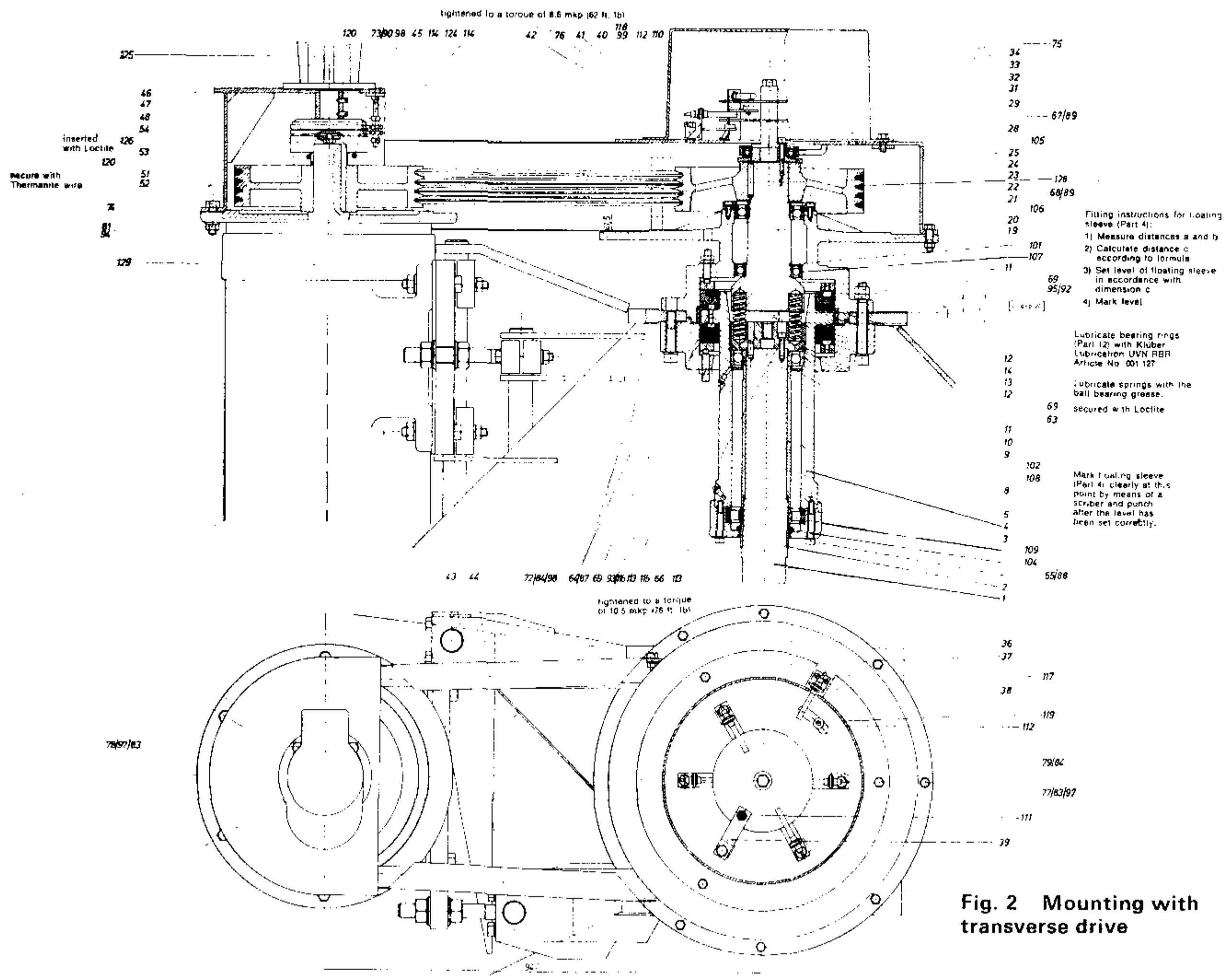


Fig. 2 Mounting with transverse drive

to the lack of understanding of these machines, although, in this case, the problem has been amplified *by the translation from one language to another as well* as being of a technical nature, since this itself can cause considerable problems among engineers, from design to user.

I would like to express my grateful thanks to my employers, the University Hospital of Wales (Cardiff) Hospital Management Committee, and to Polymark Ltd. *for their part in the arranging of the visit to* Germany, and also to Englehard & Forster Ltd. for a most interesting and enlightening visit, which I feel sure has been a great benefit to my employers and to me personally.

Data-processing system

Kovo, the Czechoslovakian foreign-trade corporation, has signed a contract worth £2·1 million with Datasaab Ltd. for the delivery of a large-scale data-processing system for use within the public-health services. The system will include various data-recording and data-processing units and biomedical equipment for use in hospitals, laboratories and intensive-care units.

National institute for South Africa

A meeting was held in November 1974 in Cape Town to form a South African Federation of Hospital Engineering. The meeting was attended by W. D. S. Clinkscales, who is at present an Associate representing South Africa in the International Federation of Hospital Engineering.

A committee was formed to set up a local branch and to draw up a Constitution with a view to establishing the South African Federation, and it is hoped that others will follow this example. The committee in Cape Town, in drafting the Constitution, intends to keep in mind the conditions laid down for membership of the International Federation of Hospital Engineering.

First steps in management

The London Graduate & Student Section of the Institution of Electrical Engineers is organising a weekend conference entitled 'First steps in management', to be held at Brunel University from the 5th–7th September. The fee for the conference, which is primarily aimed at recently qualified graduates and students, is approximately £15 including V.A.T., which will cover meals and accommodation for two nights. Further information can be obtained from A. G. Loukes, 'Denue', 45 Leacroft Staines, Middx. TW18 4NN.

Classified Advertisements

OFFICIAL APPOINTMENTS
SITUATIONS VACANT
COURSES, EQUIPMENT ETC.

To place an advertisement in this section, please write or telephone:
Classified Advertisement Department, ***HOSPITAL ENGINEERING***
Peter Peregrinus Ltd.
Station House, Nightingale Road,
Hitchin, Herts. SG5 1RJ, England
Telephone: Hitchin (s.t.d. 0462) 53331, ext. 276

APPOINTMENTS AND SITUATIONS VACANT

NORTHAMPTONSHIRE AREA HEALTH AUTHORITY

AREA ENGINEER

£5352 - £6447 plus threshold payments

Applications are invited from officers employed within the reorganized National Health Service in England and Wales for the new post of Area Engineer.

The person appointed will be responsible to the Area Works Officer for the implementation of capital engineering works undertaken at Area level and for coordinating and monitoring the programme of engineering maintenance and operation undertaken at the Area and Districts. There are currently major capital development programmes in progress within the Area, at Northampton General Hospital and Kettering General Hospital.

Applicants should be corporate members of one of the Institutions of Civil, Mechanical, Electrical or Electronic and Radio Engineers, and should also have knowledge and experience of the design, construction, operation and maintenance of engineering plant, equipment and services within the health or social services fields.

Job description and Application Form are available from

Area Personnel Officer
Northamptonshire Area Health Authority
Floor 10
Northampton House,
Northampton NN1 2HR.
Tel. No. 0604-34833 Ext. 5085

Closing date for applications is the 2nd June 1975

WHIPPS CROSS HOSPITAL, LEYTONSTONE, LONDON, E11 1NR

TECHNICIAN

required for Medical Physics Department to carry out day to day maintenance and repairs. Workshop practice desirable, and ability to use initiative is essential. Experience in instrument or prototype work would be an advantage although training will be given. Salary £2085 p.a. inclusive of London Weighting rising by annual increments to £2775 p.a. plus the current Threshold agreement. For information regarding qualifications and/or informal visit; please telephone Mr. C. Deacon, Senior Technician in the Department on 01-539 5522.

Application forms obtainable from Staff Office. Ext. 351.

KINGSTON AND RICHMOND
Area Health Authority

ASSISTANT ENGINEER

for Kingston Hospital. To assist the Hospital Engineer in the operation and maintenance of all engineering services, including PPM and supervision of labour. Training will be available in these areas but experience with steam and hot water boilers or air conditioning plants and ventilation would be an advantage.

Salary scale £2812 to £3142 per annum inclusive of London Weighting and Threshold, according to experience.

ONC in Engineering or equivalent required.

Applications to Area Personnel Officer, Kingston and Richmond Area Health Authority, 106/114 London Road, Kingston, Surrey—Tel. 01-546 2181 Ext. 28.

CUMBRIA – the LAKELAND Area Health Authority

District Works Officer

£5040 - £6060

in EAST CUMBRIA, the largest of the three districts.

HQ is in CARLISLE a convenient centre for the LAKE DISTRICT and six miles from the SCOTTISH BORDER.
Competition is restricted to those at present serving in the National Health Service in England and Wales.

The District Works Officer is the Chief Works Technical Officer; providing liaison between Works staff and client professions and managing and advising on all Works services.

To enable us to do full justice to this important post and indeed the area in which we live, please ring Carlisle 32141 (extension 250) and we will be pleased to send you further details and application form.

If you would like to have a chat about the post ring Robert Atkinson, Area Works Officer, at the same number, extension 248.

Closing date for applications: 15th May 1975.

Classified advertisements for the next issue of HOSPITAL ENGINEERING published 6th June, should be received not later than Thursday, 22nd May

CLASSIFIED ADVERTISEMENTS *continued from previous page*

APPOINTMENTS AND SITUATIONS VACANT

DISTRICT WORKS OFFICERS (2 Posts)

(i) Grimsby District
(ii) Scunthorpe District

Salary: £5040-£6060 per annum+ threshold payments

Applicants should be suitably experienced and qualified officers currently holding posts within the National Health Service in England and Wales.

Grimsby and Scunthorpe are two separate Districts in a four district area serving the county of Humberside. These two districts, formerly in North Lincolnshire now form South Humberside.

The Area contains a combination of rural and coastal scenery, together with the amenities of a city. Housing is relatively reasonable in price. Excellent ferry services to the Continent from Hull and Immingham.

The Area Works Officer is H. G. Hanson, Dip.Arch (Leeds), R.I.B.A.

Job descriptions and application forms may be obtained from the Area Personnel Office, Humberside Area Health Authority, Springfield House, Springfield Way, Anlaby, Hull.

Closing date for receipt of applications the 16th May, 1975.

Humberside Area Health Authority

Enfield and Haringey Area Health Authority (Haringey District)

Hospital Engineer

Responsible to the District Works Officer for the operation and maintenance of all engineering services at St. Ann's General Hospital, London, N.15.

Applicants must be in possession of a Higher National Certificate in mechanical engineering, electrical engineering or an equivalent City and Guilds Certificate.

Salary scale £2550 to £3000 (currently under review) plus allowance of £144 p.a.

For further details and application form write to the Sector Administrator, The Prince of Wales's General Hospital, London N.15.

MISCELLANEOUS

CIRCULATING PUMPS and Steam Turbines, Complete units, electric and steam, spares and service. TURNEY TURBINES Ltd., 67 Station Road, Harrow. Tel: 01-427 1355 and 01-427 3449

WEST MIDLANDS REGIONAL HEALTH AUTHORITY

PERSONNEL/TRAINING OFFICERS

£2676—£3291 plus threshold

Applications are invited from Health Service Staff within England and Wales who were transferred at 1st April, 1974.

The Personnel Division require personnel/training officers in the section which is concerned particularly with professional and technical staff of all grades including those working in medical laboratories, pharmacies, medical physics departments and works departments.

The first post involves the development of the personnel/training function in the medical electronics and engineering, architectural and building fields. The second post involves the training of scientists and technicians. Experience in the appropriate fields of work in the hospital service would be an advantage.

The officers appointed will be responsible for the development of specific areas of work which may include the provision of in-service training and courses for school leavers and participation in management and supervisory training.

Previous experience in training would be an advantage but appropriate training will be provided where necessary.

While these appointments are to be made to the professional and technical section, the officers concerned will be given the opportunity, as vacancies arise, to widen their experience in other sections of the Personnel Division.

Applicants should be car drivers.

Job description and application forms (quoting reference B66) from the Personnel Officer, 146 Hagley Road, Birmingham B16 9PA (021-454 4828, ext. 50) to be returned by the 16th May

REGULATIONS FOR THE ELECTRICAL EQUIPMENT FOR BUILDINGS

These regulations (formerly the 'Wiring rules'), which have been published by the IEE since 1882, are effectively the UK national code for the safety of electrical installations, specially from fire and shock, in and around building generally.

They are recognised in the statutory Electricity Supply Regulations 1937, as fulfilling the requirements of these regulations for consumers' installations. They supplement these and other statutory regulations by prescribing, in detail, methods (not necessarily the only methods) of complying with the statutory regulations.

14th edition 1966, reprinted in metric units incorporating amendments 1974, £2

Inquiries, orders and remittances should be sent to:

Publication Sales Department, IEE, Station House, Nightingale Road, Hitchin, Herts. SG5 1RJ, England

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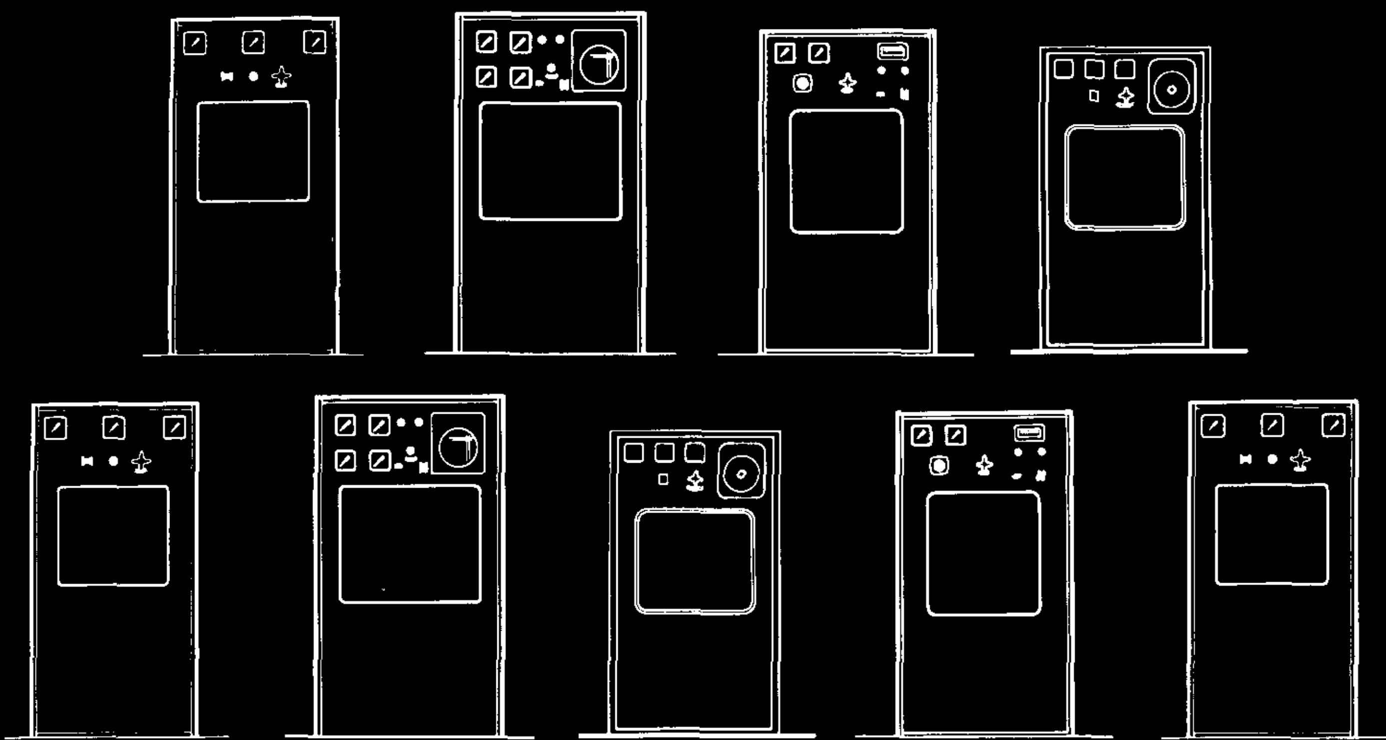
THACKRAY



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The latest range of Thackray automatic high speed autoclaves including Porous Load, Downward Displacement, Rapid Cooling Fluids and Laboratory Units incorporate many unique features and user benefits.

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Thackray autoclaves, all of which conform to BS 3970 and HTM 10, are available in a range of standard chamber sizes. These are designed to take full 10, 15, 21 and 28 cu. ft. loads even taking into account the space usually lost due to loading arrangements.

In order to ensure that your Thackray autoclave will always give you the best results, we operate an after sales service that is second to none. This includes standard service calls, planned preventive maintenance contracts, and a 24 hour emergency service which operates 365 days a year.

For further information, please contact:
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