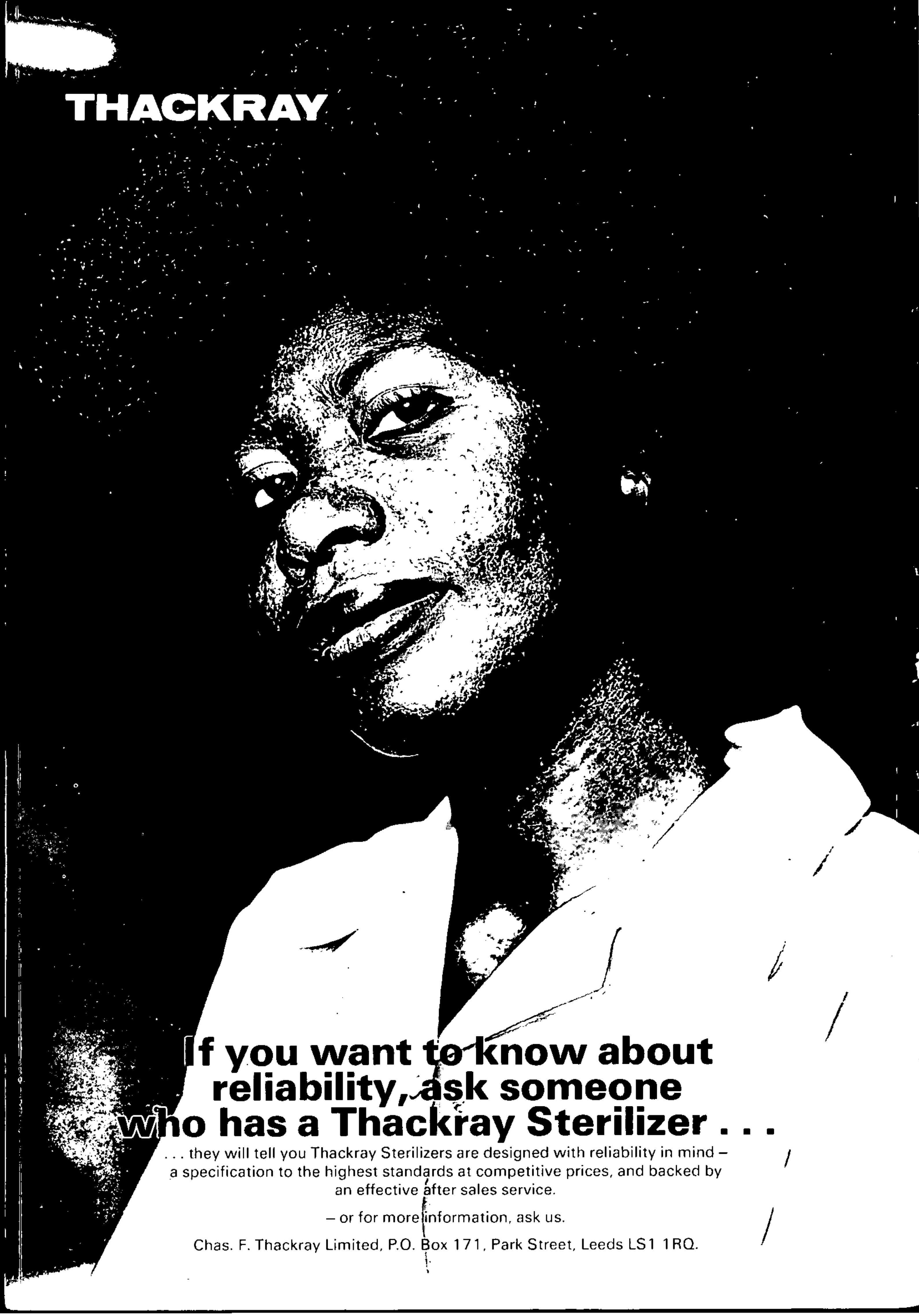
HOSPITAL ENGINEERING

May 1978

The Journal of the Institute of Hospital Engineering

Jan de Vries - Northcroft Silver Medallist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HOSPITAL ENGINEERING

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Institute News

Branch Officers

Branch Officers for the coming year have been elected as follows:

London Branch

Chairman, D. L. Davies; Vice-Chairman, W. A. Askew; Hon. Sec., P. C. Vedast, 59 Oakfield Gardens, Edmonton N18 1NY; Treasurer, W. P. Lawrence.

North Western Branch

Chairman, W. J. Smith, Vice-Chairman, A. W. Schaffel; Hon. Sec./Treas., J. Sunderland, 'The Calliards', Smithy Bridge Road, Littleborough, Lancs.

Southern Branch

Chairman, A. Round; Vice-Chairman, D. Wilson; Hon. Sec./Treas., J. H. Walker, 182 Salisbury Road, Totton, Southampton.

North Western Branch

The Annual General Meeting of the Branch was held at Ormskirk District General Hospital on March 13, 1978.

The Chairman, Mr. W. J. Smith, reported that generally the past year had been a successful year with four technical meetings and two joint meetings (one with the CIBS and the other with the Preston Maintenance Engineers).

The policy had been pursued of Committee Members giving papers this year, and Messrs. Schaffel, Richards and Sunderland gave papers and the Chairman expressed his thanks and appreciation to them.

Two social events took place over the year — one a boat cruise, and the other the annual dinner dance, both of which were successful events. The Branch Chairman of the Institute of Plant Engineers was the official guest at the annual dinner in response to an invitation to the Chairman to their own annual dinner at which Mr. Schaffel acted as representative.

The Committee held five meetings, and on behalf of the members, the Chairman thanked them for their devotion to duty and in particular to Mr. Burton and Mr. Mellows.

There were two additional members for nomination, Mr. P. Tansey and Mr. J. Lemonefiles — who were elected to the Committee together with all existing Committee members.

Regrettably Mr. J. Burton had to retire as Asistant Secretary, due to the fact that he was leaving the area to take up another appointment. Mr. D. Mellows retired as Secretary/Treasurer and Mr. J. Sutherland was elected as Secretary/Treasurer.

The composition of the Branch Committee for 1978/79 was therefore agreed as: Branch Chairman, W. J. Smith; Vice-Chairman, A. W. Schaffel; Hon. Sec./Treas., J. Sunderland; Committee Members: R. Richards, D. Mellows, D. Cunliffe, T. Hardacre, A. Juliff, A. Millington, J. Lemonefides, P. Tansey.

The Institute of Hospital Engineering One-Day Symposium

Recent Developments in Hospital Sterilising Processes

to be held in
Lecture Theatre 1, Physics Department, Imperial College of Science and Technology, Prince Consort Road, London SW7
on Wednesday, June 14, 1978

There has been a considerable growth of interest in this subject over recent years stemming from the publication of the Collingwood Report of 1967, the introduction of the Medicines Act in 1968, the issue of the Health Service Circular HSC (IS) 128, 'The Application of the Medicines Act to Health Authorities' in 1975 and the more recent Cunliffe Report.

As a result, Health Technical Memorandum No. 10 has been revised and is about to go to print, and Health Building Note No. 13 is currently undergoing revision. The Institute considers that the time is propitious for the dissemination and exchange of the latest information and views on this topic.

10.00 Coffee

10.25 OFFICIAL OPENING by
J. R. HARRISON Esq CBE CEng (Fellow), President, The Institute of Hospital Engineering

CHAIRMAN for the day:
R. MANSER Esq BSc (Eng) (Hons) CEng MIMechE FIEE PPIHospE, Assistant Chief Engineer, Department of Health and Social Security

10.30 'THE IMPACT OF THE MEDICINES ACT, 1968, ON THE HOSPITAL PHARMACIST IN RELATION TO STERILE PRODUCTS'
Speaker: DR. J. M. SPRAKE BPharm PhD FRIC CChem MPS, Quality Control Pharmacist, Trent Regional Health Authority

11.00 'COMMISSIONING AND TESTING OF STERILISERS'
Speaker: S. A. GIBBONS Esq BA CEng MIMechE MCIBS, Regional Sterilising Engineer, Trent Regional Health Authority

11.45 'SYSTEMS RELIABILITY ASSESSMENT APPLIED TO STEAM STERILISERS'
Speakers: A. C. SELMAN Esq MSc DIC CEng MIMechE, DHSS Engineering Division
K. C. HIGNETT Esq CEng MIMechE, Systems Reliability Service, UKAEA

12.30 LUNCH

14.00 'REVISION TO HEALTH TECHNICAL MEMORANDUM 10 — STERILISERS'
Speaker: L. W. M. ARROWSMITH Esq BSc CEng MIMechE, DHSS Engineering Division

14.30 'FUTURE DEVELOPMENTS IN STERILISING'
Speaker: DR. J. B. KAY BSc PhD MPS, DHSS Scientific and Technichal Branch

15.15 OPEN FORUM 16.00 CLOSURE

An application form is included with this issue. Tickets (£12 each, including refreshments) from the Secretary of the Institute.

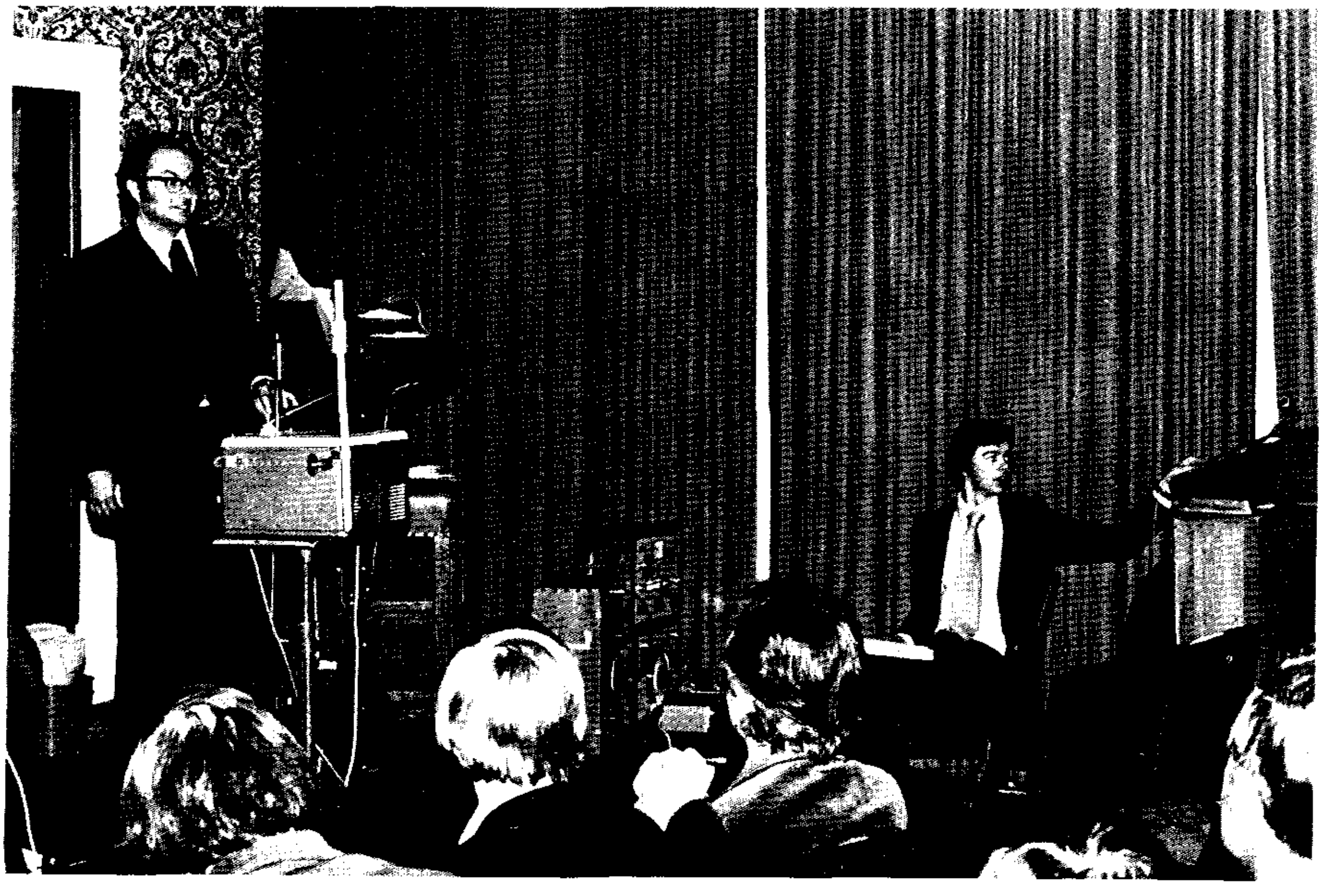
Institute Annual Conference '78

The 34th annual conference of the Institute was held at the Royal Hotel, Cardiff, from April 26 to 28. A varied programme of technical papers, but with an emphasis on energy conservation, was enjoyed by members, while their ladies braved the unseasonal weather to take advantage of the full programme of sightseeing visits that had been arranged for them.

A highlight of the conference was the presentation of the Northcroft Silver Medal for 1977 to Mr Jan de Vries, a member from Holland. The medal is awarded annually for the best technical paper published in the Institute's journal *Hospital Engineering*. Mr de Vries' paper, 'A New Concept of Energy Supply for Hospitals', was published in the March 1977 issue.

On the final evening the principal guests at the Dinner Dance were Mr Owen Morris CBE CMG, Deputy Secretary at the Welsh Office, and Councillor David Purnell, Lord Mayor of Cardiff. Proposing the toast to the Institute, Mr Morris paid tribute to the Institute, and the vital part its members play in the NHS. He said that the Service was undergoing a period of intense self-criticism, and that while going through this 'long crisis', people must wonder if what they were trying to achieve would not be totally swamped in criticism. However, looking on the brighter side, Mr Owen said that everyone at the Welsh Office was excited by new hospital development, but that priority must also be given to maintenance of existing health buildings. Public Expenditure Cuts had given great problems, but there were now hopeful signs of improvement.

Mr T. Wagstaff, Principal Acoustics Engineer, DHSS, talks on 'Noise Control in Health Buildings', while his assistant controls a battery of sound effects.



[redacted] *mprised the whole of a DHSS presen-* [redacted] *f the Institute, held at Pitlochry in*

[redacted]ilding

[redacted] problem. This can be a lengthy task but a detailed clarification of objectives often leads to answers.

What, then, is the problem? *Figure 1* shows the age distribution of NHS buildings. It shows a pattern which will be recognised, one suspects, in all areas of NHS work.

The message is fairly clear. We still have a lot of old hospital property which is either due for rebuilding or in need of ever-increasing maintenance.

Figure 2 illustrates the picture of capital expenditure over the last ten years. The figures are extracted from the DHSS published annual accounts and show capital works, total fees expenditure and the maintenance spend. These are shown as recorded and are not corrected for inflation.

In the context of this paper the most important messages are:

1. Our capital spend is of the order of £260 million per year;
2. Our fee spend is of the order of £20 million per year;
3. Our maintenance spend is of the order of £120 million per year;
4. The capital spend and, by implication, the fee spend are likely to remain at this sort of level;
5. The maintenance spend is likely to continue at this rate.

It seems reasonable to assume that we could spend the £260 million capital, the £120 million maintenance and the £20 million fee account better than we do at the moment. That is not to imply any 'saving', merely more effective spending. A better deal for all involved.

We can all point to areas where [redacted] sive maintenance due to shortcomings in design.

Scope of Work

Systems work is aimed at alleviating this situation without using extra manpower to do so.

A financial saving of only £2m a year is thought to be possible and reasonable and would seem justification enough.

In addition to financial saving, a system approach can remove much repetitive, dreary work and, hopefully, some frustrations too.

Standard Buildings

One way of more efficient working would be to produce a detailed, acceptable set of documents for repeated re-use. This saves the cost of research and development design for projects after the first one, and means that errors are progressively corrected with each successive job.

This approach has been used both by the RHAs and the DHSS. In the Department it produced the Standard Satellite series of departments, whose greatest weakness, perhaps, was that they could not easily be put together to form a whole hospital. Although still available, these departments lack the flexibility needed to meet rapidly changing medical techniques and medical technologies. The department's Best Buy is a standard whole hospital.

Harness is a step forward consisting of pre-designed departments which can be joined together in many differ- [redacted] ent ways to form a district general hospital. It is aimed at about 1,000 beds, its most economic size.

The recent economic crisis abruptly required something smaller than Harness, involving less capital outlay. This is the Nucleus hospital, *Figure 3*.

It is seen as being the minimum viable size and is buildable without attracting phasing overheads. Like Harness, it comprises a number of pre-designed departments capable of variations of assembly. Unlike Harness, the designs are taken only to line diagram stage centrally. From this point they are worked up to completion by the individual user.

System Generally

If standard design is only part of the solution, we must find an alternative, preferably dealing with the root of the matter rather than the symptoms. Much of the work in procuring and operating a building is routine, eg planning, design, operation and maintenance. If a systematic technique could be employed, aided by computer methods where these were useful, much could be gained. Many disciplines are involved in the procurement of hospitals. Simply, this means deciding what is needed functionally, how and where it is to be provided, at what cost, and then preparing the documentation necessary to construct and equip the building. This includes operational and maintenance information.

Procedures are necessarily technically complicated and time-consuming, and might at first appear to be an interlinking of separate and different activities. A closer study shows that the data being handled is basically the

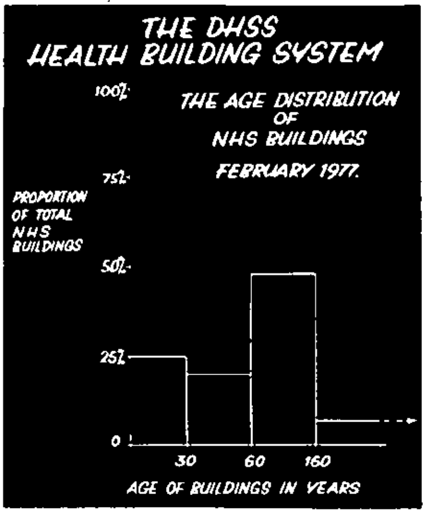


Figure 1.

same, although modified in its direction of output.

How much easier it would be if these processes could be assembled and identified as one comprehensive system which would provide a logical route map, provide an easily accessible data store, and make available various computer aids for this procurement of health buildings. This is what is meant by the Health Building System described below.

Restraints to be observed

Before planning any workable system three major constraints must be taken into account. These are as follows:

1. Any system approach must be 'neutral'. That is, there must be no constraints imposed by the system itself. Architects must be free to design the building best suited to the clients' needs, with materials best suited to the locality and market conditions;

2. Work in health service is very diverse, varying from that of large teaching hospitals to say ambulance stations, and includes upgrading work of major and minor proportions;

3. The diverse nature of both the NHS and the building industry has led to many varied practices to do the same job. Any new system can succeed only with general aceptance; for this reason we have worked very closely with the regions, the Property Services Agency and with the industry generally.

We propose to develop three main streams of work:

1. Rationalisation of data;

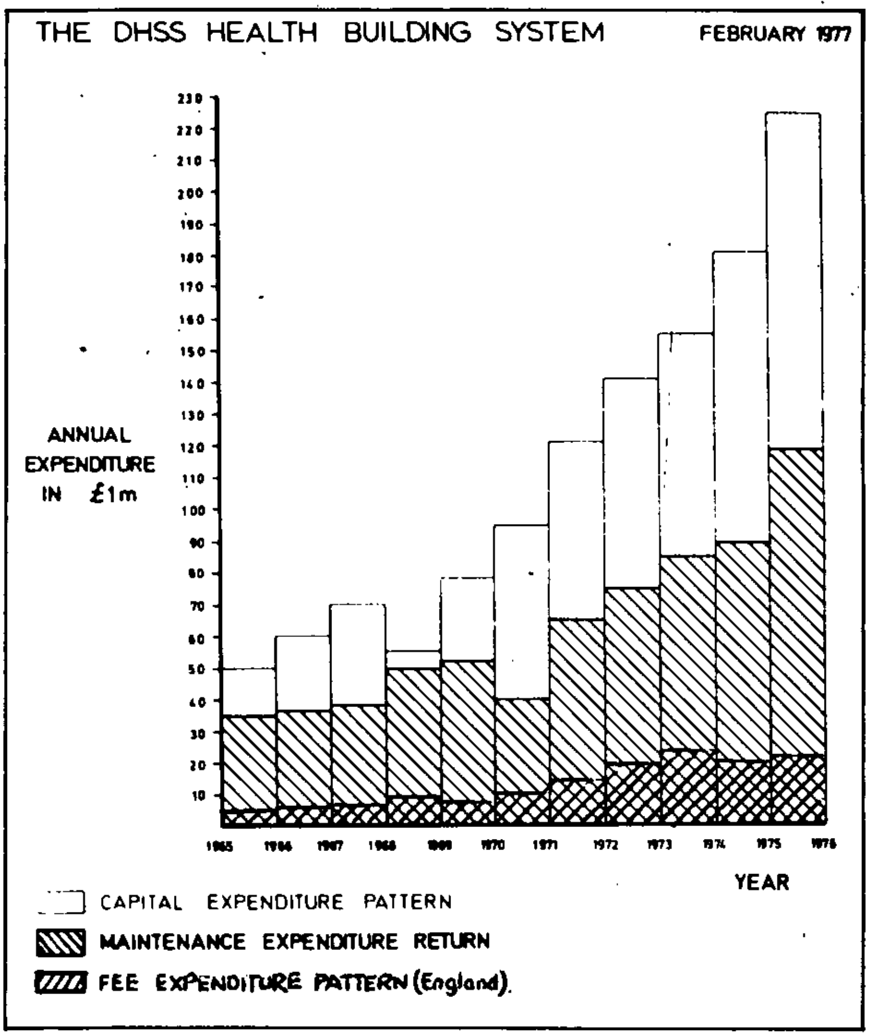


Figure 2.

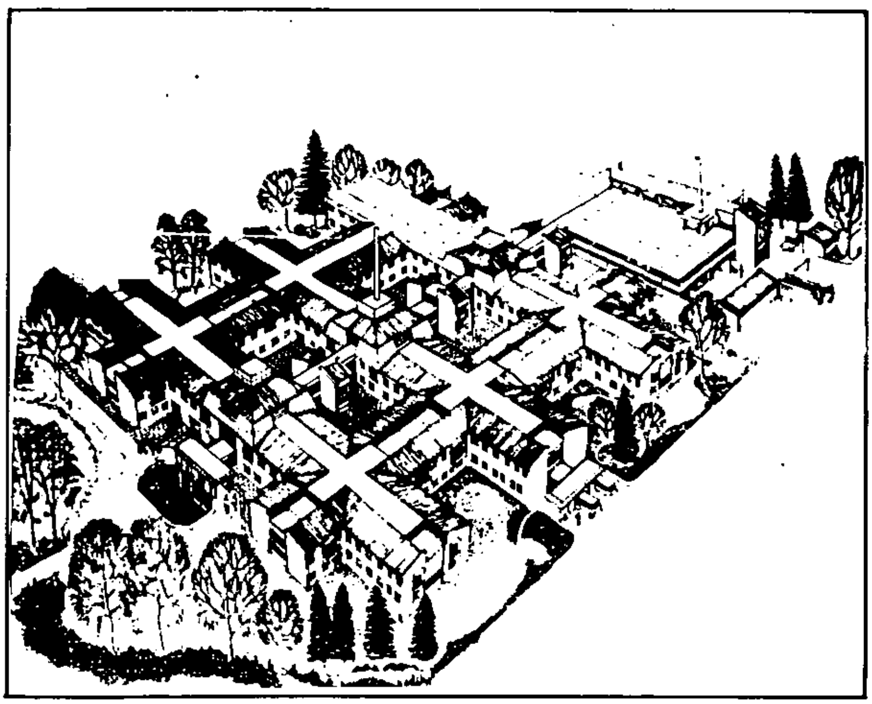


Figure 3.

2. Rationalisation of methods;
3. Rationalisation of techniques using the computer when economical.

Rationalisation of data

The usual procedure today is to have the most junior member of the design team put together on the drawing board all the data which will form a project. To do this he is faced with a morass of information of varying degrees of finality, all to be sorted and knitted together. Worse still, there is also the other data of which he may only be blissfully ignorant.

In theory, more senior staff should be able to offer guidance, but will they in practice? Can they be sure they have all the pertinent data themselves?

Rationalisation of data is not a new concept in the health service. For example, we have had *Hospital Building Notes* and *Technical Memoranda* for some years. Engineering Study Groups are working to extend the range of HSE sheets .We are taking all this work and adding to it from wider sources.

Rationalisation of methods

As with data, so it is with methods. Experience shows the many different methods used to achieve the same end. This became painfully apparent in the Harness work and led to considerable rationalisation of design methods for both Harness and Nucleus projects. Systems studies merely aim to consolidate and extend this. Probably the best example is *Capricode* which is widely known and used.

Rationalisation of techniques

The same picture appears here as with data and method. In Harness and later in Nucleus, where different parts of the design were done by different designers, there were found to be very many different methods of say, duct work sizing or arranging lighting layouts. The Harness experience was the foundations for Nucleus, but the resulting rationalised techniques are universally applicable.

There is absolutely no thought of imposing a grey uniformity over design work. The techniques are intended as a tool which the designer will use to contribute his own expertise and individuality in exploring options rapidly, economically, and accurately. In systems we aim to consolidate achievements and extend the scope of the work.

The approach must be multi-disciplinary; medical and nursing input especially is vital to success.

Benefits

The DHSS conducted a very exhaustive cost-benefit analysis before deciding on the programme outlined in the paper.

A few of the major advantages which we see are:

Saving in scarce staff resources: for example, planning doctors and nurses;

Saving in time. A typical hospital currently takes about ten years from inception to accepting patients. The system's work should reduce this time; rationalised techniques using computer aids for the more tedious tasks will improve the accuracy of the work;

The work will enable the large amounts of data used to be found and handled easily and readily;

The system will co-ordinate and make more use of the valuable feedback of information received by DHSS from the NHS.

Capricode

Capricode is an adapted version for the Health Service of a national approach to building projects. The document is familiar to all in the Health Service and is the foundation upon which we are building the system's work.

Figure 4 shows the main Capricode stages together with the further 'box' for Operation and Maintenance because Capricode, and the RIBA Plan of Work on which Capricode is closely modelled, stop at the evaluation stage and do not cover the entire life of Health buildings.

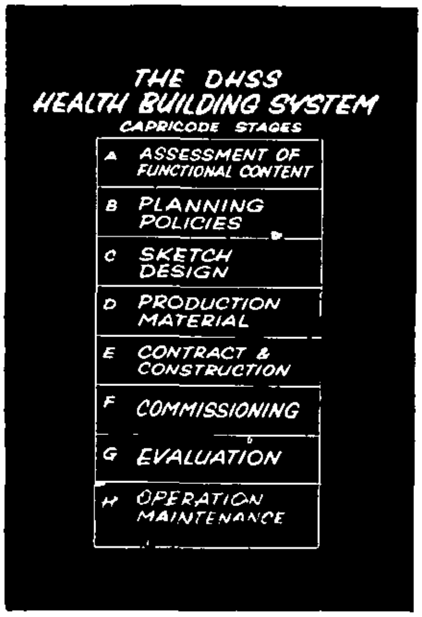


Figure 4.

To illustrate the principle of the system concept, it is, perhaps, best to examine a hypothetical planning procedure for a hospital in the form shown in the chart.

Computer Aids and their place in Systems Work

First, briefly, the concept of the use of the computer in this planning. One principle is fundamental. The machine makes no decisions. It will provide information on request, do routine calculations on request, but *always* produce the answer for inspection, acceptance or rejection. Computers are not the System. But they are a useful tool and help to illustrate the system.

Figure 5, built on Capricode is a panorama of the System approach being put together at DHSS. It consists of four streams linked into a flow chart and showing computer use where appropriate.

There are two main categories of computer application. One is purely as a reference library: for example, to store the current cost of steel pipe. The other is the manipulation of information fed into the computer. An example would be the production of a 'cut and fill' analysis from given data when a building shape was placed in the machine.

The Planning Example

To return to our example, first the Project Team will need to assess the need for the hospital. Local population figures must be set against national planning norms for hospital provision against population.

These last norms would be held in the computer data bank and in the long term this might be used for the manipulation and matching of norms with local requirements.

With this information the planning team can then decide the need for a hospital, and the size and mix of departments.

The project team then need a site or sites for the architect to try various shapes to contain the size and mix of departments required. The computer will aid in such tasks as 'cut and fill', relative revenue and capital costs assessments, etc. At this point we plan to put the site and building co-ordinates into the machine. Henceforward, the building is recorded in the com-

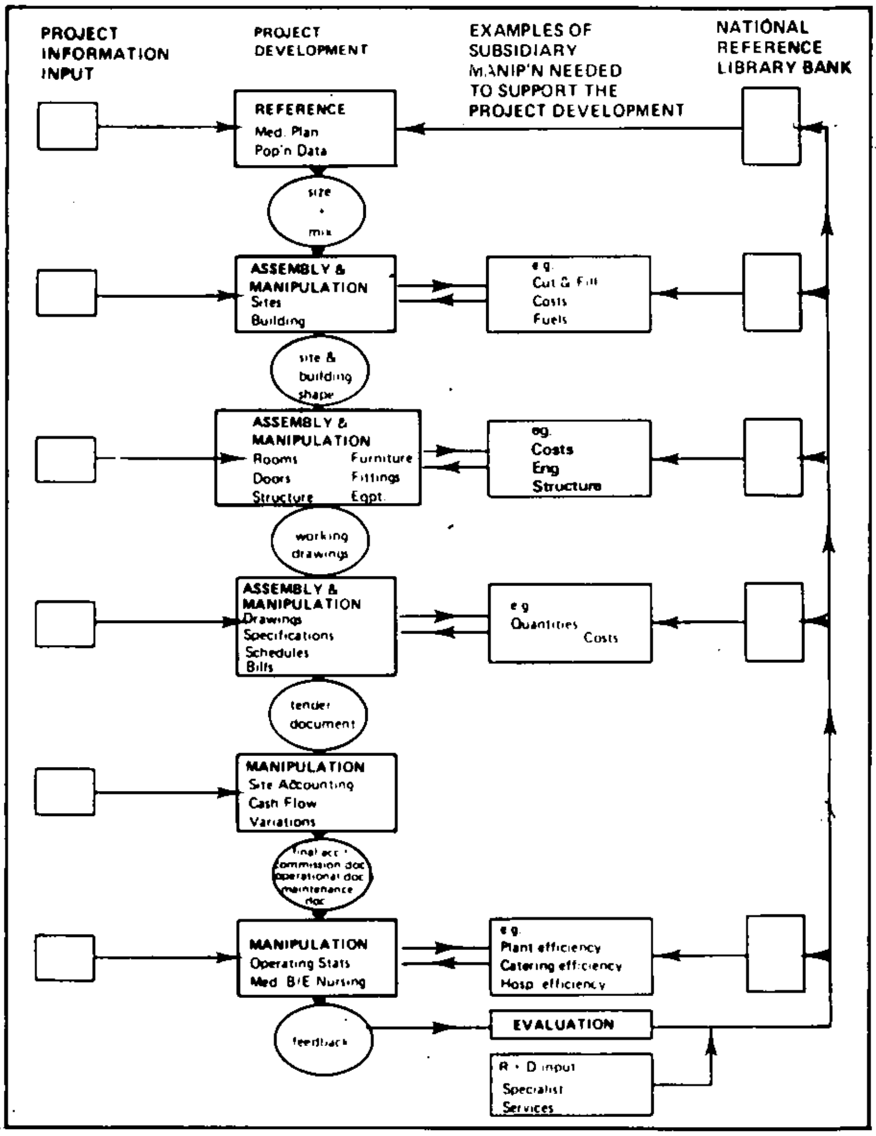


Figure 5.

puter and can be manipulated and reproduced as drawings or figures at will. The machine will print-out results of various combinations of site and building for the team to decide which option to follow.

This concept may seem to be science fiction, but many of the techniques are with us now, waiting to be applied.

Given the chosen site and shape the modelling of the building can then be done inside the machine. In this process the computer will make many manipulations for us eg, with a given layout, the engineering services can be routed by the user, be co-ordinated and sized by a manipulative process in the machine. All the computer operations will be printed out for judgement by the user, who can repeat each step of calculation until an acceptable result is achieved, when it can be incorporated in the main model.

The end result of this process will be a matched set of architectural and engineering drawings suitable for tender stored in the machine and available as prints. From these it is clearly an easy step to obtain full tender documentation.

With the whole building modelled in the computer, construction, progress and costs can easily be monitored. Commissioning manuals and building maintenance schedules can be produced easily and cheaply.

When the building is completed the model will be available to help with planned preventive maintenance, assessment and reporting on running costs, design efficiency-in-use studies, and for planning of later additions. The system is seen as being applicable to all work, not only major projects.

It should be pointed out that the picture envisaged is an immense landscape. This paper and its companion papers cover only parts of the whole design.

The System

The example above made use of and showed the place of computer aids to a great extent. It was written in this way both to show how computers could be used and, primarily, as a simple method of illustrating the System in an advanced form.

It should be emphasised again that we are not developing a computer system but a system in which computers can be of great help.

At present, the System is being developed to operate manually and the computer aids will be developed, as required, to supplement manual methods, when this replacement can be shown to be economical.

The System is being developed in stages roughly analogous to those shown on *Figure 4*. The system stages relate to the Capricode ones mainly because we are charged to work initially in this area.

We are all aware that any design process cannot be chopped into neat segments, that the lines between the stages will necessarily be blurred, and even that the stages may not always be in the same order. The better the system is designed the more orderly the progression that will be possible.

The system is seen as having three levels.

Level 1

This is a 'reference library' or 'data base'. Information is classified, and is that which applies nationally to all hospitals. For example, it would contain details of statutory regulations, and Factories Act and Health and Safety requirements. It would contain the whole manufacturers' data base.

Level 2

This is where the major activities take place: some of these computer assisted, some manual. For example, whole hospital policies and design, preparation of bills of quantities, project construction.

Level 3

This level contains the operations needed to complete the project. For example, building/engineering co-ordination, handover recording and scheduling, engineering services commissioning manual, maintenance scheduling.

Programme

The work is one of evolution extending through Harness to the present day. Some considerable parts such as the Manufacturers' Data Base and the Activity Data Bank are already in day-to-day use. The resources available limit the amount of development. The following areas of work are included in the programme up to 1981.

Development Control Planning, Site Works and Foundations: To the stage where these can be used by RHAs.

Building Design, Engineering Design, Engineering Costing, Design Cost Planning Checking: To prove Methods and collect data needed, and implement these for manual operation.

On completion of this work, the position will be assessed and approval sought for further development if appropriate.

Exhaustive cost benefit analyses have justified the work to this stage and indicated that this is the best order in which it should be undertaken. The analyses showed the work was viable with a building programme of £60 million new starts suitable for system application in 1981. It showed the greatest benefit from completing the earlier parts of the system, that is in development control planning which is short of data and relies on scarce staff resources.

Great benefits were also shown in the detail area of design, but with larger costs to obtain them, together with some degree of uncertainty in the process.

Progress

Much material has been assembled and some is now in use.

Process Executive Group Document II
A large volume describing the entire system as seen at present has been put together. It describes each item of a complex detailed network and identifies future development .A working document, it is confined to DHSS at present.

Manufacturers' Data Base
This document has been in use for some time. It is an ideal basic building component capable of extension and conversion into the system as envisaged.

Activity Data Bank
This is also a basic building brick for the system. At present some 2,000 data sheets are in use in planning hospitals. Many here will be familiar with the precise room specifications which form the output for these activity data.

Mechanical Reproduction of Drawings
Both architects and engineers have devised an operational method of digitising drawings and reproducing them from the plotter. This is one necessary step towards machine-aided design.

Co-ordination of Engineering Designs
Some very interesting work is being carried out to develop a method of ensuring automatic co-ordination of engineering services with each other and with the building: this work is well advanced.

Engineering Components
The services co-ordination and modelling work has thrown up the need for an engineering data base along the lines of the manufacturers' data base.

Engineering components have been reduced to a rationalised range, now being printed, for the use of the system or by manual drawing offices which care to use them.

Symbols
A volume of engineering symbols in rationalised unambiguous form suitable for computer reproduction by drawing plotter has been produced. The latter requirement meant careful design and the 'stalk' concept for application to drawings.

Technical Briefs
Work done for Harness, later modified for Nucleus, produced Neutral Engineering Briefs. 'Neutral' here means 'not related to a specific job and therefore available for any project'.

These technical briefs are available now, and are based on Building Notes, Technical Memoranda, HSE papers, the IHVE guide, the IEE regulations and other such material: the briefs form part of the system.

Zoning and Spacing
Work done for Harness and subsequently Nucleus showed the need for a rational space allocation for engineering services. A system of allocated zones and layers for each service has been devised and used successfully.

'Zoning and spacing rules' are available now for project use.

Capricode and DCAG
Capricode and the Departmental Cost Allowance Guides have been in use for some time. Although these have been refined from time to time, the systems work may point to further refinement.

TRAM
This is a 'Traffic and Activity Model' computer programme. It is capable of modelling the operational policies and operational statistics of a hospital.

'NETSYS'
This is the computer programme which applies TRAM to any given layout of hospital departments. This measures inter-departmental traffic, and suggests placings for stairs and lifts.

Hospital Building Notes, Hospital Technical Memoranda, HSD Sheets
As mentioned above, these are seen as building blocks of the systems approach. They take their place here with the other available pieces.

Conclusion

As the work continues the way ahead becomes clearer. The following conclusions can, however, be drawn at the moment:

First: We are spending and will continue to spend large sums of money on the Health Building Estate in the foreseeable future. We must always be vigilant for any means to spend even more wisely.

Second: A nationally co-ordinated approach to our buildings, enveloping their total life, will pay big dividends in better design and greater economy.

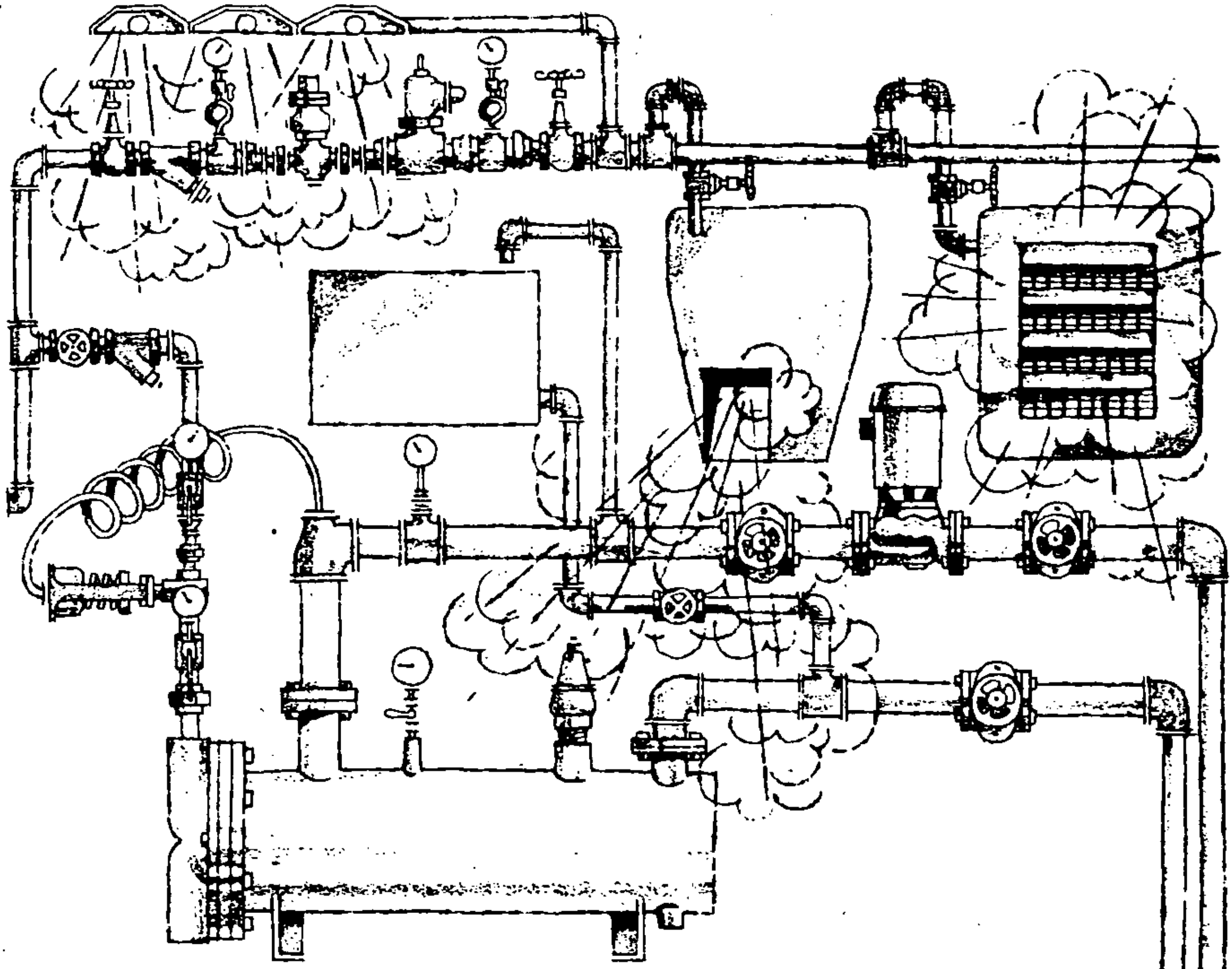
Third: The systematic approach must be neutral and as flexible as possible to give greatest advantage.

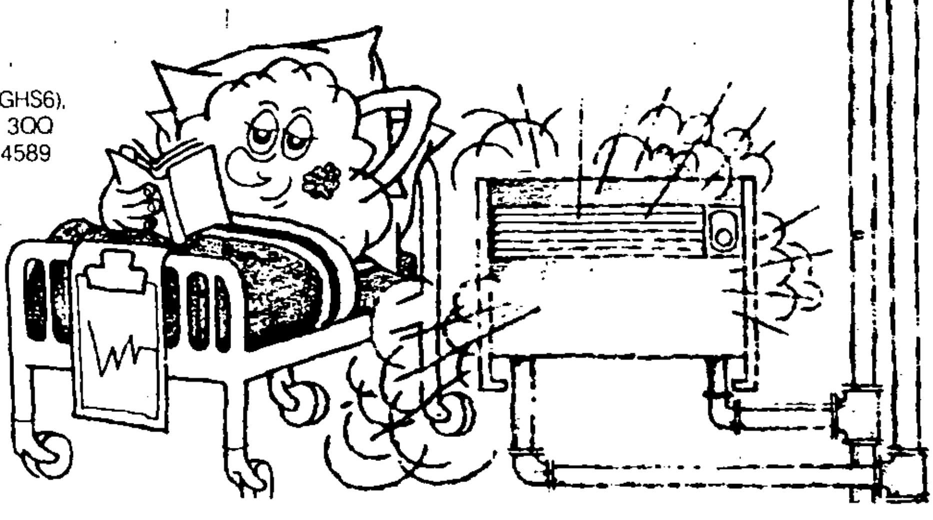
Fourth: Computer aids can be developed to assist a manual system with many of the more routine functions with consequent economy and better job satisfaction.

Fifth: Computer aids cannot in any way carry out original design work or make judgements.

Sixth: Work is well under way and even now yielding worthwhile results.

Lastly: By 1981, much more valuable material will be available.





The DHSS Health Building System

Space does not permit a full description and presentation of the identified design aids that will eventually be incorporated within the System for Health Building, so this paper concentrates on one application, which will serve as an example to enable some of the objectives of the system to be understood.

Its Engineering Components with Particular Reference to the Design and Commissioning Sub-Systems

B. C. OLIVER CEng MIMechE MInstR

Introduction

Before going into detail this paper covers some of the more important aspects of the background to the concept of the System for Health Building, and how the design aids that are envisaged will fit into it.

The Benefit to Design

The benefits that the system can provide to the design and production documentation stages of a project programme will largely result from manual and automated aids, and from improved management and control. Design aids that can be provided within the system will help to remove the mundane but expensive elements of the work, leaving more time for the design staff actually to design and optimise the project. Management and control will be improved through better co-ordination, and by the more rapid access and retrieval of data which can be stored in an organised and consistent manner between different projects and by different organisations. Both of these benefits should lead to higher quality production documentation.

The Main Needs of the System

A standard design, however good, must have a limited application in a country like ours, where there is no consistent pattern to medical care. What is needed, therefore, is a flexible design system that can enable the user to design what he wants. Such an advantage can only be provided by a system that is based on the smallest elements which make up the building and engineering designs; namely the building and engineering components. To achieve this flexibility it is necessary to ensure that the user can employ any component that he considers acceptable. However, there is advantage in the preparation and use of a component catalogue made up of an acceptable and rationalised range of components, to which additions or from which deletions can be made in a controlled manner. An additional advantage of this approach is that it not only facilitates the access of standard component arrangements, but that it also enables the user to re-use any previously designed non-standard assembly.

Secondly there is a need to define clearly the different tasks that the Engineer and his colleagues perform, both during the development of the building concept and during the subsequent detailed design of the building and its services. It is also necessary to analyse the way in which individuals operate, and to ensure that the right person makes the appropriate decision — thereby improving inter-disciplinary co-ordination. In this connection, the speed of processing, and the organised project data file that the system can offer, is of tremendous potential.

To benefit from this potential the system will incorporate aids (or tools) which enable the particular user, in this more organised approach, to do what he is required to do with the minimum of recourse to his colleagues in the Team. The objectives of these aids, must therefore be kept as limited as possible, and must be founded on using them over and over again. Thus the project solution can be refined, but with the capacity for maintaining co-ordination between the progressive stages. The aids must also be constructed to enable the user to exercise complete control over areas of judgement and innovation.

Having once identified the aids against the overall requirements, it is then necessary to define clearly what data each aid requires, whether from previous work on the project or from national and regional standard catalogues, or both, and identify what data needs to be passed on to future work. To this end, a distinction must be made between project data — the data actually used in the project — and that contained in the neutral file, from which the project data is selected and assembled. *Figure 1* illustrates how the aids and the neutral and project data files combine to give a coherent but flexible approach to the tasks that each aid is required to perform.

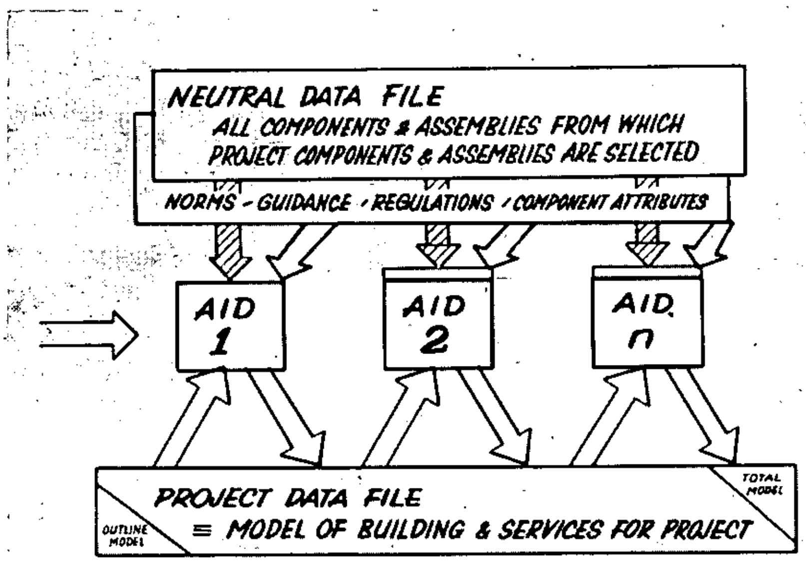


Figure 1. Neutral and Project Data File.

The Design Process

Dealing specifically with the design process, the Engineer's role can be divided into two distinct categories, one associated with the design of the building, and the other associated with the detailed design of the services, on a site and within a building envelope once these have been defined.

To identify the types of aids that can be provided the basic functions involved in design must be considered. *Figure 2* illustrates these basic functions and shows how they are progressed from the 'idea' to the 'accepted' solution. It can also be seen that only those functions of model construction, assessment and evaluation that do not have a high degree of conception or decision-making can be automated. For example, it can be appreciated that drafting aids supported by calculation procedures can assist with these functions but they must however be individual, and be linked by human intervention, to enable decisions and judgements to be made.

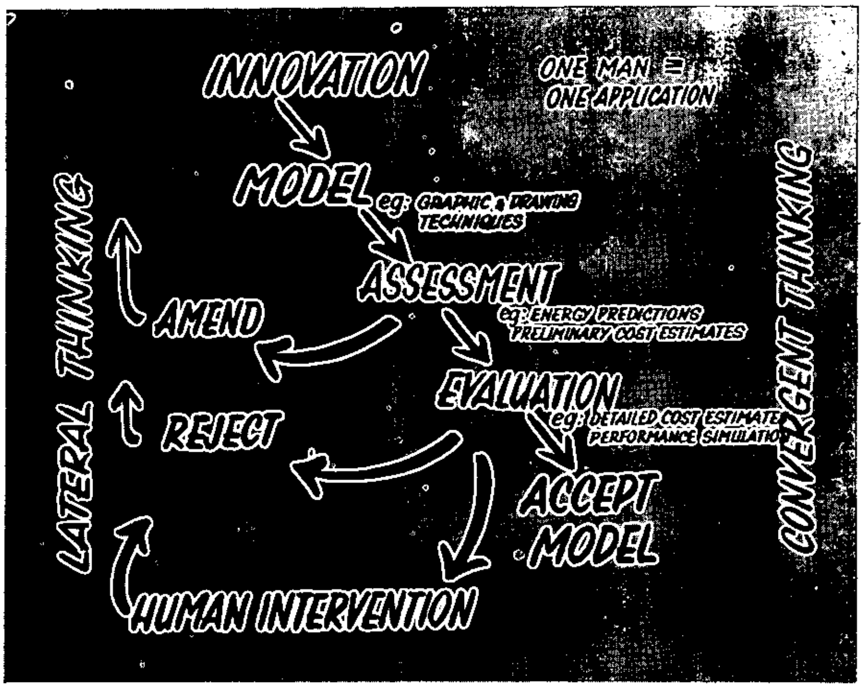


Figure 2. Basic Functions in the Design.

The Role of Computers

It is easy, even today, for people not directly involved with computers to hold them and their technology in awe. Computers are however only tools, and should not be allowed to dictate the process. Bearing these comments in mind, an attempt is made below to dispel some of the mystique.

Computers are invaluable in the construction of models (mathematical representations of processes or objects) and in the evaluation and assessment of such models, but they cannot make decisions or judgements, or replace man's innovatory qualities. Beware of computer packages which purport to be automatic, or to carry out optimisations or provide an integrated result. Such tasks are impossible for a machine without human intervention — and even then, only intervention by the right user.

Computers need to be programmed in very close association with the user, and by far the best programs are those which perform the task in much the same way as man would himself, had he the time to perform the task thoroughly. In this connection a great deal of benefit can be derived, for manual application, from the development of the detailed methodology necessary for eventual computer implementation.

It is important to realise, therefore, that computer methods are equivalent to, and where possible based on, manual methods, and that a computer is neither a genius nor an idiot — it simply has a facility to calculate extremely quickly and accurately.

The major objective for the building professional associated with computer technology is the need to record in detail the manual methods employed in the tasks, many of which are performed by the designer in a subjective or even subconscious mode of working. It has been the absence of this methodology in adequate detail in the past, and the use of computer specialists instead of professionals specialising in computing, which has often led to the development of software which has failed to produce what the user really needs.

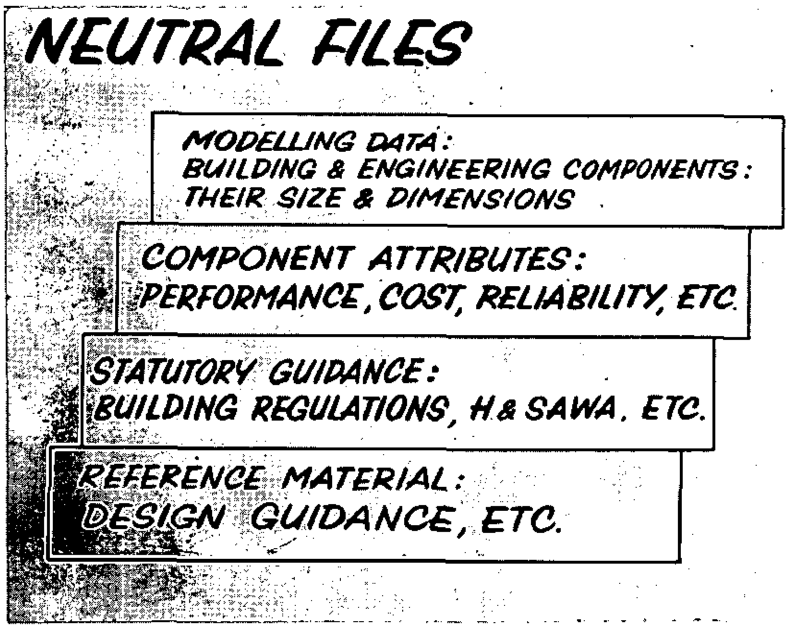


Figure 3. Neutral Files.

Data

If the system and its applications is likened to the network of tracks in a *railway system then the* data becomes the rolling stock. It is obvious that one is of no use without the other, and the importance of the data cannot be denied since it is the constructive element. However, it should be appreciated that a limited number of trains can run on a completed network of railway track, whilst a comprehensive service cannot be provided on an incomplete network. A complete system can therefore be designed around a rationalised but not necessarily complete set of data so long as the scope, range and form of all data is identified and taken into account.

Referring again to *Figure 1* it can be seen that the data can be categorised into two broad groups.

1. The first group is classified as the neutral data file, and is the ubiquitous group of components and information from which the user selects what he needs in order to meet his objective. This neutral file can be likened to the parts catalogue listing all the components that, say, British Leyland may or may not have in stock for all the vehicles they have ever produced. This of course is not a complete analogy because it only refers to the component element, but it does equate for the purpose of this description.

2. The second group of data is that held specifically for the project, and is called the project data file. Continuing the analogy, this file would hold the actual parts used for the construction of a particular motor vehicle, the number of each required, and where they are located on the particular vehicle. Again the analogy is not entirely complete since the project file would also include the less tangible data relating to commissioning, maintenance and operation, etc.

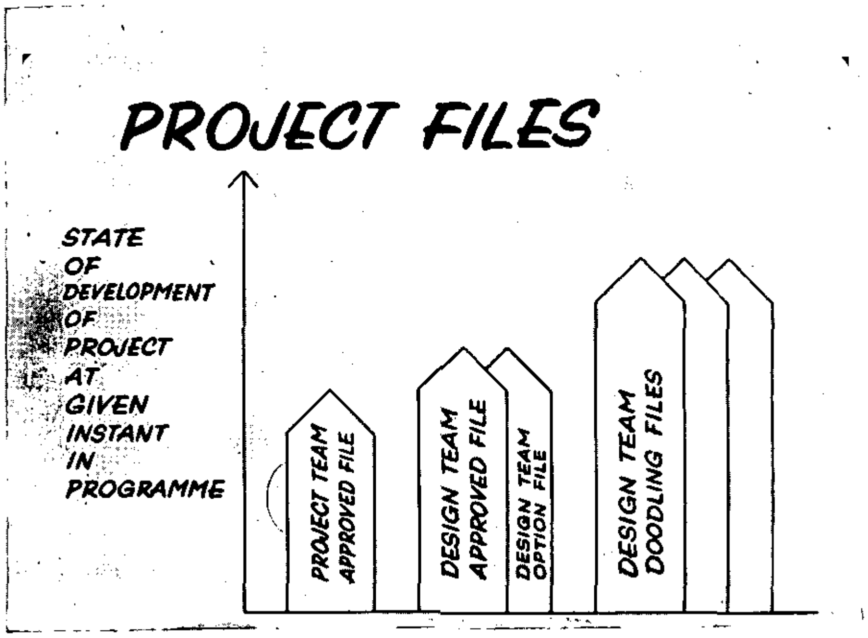


Figure 4. Project Files.

Summarising therefore:

The neutral file contains the complete range of data available to be used by all projects.

Whilst:

The project file contains the data actually used for a project.

Figure 3 illustrates the many types of data contained in the single neutral file. The file can, however, be broken into sub-sets for the use of specific general purpose aids, and this has advantages if data is required by only one aid. Furthermore data separation in this manner is necessary during the development of the aid, and has advantages if the aid is to be made available in a stand-alone mode separated from the system.

Figure 4 illustrates that the project file consists, on the other hand, of many different files, not only for the individual projects but also for the various versions of the same project. As the development of the project progresses to a successive state of acceptance so these project files are reduced, but there is always a need during the evolutionary stages of both broad and detailed design to have several project files to compare and optimise.

Aids in the Building Process

It has been explained that the system can be seen as a logical but flexible process held together by the project data files, and drawn on by separate but interrelated general purpose aids. To summarise the constituent parts of the system are:

i. Logical process network (from building conception through to operation).

ii. Identification of repetitive processes.

iii. Development of aids to assist repetitive processes.

iv. Integration through provision of data files.

The multi-disciplinary team engaged on this work have already identified the need to develop more than fifty aids to assist repetitive parts of the design and production documentation processes which are carried out by Architects, Engineers and Quantity Surveyors, but in the long term there is no limit to the number of aids which could be developed for manual, desk-top calculator or computer implementation. Of the total aids so far identified about twenty would benefit considerably from computer implementation.

Engineering Aids

On the engineering side aids to assist in the following areas of work have been identified as priority requirements. For convenience the list has been divided into two groups. First are those which are appropriate to the design of the building, and second, those that are concerned with the detailed design of engineering services within a specified building. The aids that are initially intended for computer implementation are indicated below with an asterisk.

Those aids associated primarily with the initial design of the building are:

***Engineering Cost Allowances**
***Preliminary Engineering Cost Estimates**
***Services Assessment and Verification of Energy**
Contract Procedures
Management Control Planning
Engineering Policy.

It should be stressed that these aids are identified as priority user requirements and will wherever possible use existing techniques and software.

Indeed it is DHSS philosophy that any package shall, in the longer term, if it is required by a user, be capable of interfacing with the System for Health Building.

At the detailed design stage as defined earlier, there is a priority need for the development of the engineering aids identified below.

Engineering Briefs
Wall or Partition Component Assemblies
Drawing Office Procedures
***Services Co-ordination and Modelling Program**
***Electrical Cable Routing**
***Design of External Services**
***Detailed Engineering Services Cost Estimates**
***Services Calculation Simulation and Scheduling**
***Engineering Specifications**
***Cost Schedules**
***Commissioning Manuals and Maintenance Manuals.**

One of the most complex and technically interesting of these aids is the Services Co-ordination and Modelling Program 'SCAMP'. It is this aid which is briefly described below, and which it is felt will solve many of the problems with which Engineers are all too familiar. It will also serve as an example of the philosophy behind the System for Health Building.

SCAMP

SCAMP is a general-purpose or utility application, which will enable the user to build a fully co-ordinated physical model of the engineering services, as he wants, and at any stage in the design, using as basic input the building design and the structural design from the project file and the engineering components from the neutral file.

The name SCAMP contains the essential features of the basic package which are:

S for Services, indicating that the package covers all the engineering service carriers used in the building services industry, eg: ducts, pipes, conduits, trunking and cable trays, etc.

C for Co-ordination, which is physical co-ordination, meaning that the package will record the position of each component in three dimensions as it is located in the design space. It will interactively tell the user if the space required is already occupied by another building or engineering component.

M for Modelling, which is the main feature of the package, and refers to the capability of representing the full spatial requirements in three dimensions of both the building and engineering components, held in the computer in a mathematical form. The best analogy is to consider that the computer can hold a detailed and even dynamic scale model of the proposals within the central processor or on the backing store of the computer.

P for Program, which identifies that the package is intended for computer implementation.

To gain a fuller understanding of the program we should next look at the more involved aspects that some of these features contain.

The modelling techniques indicated by *Figure 5* will enable the user to convert, or accept from compatible input, the Architect's building form, and structural details as are relevant to the particular stage of the project development, ie: line diagram, detailed design etc. It will also enable him to access a comprehensive range of component details, or to input special components of his choice once he has these adequately defined.

An added feature is the possibility of adding service zones and spaces (*Figure 5*) to control the general location of services within the total space available. In the manual mode the major advantage of zoning and spacing is the discipline it imposes during design, minimising physical co-ordination problems. However, whilst SCAMP does away with the essential need for this discipline during design, there are still benefits to be derived during design and particularly in the future stages of commissioning, maintenance and the upgrad-

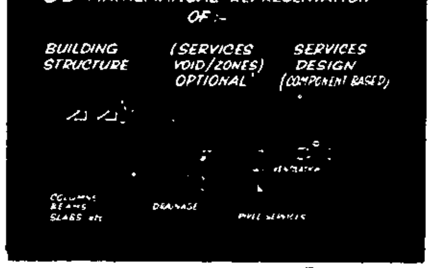


Figure 5. Location of Services.

ing of the installed engineering services.

The three-dimensional modelling techniques build on component information which is held at the lowest level in such a way that the final dimensional form can be retrieved and viewed from any position and at any scale, so that any two dimensional drawing can be reproduced in planometric or isometric form and in any sortation. Furthermore, other attributes can be held for each component, so that subsequent, relatively simple, data-sorting applications can be developed using the project component file to enable the determination of such things as cost, performance, etc.

Physical co-ordination is achieved by comparing the final geometric form of each component against any previous design description input as it is added to the engineering model and placed within the building and structural envelope. Through rapid interactive response the program will provide the following three types of warning for the user (as illustrated by *Figure 6*) all of which he can override if he so desires:

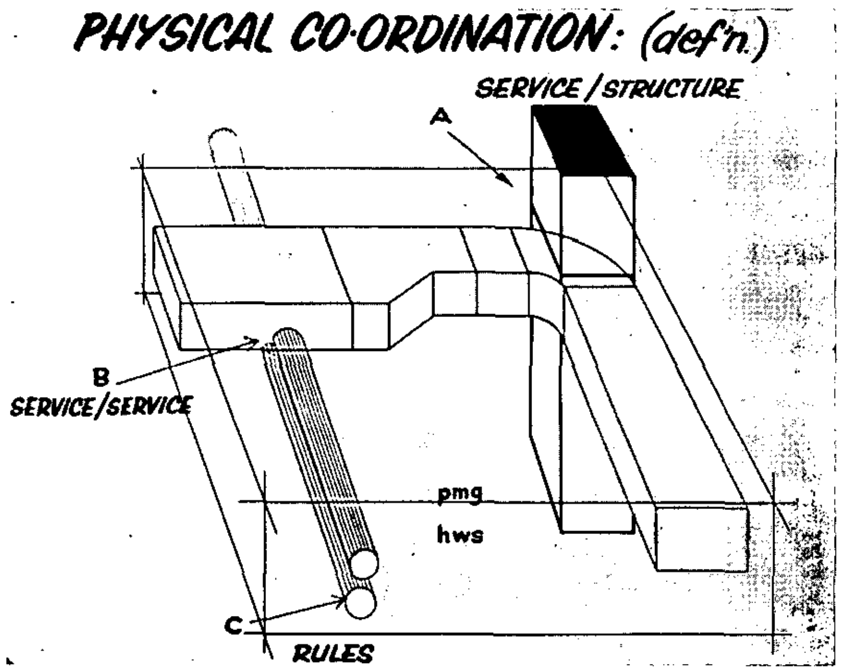
a. That the service component being added is in conflict with the structure or a building component.

b. That the service component being added is in conflict with a previously modelled service component.

c. That the position of the component does not comply with previously specified rules, eg: that the component is in the wrong zone, or it is too close to another service bearing in mind safety (eg: Oxygen/HWS) or that there is insufficient access space around a valve or mixing box to facilitate commissioning or maintenance.

An important aspect which has been considered in depth in the development of this package is the user/machine interface and this aspect can be illustrated very briefly by outlining the typical use of the system. The rudimentary parts and their working relationship for a typical work station are shown on *Figure 7*.

The work station consists of a digitising tablet, keyboard and visual display unit linked to a dedicated mini computer of about 64,000 words in size, with direct and longer term access to magnetic disc or tape stores holding the neutral component data base.



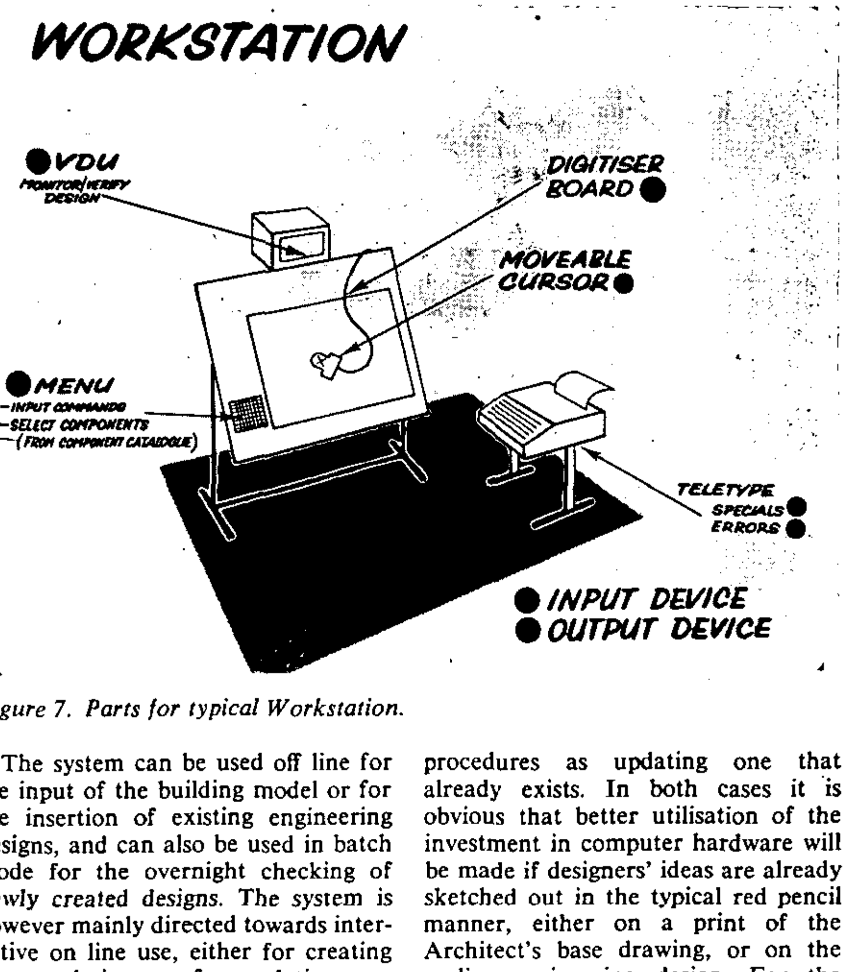


Figure 7. Parts for typical Workstation.

The system can be used off line for the input of the building model or for the insertion of existing engineering designs, and can also be used in batch mode for the overnight checking of newly created designs. The system is however mainly directed towards interactive on line use, either for creating a new design or for updating one already in existence from an earlier stage of the same project or another project. Essentially, creating a new design involves the same methods and procedures as updating one that already exists. In both cases it is obvious that better utilisation of the investment in computer hardware will be made if designers' ideas are already sketched out in the typical red pencil manner, either on a print of the Architect's base drawing, or on the earlier engineering design. For the purposes of illustration it will be assumed that an update is to be carried out.

The main means of in-putting and

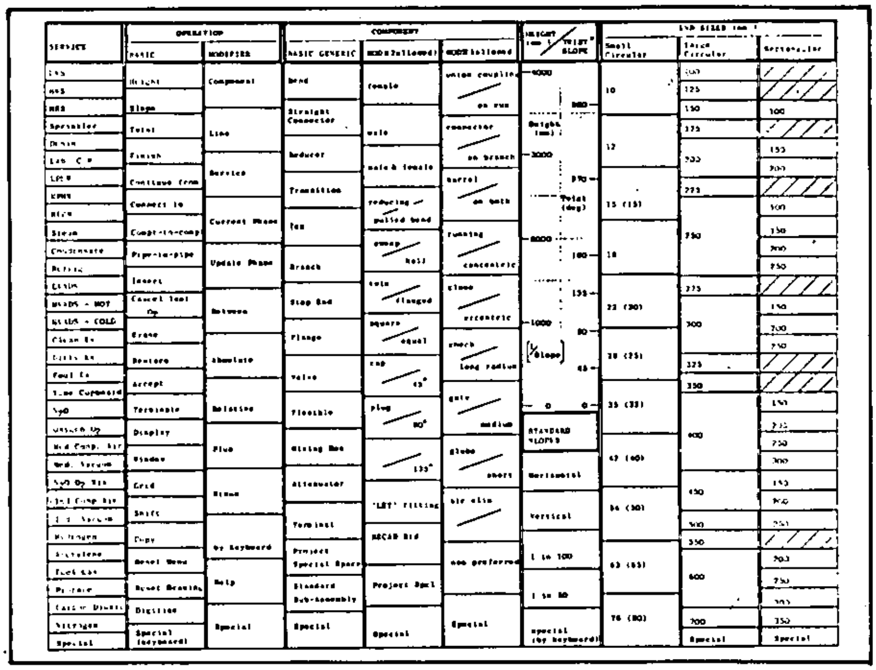


Figure 8. Type of data held on the 'menu'.

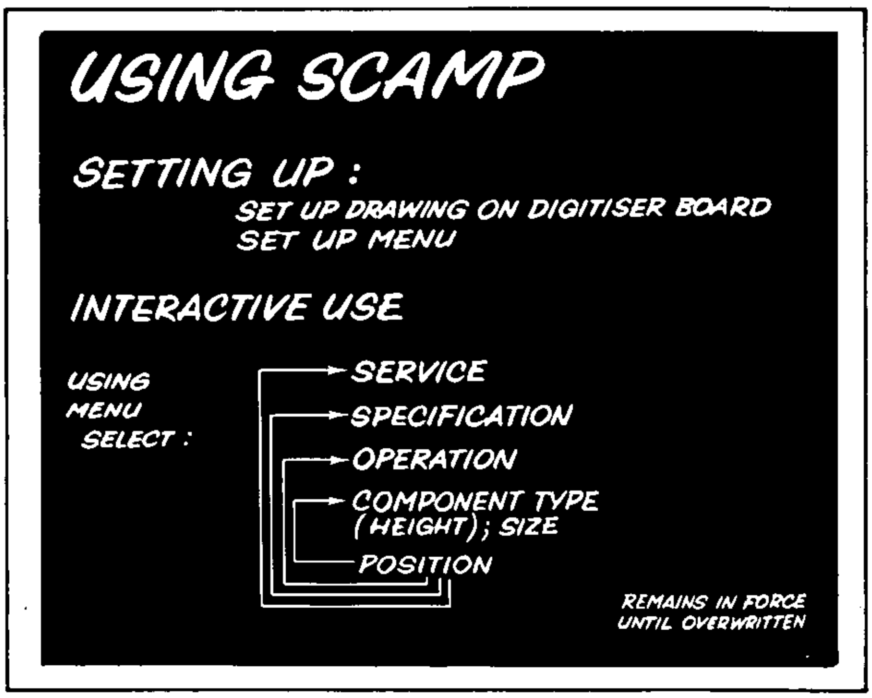


Figure 9. Setting up.

manipulating the engineering component data will be via the 'menu' and the 'digitising cursor' as illustrated in *Figure 7*. *Figure 8* shows in more detail the type of data held and typical implementing instructions on the menu. The user initially locates both the menu and the service drawing to be updated on the digitising tablet, and identifies their corner positions to the computer with the aid of the digitising cursor. (All the following sequential operations are likewise carried out and registered to the computer by depressing the record button on the digitising cursor). The user will then identify to the machine the engineering service, to a pre-defined specification, upon which the update is to be carried out, eg hot or cold water. Next, selection of one of the 23 operations is made which together with 13 modifiers will enable all the normally required functions to be carried out, eg add component, delete line or height absolute, etc, etc. In this short paper a fuller explanation of the operations possible cannot be described, but there is a comprehensive selection which minimises the need for keyboard input.

Having consulted the component catalogue and using the menu, the component can be identified and selected. The slope, height (third dimension) and size only needing to be re-specified where a change from the preceding component is required. The designer then places the cursor in the appropriate position on the drawing and, once satisfied that the location is correct, depresses the record button which relates the x and y co-ordinates of the component to the computer.

For example: In a hot water service application, *Figure 8*, the absolute height and slope must first be specified. Next, the component itself will need to be defined using appropriate modifiers to describe it adequately, together with its size. Finally the x and y co-ordinates will be relayed to the machine. An echo (cross lines or flashing spot) on the visual display unit screen will enable its position and the already completed design to be monitored by the operator.

Continuity and compatibility checks are performed by the computer program and errors are fed back to the user as a result of illogical or incomplete instructions. During any stage errors are corrected by over writing or, if a component has been wrongly placed, by the use of the delete function on the menu.

Rogue or new components, not included within the component catalogue, and non-standard instructions employing the high level language upon which the menu is based, can be input via the tele type.

The menu is however designed to perform all but a very few of the normal functions required and as a consequence the keyboard should rarely be needed.

The interface between the engineering designer and the computer is designed for easy use, and to present the minimum retraining requirements for the building services design engineer and draughtsman. It will be seen from the description that the way in which the menu is structured means that only the aspects that have changed need to be specified at any given time (*Figure 9*). The addition of components therefore is very rapid indeed, in its simplest form reducing to 'what it is' and 'where it is'.

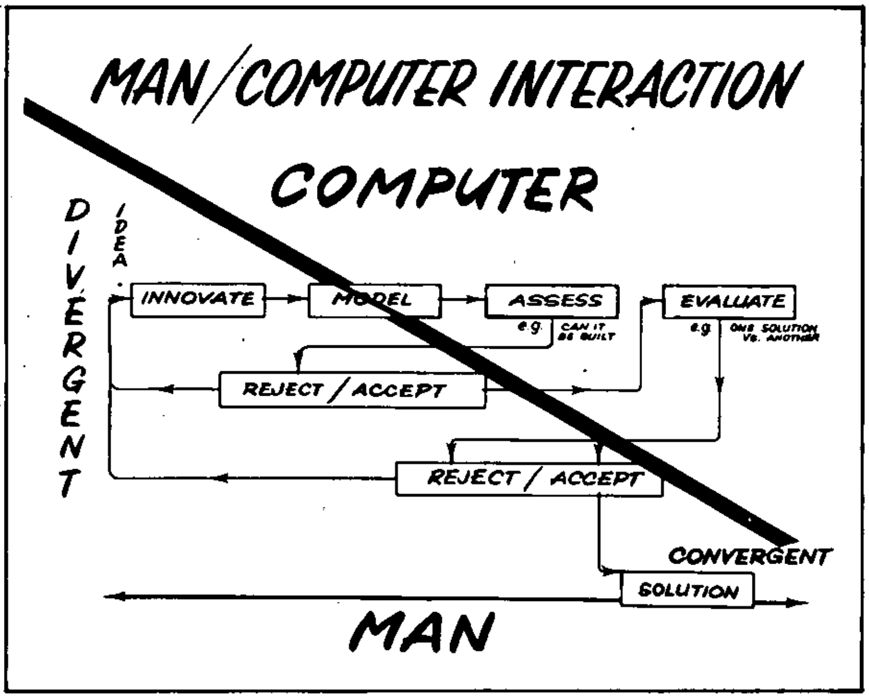


Figure 10. Man/Computer Interaction.

This interface will enable the operator to exercise absolute control and judgement: an essential feature as described earlier in the design process. A repeat of *Figure 2* in a different form (see *Figure 10*) will show this better than a written description.

It is worth stressing that the form of output can be varied to suit the user's need. It will be particularly important for the user to note and record the status of the input for inclusion on the output drawings because the system will for many stages of development be capable of producing higher quality drawings than the input status warrants. If, therefore, notional sizes are given to components at an early stage then drawings could look for all intents and purpose the same as a fully detailed production drawing.

It is also worthwhile amplifying that detailed drawings, or detailed insets such as those shown in *Figure 11* on smaller scale drawings, can be provided to any degree of detail and to any drawing convention. The rapid preparation of isometric inset details will be of immense value to users of the system.

Summarising: SCAMP is a component-based computer package which models, co-ordinates, and enables detailed drawings to be prepared easily. It is, however, not a substitute for good design. This is left firmly in the hands of the user. It also enables further computer applications to be developed easily to perform the many subsidiary and arduous tasks which are currently very time-consuming and expensive to perform.

With the aid of SCAMP the user can:

i. Ensure physical co-ordination and reduce variation orders.
ii. Improve quality of his output drawings and documents.
iii. Prepare rapidly drawings throughout all stages of design giving rise to a serial working process with his professional colleagues and obviating co-ordination problems with Architects and Quantity Surveyor.
iv. Iterate design more frequently using different parameters to provide a more optimised design.
v. Rapidly update drawings and other documents to accommodate the inevitable changes to the project data.
vi. Facilitate a rapid interface with evaluation packages for costing and duct and pipe sizing etc.

The Engineering Component Catalogue

Before looking at the potential offered by the additional computer aids, a brief mention of the engineering components which are an essential part of the neutral engineering data file for the basic system would be worthwhile.

The basic SCAMP aid requires only the material and dimensional description of the components, and is novel because it will accept a single variable, namely component size, against each specification and component type, the other dimensions being held as attributes of the size. *Figure 12* shows the type of information held in the manual component catalogue which the user will need to have on hand when operating the system.

As implied earlier it is the component data base (that is the limited rolling stock in the railway network analogy) that restricts the initial use of the system. Consequently SCAMP, because of the limited size and range of components held in the prototype component catalogue, will initially deal only with those services within the context of departmental and room service distribution systems ie Engineering services levels 1 and 2 shown below:

1. Room level — Building and Engineering Assemblies.

2. Department level — Distribution of services within building compartments.

3. Communications level — Service distribution to departments (Internal/External).

4. Whole Hospital level — Site Services (Externals).

Extension of the component catalogue will enable SCAMP to be used in the internal/external service areas of the building (level 3)

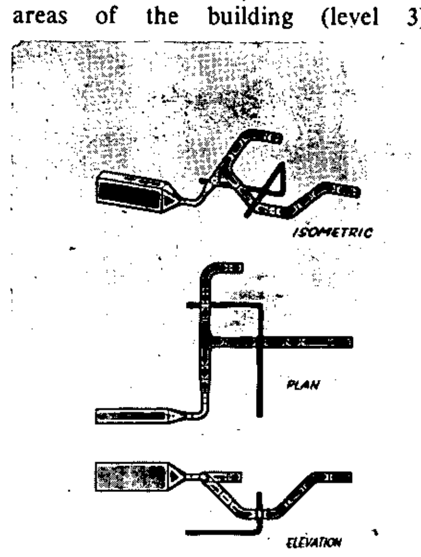
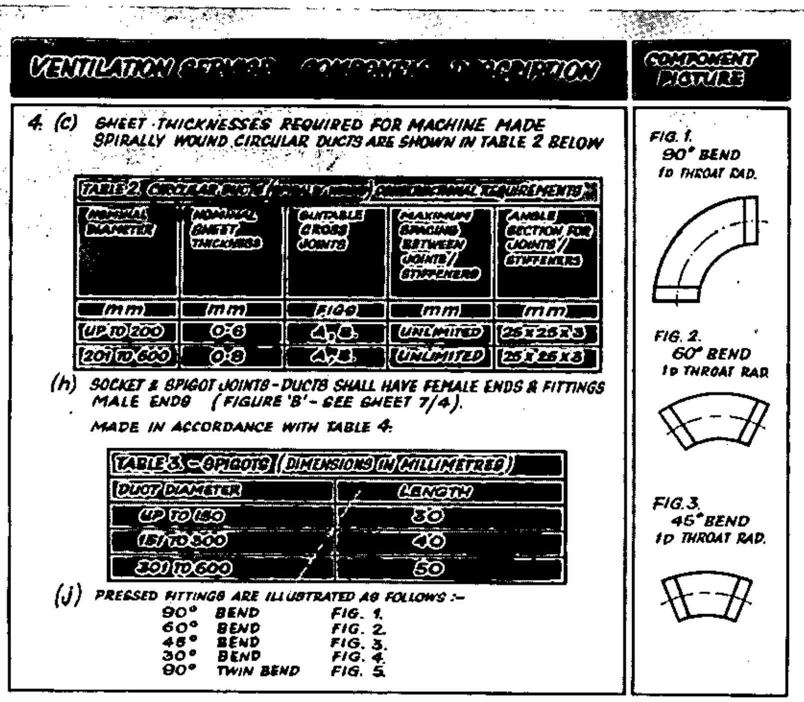


Figure 11. Detailed insets can be provided.


VENTILATION

COMPONENT PICTURE

4. (c) SHEET THICKNESSES REQUIRED FOR MACHINE MADE SPIRALLY WOUND CIRCULAR DUCTS ARE SHOWN IN TABLE 2 BELOW

TABLE 2 CIRCULAR DUCTS DIMENSIONAL REQUIREMENTS

NOMINAL DIAMETER	NOMINAL SHEET THICKNESS	SUITABLE CROSS JOINTS	MAXIMUM SPACING BETWEEN JOINTS/STIFFENERS	ANGLE SECTION FOR JOINTS/STIFFENERS
mm	mm	FIGS	mm	mm
UP TO 200	0·6	A, B.	UNLIMITED	25 x 25 x 3
201 TO 600	0·8	A, B.	UNLIMITED	25 x 25 x 3

(h) SOCKET & SPIGOT JOINTS - DUCTS SHALL HAVE FEMALE ENDS & FITTINGS MALE ENDS (FIGURE 'B' - SEE SHEET 7/4).

MADE IN ACCORDANCE WITH TABLE 4.

TABLE 3 - SPIGOTS (DIMENSIONS IN MILLIMETRES)

DUCT DIAMETER	LENGTH
UP TO 150	30
151 TO 300	40
301 TO 600	50

(j) PRESSED FITTINGS ARE ILLUSTRATED AS FOLLOWS :-

90° BEND FIG. 1.
60° BEND FIG. 2.
45° BEND FIG. 3.
30° BEND FIG. 4.
90° TWIN BEND FIG. 5.

FIG. 1. 90° BEND 1D THROAT RAD.

FIG. 2. 60° BEND 1D THROAT RAD.

FIG. 3. 45° BEND 1D THROAT RAD.

Figure 12. Type of information held in manual component catalogue.

although this will need a large increase in the number and range of component descriptions. The basic SCAMP will also enable sub-assemblies to be prepared for routing services within partitions and walls (level 1). (Such sub-assemblies are commonly referred to as building and engineering assemblies). The design of the External Services (level 4) will probably warrant an abridged and slightly different version of SCAMP. This has been identified as the separate application Design of External Services (DOES).

Further Aids Emanating from SCAMP

In addition to the preparation of data processing applications for the scheduling of components, their costs and the compilation of engineering specifications, the concept of holding a physical model will make possible the development of further very powerful applications, assisting commissioning, maintenance and operation. Those identified earlier as computer aids in the detail design stage all become relatively easy to interface once the basic SCAMP package has been developed.

For example, given that the component data base is provided with the performance attributes of each component, the model can be used as an analogue, not only to size and resize the component during design, but to assess accurately the controls and their setting requirements for both design and commissioning. Furthermore this can be carried out without the need to complete the large numbers of forms currently required by existing computer programs.

In addition, if component reliability information can also be compiled for the range of components and equipment held in the catalogue, then this can also be accessed to allow the reliability of the engineering installation as a whole to be predicted.

The major advantage in the maintenance and operation field will be the potential to supply structured and quantitative information about all the components and equipment that are installed in a building. To gain full benefit from this aspect it will obviously be desirable if the contractor and/or the client uses the basic SCAMP package for updating his documentation during construction, in order that as-fitted drawings and schedules are prepared quickly. A perfectly feasible proposition.

Programme

In the area of building design and evaluation emphasis has been placed on the energy requirements of buildings. Investigation is now being undertaken of the factors involved in preparing a suite of aids which could assess the total energy balance of a proposed building, from conception to its design formulation. Additionally, for application during the development control planning phase of a project design, the methodology for two further aids is currently nearing completion. These deal with the calculation of engineering cost allowances and the estimation of the actual engineering costs that the proposed solution may attract.

With regard to SCAMP we have for convenience broken the basic package into five component parts: the input method; the modelling; the preparation of drawings; the co-ordination of services with services; and finally the co-ordination of services with the building and its structure. The additional applications that have been identified in the current programme also include the scheduling of components, pipe and duct sizing, and detailed cost planning and control.

Progress

With regard to the development control planning applications dealing with energy and costs, a stage has been reached where the user requirement has been defined adequately, and other organisations, such as the Property Services Agency, are being consulted to see if use or adaption of existing computer packages is possible. During this process the user requirements and methodology already established will be consolidated and the manual guidance that already exists will be further refined and complemented.

With regard to SCAMP, the methodology for the input method and modelling technique has been established since the completion of the feasibility study in June 1975. During the year 1977 the pilot system was due to be working for input of data and for output of drawings. The next stage, which was due for completion early in 1978 at the time of writing, will deal with the co-ordination of services with services. By the middle of 1978 a position should be reached, having established the methodology associated with all aspects including the co-ordination of services with the building structure, to commence system design.

Given the go-ahead on this aspect, a completed and fully operational basic SCAMP package could be available by the beginning of 1981.

Once the methodology has been completed for the basic SCAMP package the more important of the additional aids dealing with scheduling, pipe and duct sizing, and cost planning will be concentrated on.

Again during this work it will be necessary to produce manual guidance which can give more immediate benefit to those engaged in the design and construction of hospitals.

Summary of Benefits that the System for Health Building Can Give to the Engineering Designer

There are very many advantages which can be attributed to such a system, and to a degree they all interact with each other. The following summary itemises ten of the more important:

i. The **design period can be reduced considerably,** client and designers willing, to a very much shorter period.

ii. The **scarce professional resources** necessary for the planning and design of hospitals could be **better utilised** by being concentrated on the cost significant areas of planning and design at the earlier stages when the site and building shape are formulated, rather than on preparing detailed drawings at the production stages.

iii. All design is a compromise and the **more options** that can be modelled and **evaluated** the better the result.

iv. In the same way **better cost planning and control** can be implemented and cost plans and schedules could be mechanically produced.

v. The quality of the design information and the degree of detail will be superior, and designs can be produced with **100% assurance of co-ordination** between components.

vi. The **quality of drawings and other production documents can be improved considerably.** Component schedules and specifications could be prepared very rapidly and be structured in any way that the user requires.

vii. By **using a common basis** not only for design, but also for the management of the project **the user will be able to evaluate and improve his methods.**

viii. The user will also be able to **collect and collate his data to a common standard** enabling him to more clearly evaluate the reasons for success or failure on previous projects.

ix. Timetables and critical paths will be more readily produced and appreciated giving rise to better **project management.**

x. Users can take any **existing design of building already machine processed and modify** them without lengthy digitisation, to the degree required so that they meet the planning and design rquirements, and can be repeated for other projects.

The DHSS Health Building System

This paper considers firstly the objectives of those involved in maintenance and operations, and indicates the size of these functions together with some of their historical background. It identifies some of the fields of work with which DHSS Engineering Division is concerned in connection with maintenance and operations, including reference to developments in the application of computer aids to maintenance management. The paper goes on to review the various relevant types of official 'guidance material', making particular mention of Estmancode and various points of current interest.

The Maintenance and Operations Sub-Systems

R. J. TUTHILL CEng MIMechE MIProdE

Objectives

Taken on a broad basis, the objectives of all of us who are concerned with the Works side of the NHS can be expressed in similar terms, thus:

The provision of the works services necessary to support the NHS in its functions for the health care of patients. These services to be provided at optimum levels of safety, effectiveness, reliability and cost within the constraints of statute, official policy, finance, available facilities and practicability.

Within our individual spheres of activity, we have our own narrower and more specific aims, but all of them should be directed ultimately towards those broad objectives.

The attainment of optimum levels of safety, effectiveness, reliability and cost is particularly important, and that theme runs through many of the Department's activities. Safety, reliability and effectiveness are all capable of being pursued ad infinitum in search of ever higher standards, but, as standards are raised, a situation of diminishing returns is reached so that the cost or other consequences of further advance become prohibitive. Judgements must be made to achieve the optimum balance between conflicting demands so as to derive the greatest net benefit from available resources. In the case of the costs, the aim should be to minimise the total life cycle costs necessary to deliver a service of acceptable quality to the user.

Figure 1. **Value of NHS estate at 1976 levels**

Total	£8,000 M
Engineering content	£3,000 M
Total maintenance costs for 1975/76	
Engineering	£61 M
Building	£59 M
Grounds and gardens	£14 M
	£134 M
Total energy costs for 1975/76 (includes fuel, boilerhouse operation, electricity, gas and water)	£120 M
Backlog of engineering maintenance and plant replacement works	£200 M
Staff employed on maintenance and operation of engineering services in hospitals	>16,000

Note: 1. All figures relate to England and Wales.
2. All figures are approximate.

Size of the Operation

Figure 1 indicates the size of the task involved in maintenance and operation of the health service estate.

Any operation on such a scale clearly merits a good deal of attention to efficient management both to achieve acceptable standards of performance and to obtain good value for the vast sums of public money involved.

Historical background

Various events focussed attention on the way maintenance in the NHS was managed and executed, and led to two important advances.

Firstly, in 1961 the then Chief Engineer felt there was a general need for planned preventive maintenance in the Health Service and investigated available systems.

After examination of many systems and the operation of a pilot scheme, the Ministry of Health recommended that the principles of planned preventive maintenance should be applied to hospitals and in 1964/65 published:

1. *Hospital Technical Memorandum No. 12* which discussed the administrative arrangements needed effectively to plan and control the maintenance of hospital buildings, plant and equipment; and
2. *Hospital Technical Memorandum No. 13* which described a system of planned preventive maintenance for engineering plant and services, together with *Hospital Memorandum (65) 28* which recommended the adoption of that system and gave guidance on procedure and staffing.

Secondly, during 1967/68 the Exchequer and Audit Department examined the maintenance accounts of 21 hospital authorities. Their adverse report to Parliament led to the Department's Accounting Officer twice appearing before the Public Accounts Committee where he was charged to ensure that the deficiencies revealed in management and financial control were rectified.

About that same time, a Committee of Inquiry, known as the Woodbine-Parish Committee, examined the arrangement for the conduct of hospital building maintenance and minor capital works, and their report, in

1970, was accepted by the Secretary of State.

In the light of these events a Circular was issued (*HM(71)67*) which set the course for subsequent action and allocated to the various tiers of management the roles envisaged for them in the hospital service in respect of maintenance of the estate. The Department's responsibility was to provide guidance on the principles and organisation to be adopted for maintenance, and a framework for reviewing performance.

The Department set up a Steering Committee on maintenance to formulate strategic policies and guidelines, and a multi-discipline Working Party to undertake the detailed work. The broad aim of the reforms was to secure the adoption throughout the National Health Service of a system of planned and programmed maintenance, based on modern management principles and good practice, but taking into account other priorities and pressures in the NHS as a whole.

Some new vehicle was needed for the promulgation of guidance about estate management, to complement Capricode which deals with the management of capital projects, and so 'Estmancode' came into being.

Areas in which we work

There is an ongoing programme of research and development work examining a diverse range of factors which influence the management and execution of maintenance and operations, and the results of that work usually appear in guidance material of one form or another.

An important function is the analysis of various statistical returns. Norms and trends are derived and published, against which local managements can compare their performance, and which DHSS and Health Authorities can use as tools in connection with their monitoring responsibilities and future design work.

The maintenance and operations Section of the Engineering Division is frequently consulted by other sections of the Department and by people in the field. We are particularly concerned with those problems where precedents may be created, with service-wide implications. Many matters concern broad management issues, but on other occasions, as when some new technical problem or a safety principle is involved, we have to get down to the detailed 'nuts and bolts'.

DHSS maintains a liaison with other bodies and government departments to look after the NHS's interests. These include, for example, the Health and Safety Executive about safety matters, the Home Office about fire defence, the British Standards Institution and various public utilities.

Another feature of the Department's work is the role we play as organiser and co-ordinator for activities which are of general concern across the NHS. The Department organises many metings, some ad-hoc, others on a regular basis. For example, the Maintenance Management Discussion Meetings at which representatives of the English Health Authorities, Scotland and Wales meet their DHSS counterparts to discuss matters of common interest.

A further function in which the Engineering Division at DHSS plays a central role, is in organising and operating a system for reporting of defects and failures. The purpose of the system, written up in *Health Service Engineering No. 30* is to enable potentially serious defects experienced at one site, to be brought speedily to the attention of central authority, so they can be investigated and, if appropriate, a suitable warning issued to forestall any further accident or major breakdown.

The defect and failure reporting system is one example of the links between the present subject, and that of the papers by Mr Ratcliffe and Mr Oliver.

These reports, which originate from maintenance and operations, are one route by which information should be fed back and used for updating the data stored in the systems described in their papers.

Another activity is concerned with the training of maintenance and operations staff which is carried out via a number of channels.

1. The Hospital Engineering Centre at Falfield offers a diverse range of courses suitable for training people, at all levels from craftsmen up to senior management, in the specialist services and requirements of health service engineering.
2. For some of the more common subjects, not special to the health service, arrangements are made for NHS personnel to attend training courses run by the Department of the Environment.
3. Courses in planned preventive maintenance are run directly by Engineering Division staff at Euston Tower.

Specialist Divisions at DHSS deal with staffing matters but in respect of professional or technical aspects, they are advised by the Engineering Division, which also provides technical and professional members for selection boards and appeal panels.

Lastly, but by no means least since it is our most important single task, is the production of what is generally known as guidance material. This appears in a multitude of different guises and one may ask where amongst the various publications in the works field do we find matters of interest to those responsible for maintenance and operations? The short answer is, in nearly all of them. Even the *Building Notes* and *Design Guides* which are predominantly orientated to capital work, contain some items of relevance. By far the major publication, however, is *Estmancode.*

Estmancode

What is Estmancode? This can best be answered, I think, by quoting the first paragraph of the introduction:

"Estmancode is intended to be a source of guidance and reference for all those accountable for the management of the health service estate, including buildings, plant and grounds, on behalf of the Secretaries of State for Social Services and for Wales. Eventually, it will contain all procedural and financial guidance for the management of the present and proposed future estate; and will incorporate professional, technical and general management guidance, including, where appropriate, guidance developed by other bodies in the public and private sectors."

Who should have Estmancode?

There are few, if any, people who will need to be familiar with the whole of Estmancode but there are a multitude to whom parts of it are relevant. Although related to 'works', it is a multi-disciplinary document, and touches the functions of a wide range of staff including Administrators, Treasurers, Catering Managers and Domestic Services Managers etc, as well as works staff. Within the works organisation, Estmancode impinges on the tasks of all management staff, from Assistant Engineer level up to the Works Officer himself. All these people should have ready access to a copy of Estmancode.

Is it mandatory?

With certain exceptions, Estmancode is not mandatory but is rather like the

Estmancode

Estate Management (Building, Engineering and Grounds) Practices Code for the National Health Service

Proposed General Framework[1]

Chapter I	— **Planning and Controlling Maintenance Expenditure**
*Section 1	— Planned maintenance and inspection systems
*Section 2	— Management of the maintenance programme (including a framework for reviewing performance)
†Section 3	— Estate records (Building and Grounds)
‡Section 4	— Estate records (Engineering)
Chapter II	— **Executing Maintenance Work**
*Section 1	— Contracts policy and procedure.
*Section 2	— System of planned preventive engineering maintenance (HTM13 revised)
*Section 3	— System of surveys ,forward inspections and planned preventive maintenance for building
‡Section 4	— Use of directly employed labour
‡Section 5	— Staff aspects
†Section 6	— Maintenance stores
†Section 7	— Grounds and gardens maintenance
†Section 8	— Relationship between cleaning and maintenance of health buildings
Chapter III	— **The Relationship between Design and Maintenance**
*Section 1	— Project Information Manuals (Feed Forward)
Section 2	— Defect and performance data reporting (Feed Back)
‡Section 3	— Landscaping and maintenance
Chapter	— **Property Management**
Section 1	— Estate Strategy
Section 2	— Estate economics
Chapter	— **Legislation relating to the Estate**
Section 1	— Relevant legislation
Section 2	— The effect of legislation and regulations on estate economics
Chapter	— **Maintenance Policy, Standards and Efficiency**
Section 1	— Determination of Policy
Section 2	— Maintenance standards
Section 3	— A system of measuring maintenance standards in relation to costs
Section 4	— System reliability assessment
Section 5	— Monitoring of maintenance services
Section 6	— Energy Audit
Section 7	— Safety
‡Section 8	— Infestation control, works department responsibilities
Chapter	— **Works Department Organisation**
Section 1	— Liaison and co-ordination between departments.
Section 2	— Transport maintenance management
Section 3	— Contingency plans and emergency procedures
Chapter	— **Maintenance Management Information**
Section 1	— Principles of terotechnology
Section 2	— Computer and mechanical systems for estate management
Section 3	— Replacement of assets
Section 4	— Operational policies
Section 5	— Commissioning
Chapter	— **Property Transactions**
Section 1	— Commercial exploitation of the estate
‡Section 2	— Acquisition of land for the National Health Service
‡Section 3	— Acquisition of buildings for the National Health Service
‡Section 4	— Leasing of National Health Service property to tenants
‡Section 5	— Disposal of land and property
Section 6	— Short term leases, Licences of land, Easements and Wayleaves
***Chapter X**	— **Estate Management Information Directory**

*Already issued †Issued in draft form ‡Drafting commenced

[1]The future content and arrangement of those Chapters and Sections not yet drafted is still under discussion (at April 1977) and could be subject to alteration.

'Highway Code'; it is strongly recommended that it be followed, although you do not have to, but you ignore it at your peril!

Although a lot has already been published much work remains to be done before Estmancode is complete, but the present position and the probable future content are shown below.

Sections 1 and 2 of Chapter I are two of the most important in Estmancode since they deal with the broad management issues, including planning, budgeting and monitoring. Although Estmancode is not mandatory, the Department, with these management aspects in mind, has said in *HRC(74)37* that it will adhere to these practices and procedures and expects Health Authorities to do likewise.

Chapter II Section 1, deals with 'Contracts Policy and Procedure' and is under revision to embody the recommendations of a joint DHSS/NHS Working Party on engineering maintenance contracting. It will include, for example, more explicit guidance about the use of the Engineering Institutions' forms of contract, and will provide model conditions for engineering term contracting.

Chapter II Section 2, issued in 1976, is an updated version of *HTM 13* dealing with planned preventive engineering maintenance. The basic principles and structure of the scheme remain unchanged but some detail alterations have been made.

One point given increased emphasis arises from the theme of optimisation of costs and quality. PPM schemes can make a major contribution towards minimising total life cycle costs, by reducing the number and cost of breakdowns including indirect costs due to loss of the service, by prolonging the life of plant, by sustaining a higher level of operational efficiency, and by facilitating effective control of the maintenance labour force. But to secure these benefits, schemes must be effectively managed so that installations are neither over- nor under-maintained. The schedules of maintenance tasks and frequencies in the Department's *Maintenance Manuals* are intended as a good starting point and generic guide, but they must in every case be reviewed regularly in the light of experience, and be adapted to suit local circumstances.

Despite the number of years this scheme has been available, a great deal remains to be done before the full benefits of PPM are realised by the NHS.

Chapter X, issued recently, merits a

mention. It is an information directory compromising a cross-referenced index together with a bibliography giving a synopsis of each of the more significant sources of information of interest to works staff and the addresses from which they may be obtained; it should be a valuable aid to works management.

Future sections

Now to some of the current work in aid of future Estmancode sections.

Following Public Acounts Committee criticism of the lack of effective means for measuring maintenance standards, a research project has evolved a method for appraising engineering maintenance standards, and is developing it into a practical tool suitable for general application. Associated with that work is an investigation into the relationship between the measured standards of maintenance and related costs.

Several lines of investigation are in progress looking at ways in which maintenance management efficiency may be improved by automatic data processing. These range from simple mechanical systems for producing PPM work dockets, to computer systems handling a wide range of management information.

Northern RHA, whose computer-based Estate Management Information System (EMIS) is already operational in several Areas, has ben designated to develop its system as a national standard in the NHS. They have prepared a booklet and this has recently been circulated under cover of *HN (77) 36* which offers the system to other Health Authorities. In its present form it relates to the management of maintenance programmes and embraces the Department's financial incentive scheme. It is capable of development to interface with other functions which might be put on a computer, for example, stores stock control and accounting.

There is a link here with the computer applications described by Mr Ratcliffe and Mr Oliver. EMIS require as part of its input the programme for PPM, whilst preparation of that programme itself requires information which can be made available as output data from the systems described in their papers.

We are also aware that the Property Services Agency are working on a computer project for handling PPM planning. It is therefore possible to envisage in the future that computer-based systems will be available for handling a continuous spectrum of functions connected with activities right through the life cycle, from initial conception, design and provision, through the stages of planning maintenance and commissioning, to the 'in-service' management and monitoring of maintenance and operations.

Another current project aims to develop a practical technique, suitable for application in hospitals, for the conduct of 'energy audits'. That is, to be able to check energy efficiency of the premises as a whole.

Safety is a matter we have always taken seriously, but the advent of the Health and Safety at Work etc Act 1974, has provided an added impetus, and there is now a Section in the Engineering Division devoted solely to that subject.

Emergency and contingency plans are the subject of activity. Many Engineers are already familiar with the *Engineering Emergency Manual* produced by an Inter-Authority Study Group. That manual relates to the types of emergency which arise at hospital level. There remains a need for consideration of plans for the larger scale contingencies which occur on a Regional or National scale. The committee is now examining the problem from the regional standpoint, and the Department has to consider the possible problems at a National level.

DHSS Engineers are also involved in many other 'estate management' matters including, for example, systems reliability studies, condition monitoring, management of transport fleets, economics of power generation and power factor corection, and infestation control.

HTMs

Many of the *Health Technical Memoranda* (formerly *Hospital Technical Memoranda*) contain material relevant to maintenance and operations, and two merit particular mention because current revisions entail significant departures from previous policy and practice.

Firstly, *HTM10* dealing with sterilisers. Armed with the powers given them by the Medicines Act 1968 the Medicines Inspectorate are taking a very close interest in maintenance and operation of sterilisers.

To enable the Inspectorate to satisfy themselves regarding their statutory responsibilities it has been necessary to compile a document setting down detailed requirements to govern the commissioning, maintenance and use of sterilisers. It will be incorporated is an appendix to the revised *HTM10* and will be exceptional amongst the Department's guidance material in that, at least for sterilisers processing 'medicinal substances', it will be mandatory.

Secondly, *HTM17* dealing with commissioning. The way in which plant and services are commissioned can have a significant effect upon their subsequent performance, both technical and economic, but commissioning has hitherto been one of those 'grey' areas, often ill-defined in contractual terms, and a prolific source of disputes about who is responsible for what.

A joint committee has been thrashing out this tangled problem and is now very near final agreement. The arrangements evolved will be embodied in the revised *HTM17* and hopefully should overcome the all too familiar problems of the past.

Blue Glossies

Various Engineering Division reports are published in the series sometimes known as 'blue glossies'. Some of these are relevant to maintenance and operations, for example the *Introduction to Present Worth Techniques* which is one of the tools managers should be using in taking decisions aimed at minimising life cycle costs.

Other publications

In conclusion, a brief mention of some other routes by which maintenance and operations information is disseminated. They are:

1. *Health Notices (HNs)* and *Health Circulars (HCs)*, used for promulgation of policy, for guidance on staffing matters and by Supplies Division for their hazard warnings;
2. Chief Professional Officers' letters, notably those from the Chief Works Officer and the Chief Engineer. These are the usual method by which the Engineering Division publishes hazard warnings;
3. *Health Service Engineering* magazine, published quarterly by the Engineering Division;
4. HSE data sheets, including the 'CS' series of standard specifications;
5. Health Equipment Information published by the Supplies Division;

In addition to these current series, much relevant information which is still applicable is to be found in earlier series such as 'Dear Secretary' letters, 'Health Memoranda', 'Health Reorganisation Circulars' and the like.

The DHSS Health Building System

Subjects particularly sensitive to changes in recent years have been those services and equipments associated directly with patient care. The control and handling of this aspect of the hospital engineering operation has not, to date, received the degree of attention that it surely merits, despite the publication of DHSS Engineering Division advice in the form of Data Sheet EY 1-0 some seven years ago. It is towards this field that the paper is specifically directed.

Unless specific Department of Health guidance is referred to, any comments made express the personal views of the author and are not necessarily representative of DHSS policy.

Specialist Services

The Maintenance of Electronic and Bio-Medical Engineering Equipment

ANTHONY C. SELMAN, MSc DIC CEng MIMechE MInstF

Cost Implications

The keeping of engineering records in general, and EBME maintenance units in particular, falls short of a good standard. It is thus extremely difficult to produce accurate statistics for the country as a whole. A number of global figures have been produced in the past, various 'averages' have been produced and extrapolations made, but one is invariably left with the suspicion that fundamental assumptions may have been in error, or that one has not been comparing like with like.

Figure 1 gives an equipment inventory for a fairly average District provision, consisting of two acute hospitals (575 and 203 beds respectively), a 132-bed geriatric hospital, a 72-bed maternity hospital, a 1,492-bed mental illness hospital, and a 101-bed partly acute and a 480-bed mental handicap hospital. Whilst one concedes that averages can be misleading it is argued that this example is acceptable for the purpose. It may be added that this District is real and not hypothetical, as are also the inventories and other statistics that will be referred to. Note that no teaching hospital facility is included, thus avoiding the distortion that this can introduce, nor is there any inclusion of equipment associated with X-rays or nuclear physics. We have, therefore, an average District with a typical EBME maintenance commitment,

HOSPITAL	ECG MONITOR		ECG MONITOR WITH DEF 1B		DEF 1B		CHART RECORDER		FIBRE OPTICS CRYOGEN ETC.		PACEMAKER		ALL MULTI CHANNEL RECORDER		SW DIATHERMY		PULSE GENERATOR		ULTRASONIC GENERATOR	
575 (ACT)	31	155	11	176	8	128	1	5	9	45	3	48	13	65	6	30	5	25	1	5
203 (ACT)	8	40	5	80	4	64	4	20	7	35	1	16			6	30	2	10	2	10
132 (GER)															1	5	2	10	1	5
72 (MAT)			1	16	1	16	5	25	1	5										
1,492 (MI)																			2	10
101 (P/ACT)			1	16	1	16	5	25												
490 (MH)																				
TOTAL	39	195	18	288	14	224	15	75	17	85	4	64	13	65	13	65	9	45	6	30

HOSPITAL	ECG MACHINE		PILL COUNTER		PULSE MONITOR		OTHER MONITORS		SURGICAL DIATHERMY		BLOOD WARMERS		TELECONS		CONTROLS	
575 (ACT)	7	35	4	20	3	15	16	80	15	75	5	25	21	105	4	20
203 (ACT)	3	15					4	20			3	15	5	25		
132 (GER)	2	10														
72 (MAT)	1	5			1	5					1	5	15	75		
1,492 (MI)	1	5											14	70		
101 (P/ACT)													228	1140	5	25
490 (MH)															124	1120
TOTAL	14	70	4	20	4	20	20	100	15	75	9	45	283	1455	133	1165

	WEIGHING MACHINE		MISC' MEASURING INSTRUMENTS		DIALYSIS M/CS		FOETAL HEART AND APNOEA MONITORS		EMG M/C		PATH LAB INSTRUMENTS		PULMONARY FUNCTION INSTRUMENTS		INCUBATOR	
575 (ACT)	1	5	41	205	1	5	2	10	8	40	62	305	10	50	4	20
203 (ACT)			9	45			2	10			24	120				
132 (GER)																
72 (MAT)			9	45			8	40			3	15			10	50
1.492 (MI)													2	10		
101 (P/ACT)			34	170												
480 (MH)																
TOTAL	1	5	93	465	1	5	12	60	8	40	89	440	12	60	14	70

	N19 SYSTEM		TEACHING AIDS		ANAESTHETIC INSTRUMENTS		EEG M/C		DENTAL		ECT		VENTILATORS		SUCTION UNITS	
575 (ACT)	32	160	6	30	3	15	6	30	7	35		3	22	836	128	1920
203 (ACT)													11	418	80	1200
132 (GER)															15	225
72 (MAT)															25	375
1.492 (MI)															5	75
101 (P/ACT)			18	90			8	40	2	10	6	30			20	300
480 (MH)			8	40											5	75
TOTAL	32	160	32	160	3	15	14	70	9	45	6	30	33	1254	278	4170

Figure 1. **Schedule of medical equipment in District 'Q' showing numbers of equipment by type and required man hours for maintenance.**

Equipment Type	Quantity	Range of Item Costs £	Weighted Mean	Total £ Equipment Value
ECG Monitor	39	900-2700	1400	54,600
ECG Monitor with defib	18	1200-2100	1800	32,400
Defib	14	600-1200	1000	14,000
Chart Recorder	15	300-1500	1200	18,000
Fibre Optics, Cryogen, etc	17	3000-5000	3000	51,000
Pacemaker	4	200- 350	300	1,200
All multi-channel Recorder	13	3000-4500	3500	45,500
S W Diathermy	13	1400-2000	1700	22,100
Pulse Generator	9	200- 350	250	2,250
Ultrasonic Generator	6	about 360	360	2,160
ECG Machine	14	about 850	850	11,900
Pill Counter	4	200-1000	600	2,400
Pulse Monitor	4	80- 100	80	320
Other Monitors	20	150- 500	250	5,000
Surgical Diathermy	15	1100-2000	1600	24,000
Blood Warmers	9	about 100	100	900
Telecoms	283	100	100	28,300
Controls	133	about 200	200	26,600
Weighing M/C	1	about 1800	1800	1,800
Misc Measuring Inst	93	100	100	9,300
Dialysis M/C	5	5000	5000	25,000
Foetal Heart Monitor	8	3500-4500	4000	32,000
Apnoea Alarms	4	150- 250	150	600
EMG M/C	8	about 6000	6000	48,000
Path Lab Instruments	89	250-8000	750	66,750
Pulmonary Function Inst	12	300-3000	1200	14,400
Incubators	14	1300-1600	1500	21,000
M 19 System	2	7000	7000	14,000
Teaching Aids	32	about 100	100	3,200
Anaesthetic Instruments	3	not known		
EEG M/C	14	6000-14000	9000	126,000
Dental	9	250	250	2,250
ECT	6	100- 200	150	900
Ventilators	33	2000-6000	3000	99,000
Suction Units		200- 500	300	39,300
(Floor-mounted)	131	200- 500	300	
Suction Units		100	100	14,700
(Wall-mounted)	147	100	100	
			Total	£860,830

Figure 2. **Approximate Value of EBME Equipment in District 'Q'.**

be it in-house or otherwise.

Looking at the next table (*Figure 2*) we have in column one the equipment types from the previous table with the numbers of each item held in column two. Column three gives the current price ranges for the equipment and column four gives a weighted mean unit price for the particular equipment. For example, if we consider the first item, ECG monitors, one can see that cheap basic units can be obtained for about £900. On the other hand highly versatile units can be obtained for getting on towards £3,000. Whilst there may be a few of the latter, experience shows that low to middle price range ECG monitors are more common and the mean is weighted acordingly. Column five gives the total value of the equipments registered, on the basis of weighted mean cost. A number of interesting points arise.

i. It will be seen that some 15 per cent of the total equipment value is tied up in EEG machines used predominantly in the District's two mental hospitals, thus giving food for thought to the contention that there is no high technology in mental health provision.

ii. Basic engineering electronics (eg telecommunications, boiler controls, air conditioning controls etc) account for eight per cent, and these hospitals do not have particularly sophisticated alarm systems.

iii. The total capital value of the equipment is about £860,000. If we use a nominal ten per cent for maintenance costs it is apparent that the maintenance operation for this schedule of equipment should be in the order of £86,000. It is worth noting that whilst ten per cent may, in other fields, be considered a bit high, with EBME twenty per cent is not, at first sight, unreasonable.

Indeed, we can look at the maintenance cost another way, and the next table (*Figure 3*) shows this. Columns one and two give the same information as the last table. Column three gives the total man hours that would need to be allocated to the groups of equipment, based on a careful item by item assessment of maintenance involved. Labour costs are at £8.50 per hour (including 100 per cent overheads) and spares are rated at a nominal (and slightly suspect) ten per cent of labour cost. One is thus able to arrive at an annual cost for each category of equipment and, ultimately, a total annual EBME maintenance cost for the scheduled equipment. This can be seen to be over £100,000.

On the basis of the capital investment figure for District 'Q', and given that there are 205 Districts in England, a conservative estimate of NHS capital invested in medical equipment and industrial electronics in England would be of the order

$205 \times 860{,}000 = £176$ million.

Returning to the guinea pig District 'Q', investigation has produced the following data:

The current average hourly charge for manufacturers' labour is around £11 per hour, this charge being incurred during the operative's travel to and from the hospital, as well as while he is actually working there, plus the hospital's overhead. Again on average, travelling time worked out at two hours per job whilst time spent gainfully employed repairing would also be approximately two hours. This latter figure is derived from the records of the 'in-house' maintenance facility, as is the fact that, on average, there were 1.5 equipment defect call-outs per day. On the basis of 250 working days per year the cost of contract breakdown maintenance per year would be

$1.5 \times 250 \times 4 \times 11 = £16{,}500$ per annum.

Note that of the 1,500 hours paid for only 750 would have been spent working on the equipment. The other 750 hours would have been spent motoring around the countryside at a cost of £8,250. Furthermore, the 1.5 calls per day were simply those recorded as calls by the 'in-house' EBME department. It is likely that some calls by-passed the EBME department in question and were, therefore, not recorded. The figure of £16,500 may, in consequence, be low.

On the crude basis of a technician earning an average bare salary of £4,000 pa it can be seen that two technicians would cost £8,000 pa. Allowing overheads at 100 per cent, the cost of the two technicians would be £16,000 per annum. However, although this figure is similar to that for the 'out-of-house' service, a number of advantages accrue:

i. On the basis of a 48-week year, and a 40-hour week, one would have at one's disposal 1,920 man hours per year available/man.

ii. The facility would permit equipment to be looked after properly instead of on a breakdown basis only. It will be appreciated that the £16,500 referred to only covers breakdown maintenance.

iii. The range of equipment covered for £16,000 would be considerably increased, eg boiler and air conditioning electronics, with consequent revenue savings elsewhere.

iv. Breakdowns can be handled expediently since travelling time is minimal.

v. The system of maintenance provides a degree of flexibility that could not otherwise be achieved.

vi. The requirement of continuously exercising vigilance with a view to maintaining high standards of safety — so very important in this field — can become systemised.

Equipment Type	Quantity	Total Maint Hrs/Yr	Labour Cost at £8.50/hr inc O/H	Spares Costs at 10% Lab	Total £ Maint Costs
ECG Monitor	39	195	1657.5	165.75	1823.25
ECG Monitor with defib	18	288	2448.0	244.8	2692.8
Defib	14	224	1904.0	190.4	2094.4
Chart Recorder	15	75	637.5	63.75	701.25
Fibre Optics, Cryogen, etc	17	85	722.5	72.25	794.75
Pacemaker	4	64	544.0	54.4	598.4
All Muti Channel Recorder	13	65	552.5	55.25	607.75
S W Diathermy	13	65	552.5	55.25	607.75
Pulse Generator	9	45	382.5	38.25	420.75
Ultrasonic Generator	6	30	255	25.5	280.5
ECG Machine	14	70	595	59.5	654.5
Pill Counter	4	20	170	17.0	187.0
Pulse Monitor	4	20	170	17.0	187.0
Other Monitors	20	100	850	85.0	935.0
Surgical Diathermy	15	75	637.5	63.75	701.25
Blood Warmers	9	45	382.5	38.25	420.75
Telecoms	283	1455	12367.5	1236.75	13604.25
Controls	133	1165	9902.5	990.25	10892.75
Weighing M/C	1	5	42.5	4.25	46.75
Misc Measuring Instruments	93	465	3952.5	395.25	4347.75
Dialysis M/C	1	5	42.5	4.25	46.75
Foetal Heart and Aphoea M	12	60	510.0	51.0	561.0
EMG M/C	8	40	340.0	34.0	374.0
Path Lab Instruments	89	440	3740.0	374.0	4114.0
Pulmonary Function Inst	12	60	510.0	51.0	561.0
Incubators	14	70	595.0	59.5	654.5
N 19 System	32	160	1360.0	136.0	1496.0
Teaching Aids	32	160	1360.0	136.0	1496.0
Anaesthetic Instruments	3	15	127.5	12.75	140.25
EEG M/C	14	70	595.0	59.5	654.5
Dental	9	45	382.5	38.25	420.75
ECT	6	30	255.0	25.50	280.50
Ventilators	33	1254	10659.0	1065.9	11724.90
Suction Units	278	4170	35445.0	3544.5	38989.50
Totals	**1267**	**11135**	**94647.5**	**9464.75**	**104112**

Figure 3. **Approximate Maintenance Cost of EBME Equipment in District 'Q' per annum.**

The Maintenance of Electronics in the Hospital

The work that may be carried out at a given EBME workshop will obviously be dependent on local circumstances, but in general facilities should allow for the following activities to be undertaken:

i. Maintenance, repair, calibration, safety testing and general examination of all classes of electronic, electro-mechanical and mechanical medical equipment, with particular emphasis on electro-medical equipment, including that related to pathological laboratory services and X-ray equipment.

ii. Reception of new medical equipment for pre-installation performance checks.

ii. Preparation and maintenance of records, test certificates, reports and other essentially administrative procedures.

iv. Dirty procedures involving the dismantling and cleaning of equipment prior to the commencement of maintenance.

In many cases where EBME maintenance facilities have been established, they have been designed to handle, in the main, electronic equipment only. Yet, as will be recalled from the discussion concerning economic aspects, the capital value of electro-mechanical and mechanical medical equipment in the hospital is not inconsiderable. Let us consider for a moment ventilators, incubators and suction units. The first point worth making about these equipments is that they tend to be rather bulky. The room they take up is considerable and it is obvious that one cannot afford to have too many of these machines resident in the workshop. The second point is that some of these machines, particularly the ventilators, take a long time to dismantle and reassemble. Furthermore the re-assembly procedure may need undertaking at an uncomfortably high frequency since one can detect a trend towards unskilled dismantling for routine disinfection purposes in new Hospital Sterilising and Disinfecting Units with the attendant dangers of unskilled reassembly. Working on the basis of the 33 ventilators quoted in our earlier example of District 'Q', the HSDU in this District expects to process each ventilator **at least** twice a week, thus assistance will be required in the checking out of over sixty ventilators per week. At only ten minutes each (which is pretty optimistic) there is a commitment of one quarter of a man-week per week just checking that ventilator patient circuits have been reassembled correctly. The third point refers to the possibility that staff may be exposed to infection risk when working on this equipment — on ventilators and suction units in particular. It is most important when working with these machines that advice is sought concerning procedures necessary to avoid infection. eg from tuberculosis or australia antigen, and staff screening precautions are necessary for their continued safety.

Staff

There exists at present no formal organisational structure for EBME maintenance at any level in the field. Nonetheless a small number of authorities have tailored EBME maintenance systems to suit their particular circumstances and *Figure 4* shows a hypothetical structure incorporating those characteristics common to existing systems that have met with some degree of success in the past. It will be recalled from earlier discussion that the need to balance manpower against workload, and the structure must be considered against this background. As is immediately apparent the structure embodies certain management shortcomings already identified in other NHS management areas, and this point will be returned to shortly.

Before considering the roles of RHAs, AHAs and DHTs it is necessary to examine the relationship between physicists and engineers as far as EBME maintenance goes. In a number of establishments, departments of medical physics have found themselves able to handle EBME maintenance in addition to their normal workload and the Chief Engineer of the DHSS indicated, in his letter of October 5, 1973, that where such an arrangement is operating satisfactorily it should be allowed to continue. In general, however, it is convenient to draw a line between EBME development and EBME maintenance, with physics departments applying themselves to the former and engineering departments to the latter. Although this division is convenient, it should not be deemed to be inflexible, and it is obviously desirable that development work be based on practical reality, thus indicating a need for the developer to be in touch with the operational level. The recently published Health Circular on Pay and Conditions of Service — Electronic and Medical Equipment Maintenance provides the necessary job descriptions to allow comparison between physics

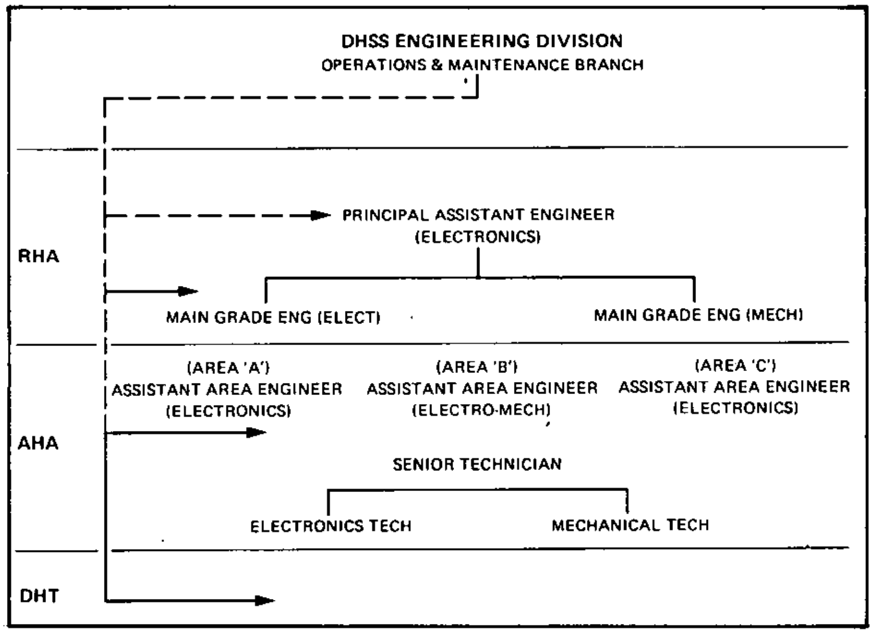


Figure 4. Hypothetical EBME maintenance system.

and engineering grades and, in consequence, basis for personnel exchange.

It is the author's view that there is a need for professional engineering capability in the EBME maintenance structure and this could reasonably be placed at Region. Several reasons militate towards this, the more important being as follows:

a. The overall pattern of EBME usage in a given Region should be monitored so that a focal point for information exchange between Areas can be established;

b. In the event of a particular technical problem being beyond the expertise of the Area personnel, a central point for obtaining technical guidance exists. This central point will have far greater facility for obtaining information from expert authorities particularly those outside the NHS;

c. Many policy decisions reflecting directly on the EBME maintenance function are taken at Regional level, and it is essential, if the EBME service is to be effective, that its voice be heard when these decisions are taken;

d. For a service to be efficient it is important that as much standardisation is introduced as is possible. For this to happen it is generally necessary for a quasi-independent body to guide the standardisation exercise. It is suggested that the RHA is ideally suited to this role;

e. From time to time local inter-disciplinary problems arise, either due to conflict of interest or personality, and in such circumstances an independent arbiter can be of considerable use;

f. Certain of the test equipments needed for the comprehensive maintenance of medical equipments are extremely expensive and, at Area level, infrequently used.

The need for an EBME maintenance presence at Area is indisputable, since it is at this level that some degree of compromise can be achieved between practical application and professional qualifications. As can be seen from the 'family tree' it is envisaged that the senior person who deals only with EBME would be at Assistant Area Engineer level. This proposal is justifiable on at least three grounds. Firstly, as was evident from earlier discussion on equipment value, the investment merits proper care. Implicit in this statement is the requirement for highly competent engineers/technicians to look after it. Secondly if EBME maintenance organisations are to be able to recruit the right sort of people, a career development process must be in evidence. By integrating the engineer based EBME service with the main Works Career Structure this can be achieved so that, with adequate 'in post' management training, a person entering the NHS to work on EBME does not have the bleak prospect of his career development terminating in his late twenties or early thirties. It also offers a path towards corporate membership of a suitable professional institution, which does not exist if one conveniently, but shortsightedly, fits him into an unsuitable technician grade such as Physics Technician.

Thirdly, it is frequently the case that effective communication with the clinical user can only take place if there is an engineer available who that user believes is intellectually capable of communicating at the user's level. It is pointless attempting to conceal the fact that the success of any EBME service will, to a considerable extent, be a function of the personalities concerned, and the technical and intellectual integrity of the senior EBME person involved must be adequate to the situation.

It is important that the EBME organisation embraces both electronic, electro-mechanical and purely mechanical equipment, not simply because of the safety aspect, which is obviously essential, but on account of the large capital replacement cost incurred if the equipment is permitted to deteriorate unnecessarily.

Training

By its nature much of the equipment included in this discussion will be attached, or used in close proximity, to the patient. There is, in consequence, a greater than normal risk of accident. It follows, therefore, that the utmost care must be taken to ensure that the equipment is kept in a completely safe and serviceable condition.

Implicit in this statement is the stipulation that only staff who are trained and competent to maintain the equipment shall be authorised to work on it. Thus one immediately defines a training need.

Considering the technical aspect first, it is of note that, whilst formal courses exist for the training of electronic and mechanical technicians and engineers, there apear to be few, if any, courses apart from courses at post-graduate level containing the equivalent of an endorsement in 'Engineering in Medicine'. This, therefore, means that some 'on the job' training is inevitable unless, of course, one is able to recruit from the medical equipment manufacturing supply industry or user departments within the hospital service itself. Even if recruits from these latter sources are available, it will almost certainly be necessary to indulge in a degree of retraining since, by and large, people working in these fields tend to be specialised and unfamiliar with equipment outside their speciality. Although with many recruits to the EBME service the basic professional or technician qualifications will already be evident (particularly in the case of electronic and medical equipment technicians since the requirements for this grade are set out clearly in *HC (PC) (76) 24* and *PTB283*, a need will exist for training in para-medical subjects such as basic physiology. Apart from a degree of knowledge in such subjects being necessary to permit understanding of the equipment, it is even more necessary if there is to be intelligent communication with people in the medical or para-medical disciplines.

In the general absence of any college-based courses the Hospital Engineering Centre at Falfield has created a number of courses to cover different staff grades in the fields of Electro-Medical Equipment Maintenance and Mechanical Medical Equipment Maintenance. These courses are in addition to more general courses such as those in Electronics.

Documentation

The amount, complexity and cost (revenue as well as capital) of electronic and biomedical equipment in our hospitals increases year by year, and upon this equipment depends the success of medical procedures being employed. There is, in consequence, a need for maintenance to be undertaken on a systematic and planned basis so that responsible management may be fully aware of the condition of equipment, and be able to control effectively the maintenance programme, work force and related costs.

A planned system of maintenance requires the keeping of adequate documentary records if the foregoing objectives are to be achieved. Many of the requirements of a documentary system for the planned preventive maintenance system for EBME are contained in *Estmancode, Chapter II Section 2 (HTM13 Revised)*. Although this document was written essentially for a system dealing with engineering services in general it has much to commend it for direct application to EBME. There are a number of pieces of information that the documentation must provide. Firstly, it must list all equipment whose maintenance is the responsibility of the EBME maintenance department concerned. In the process the documentation should record the normal location of the equipment, its manufacturer and type, agent if applicable and any other maintenance contracts. Of paramount importance in connection with this aspect of documentation is a continuing history of an equipment's behaviour in service. The equipment history sheet should record all attention that a particular equipment receives, irrespective of whether that attention was planned or on a breakdown basis. It should also record the man hours spent and the nature and cost of any spares used. In this manner, over a period of time, it is possible to establish whether or not the EBME operation is economically effective, and to modify policies accordingly.

While dealing with equipment histories the contents of *Health Notice HN(76)218* distributed in December 1976 is worthy of note. This drew attention to the fact that as more 'in house' maintenance was employed it reduced the amount of technical feedback to the manufacturers that would previously have been forthcoming from their own service engineers. In the circumstances it becomes important to ensure that manufacturers are made aware of any shortcomings in their equipment as soon as they become evident. Obviously much goodwill can be lost and harm done if reports on equipment defects are given wide circulation without the manufacturers having an opportunity to consider them and take appropriate action.

Secondly, the documentation must include a system of notifying interested parties of any defects or failures in equipment. More specifically, any defect observed in equipment which constitutes a hazard or potential hazard to patients or staff should be notified to the DHSS as laid down in *HSC(15)41*, or, in the case of Scotland *SC1974(Gen)68* or, in the case of Northern Ireland Circular *HSS(CS21)*.

Thirdly the system should provide for the indexing and storage of data relating to the equipments concerned. This may originate from the manufacturer or be produced within the NHS. Interboard Study Group No. 8 has been working on the production of EBME maintenance data sheets for some time, the first two consisting of an introduction and a maintenance schedule for electrocardioscopes have been released, and will be followed by others on surgical diathermy, direct current defibrillators, and a wide range of equipment including essentially non-electronic equipment such as incubators, ventilators and centrifuges.

Summary

Shortage of space precludes an 'in-depth' consideration of all the aspects of EBME maintenance in this paper. Indeed those points that have been mentioned have received less than justice in their treatment and apology is made for the superficial nature of their coverage.

Nonetheless, it is hoped that a bit more flesh has been put on the bones of EBME. It often appears, from the many articles that are written on the subject, that people are disciplined to really get on terms with the statistics of the animal — but this is where the crunch comes. That EBME maintenance has not yet demonstrated its economic viability is largely due to lack of expertise in the field. Engineers have appreciated this and are making every effort to rectify the situation. Every endeavour must be made to provide the best service for the patient and the clinical staff.

Product News

New Range of Miniature Filters, Regulators and Lubricators

Schrader Pneumatics have introduced a new range of miniature filters, regulators, lubricators and filter/regulators in $\frac{1}{8}$in and $\frac{1}{4}$in BSP sizes. They can be used either singly or combined as complete FRL units.

The filters have polycarbonate bowls, manual drains and a 20 micron element as standard. Options are, an automatic drain for inaccessible locations, a metal bowl and a 5 micron element.

The regulators give a regulated air flow at a required point and have a standard outlet pressure range of 0-125 psig (0-9 bar). They come with a panel mounting ring, non-rising knob, lock screw and a gauge if required. Pressure ranges of 0-60 psig (0-4 bar) and 0-25 psig (0-2 bar) are also available.

The lubricators have a built-in by-pass to nullify air flow fluctuations, and also feature an oil drip sight glass, two filler points and a filter fitted into the syphon tube. Again, metal bowls are optional to the standard polycarbonate bowl.

The filter/regulator combination has all the features and options of both separate units.

With polycarbonate bowls, the filters, lubricators and filter/regulators can handle up to 200 psig (14 bar). Metal bowls handle up to 300 psig (20 bar), which is also standard for the new regulators.

Further information: P. J. Lane Esq, Schrader Pneumatics, Walkmill Lane, Bridgtown, Cannock, Staffs WS11 3LR. Tel. Cannock 2644.

Schrader's new range of pneumatic fittings.

Hellerman Electric Product Finder

Hellerman Electrics have produced a Product Finder which is designed to give a short-form guide to their products. Each product is coded. Data sheets are available on types of products, as well as the full catalogue carrying the complete range.

For further information contact: Hellerman Electric, Gatwick Road, Crawley, West Sussex. Tel. Crawley 28888.

Pressalit Rehab Equipment

Pressalit Rehab have introduced new Adjustable Shower Seat and Wash Hand Basin units. The approximate retail price of the Shower Seat unit it £260 exclusive of VAT. For the Adjustable Basin unit and plumbing fittings, but excluding basin, taps and VAT the approximate retail price is £175.

Distributors are Nicholls and Clarke Ltd, 3-10 Shoreditch High Street, London E1 6PE. Tel. 01-247 5432, contact Mr L. E. Mason; and also F. Llewellyn and Co Ltd, Carlton Street, Liverpool L3 7ED. Tel. 051-236 5311, contact Mr I. A. W. Berry.

Marley Extrusions Technical Paper

A third Technical Paper in the Marley Plumbing series for invited authors has been prepared by D. S. Hawes, FIHVE, MASHRAE, a Director of H. H. Airpower Engineering Ltd and Aldes Ventilation Ltd. 'Toilet Ventilation in Multi-Storey Buildings' contains 17 drawings together with photographs and design tables within its 16 pages.

The author has produced a guide for the design of extract ventilation systems which includes an examination of various system layouts and relevant Borough and Bye-law requirements. Details of essential equipment and simple air quantity calculations for a typical eight-storey toilet extract installation are given in the paper. Methods of testing and balancing duct-work assemblies are also described.

Copies of Marley Plumbing Technical Paper No. 3 are available from the address given below — price 75p including postage.

Marley Extrusions Ltd, Lenham, Maidstone, Kent ME17 2DE. Tel. Maidstone 54366.

High-speed Calculator from British Gas

The British Gas Corporation have developed the Metriflow Calculator which will deal with gases, steam and a wide range of liquids in metric units. From a set of given conditions it is possible to determine pressure differences, rates of flow and the size and length of pipes. Additional information may be obtained on the Reynolds Number or the friction condition in a particular set of circumstances.

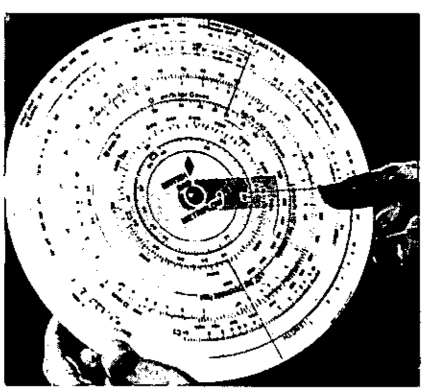
The calculator can be used to apply corrections according to the Reynolds Number, and correct or adjust initial results obtained using a built-in basic friction factor. More accurate friction factors, obtained during the calculation can be substituted, or any preferred friction factor applied.

Used in conjunction with its booklet of instructions and data, the Metriflow Calculator can deal with calculations for pipe lengths from 1m to 1,500km; pipe diameters from 10mm to 1,500mm; pressure ranges from −600m bar (vac) to 105 bar; gas flow up to 10^6m^3 per hour; steam up to 10^7 kg per hour; and liquids up to 10^8 litres per hour.

The price of the Metriflow Calculator and instruction booklet is £15, plus VAT and postage and packing.

It is available from the Metrication Officer of any Region of British Gas, or from the Metrication and Standards Department, British Gas, 326 High Holborn, London WC1V 7PT.

The Metriflow Calculator for pressure, flow and pipe problems.



Maintenance-free Battery from Alcad

The new 'Unibloc' battery, developed by Chloride Alcad Limited, has been designed specifically to provide the standards of reliability required for emergency lighting, switch tripping and fire alarm systems.

Alcad's 'Unibloc' breaks away from the traditional concept of alkaline batteries which up to now have been made up from separate cell units. The Company's development team has designed a unit construction 6 volt battery made up from five integral 1.2 volt cells. These are incorporated into a plastic case containing a greater amount of potassium hydroxide electrolyte. This extra reserve of electrolyte enables the battery's periodic topping-up to be extended under ideal conditions up to a maximum of twenty years, although seven to ten years will probably be the average.

The new 'Unibloc' battery will be available in a range of four capacities:

7.5 Ampere hours at ten hour rating battery type No. 5LP7

12.5 Ampere hours at ten hour rating battery type No. 5LP12

15 Ampere hours at ten hour rating battery type No. 5LP15

27 Ampere hours at ten hour rating battery type No. 5LP27

All four capacities of 'Unibloc' are being engineered into one size of battery case; 272mm (long) by 114mm (wide) by 275mm (high) whose weight ranges from 6.5 kg (7.5 Ah/type 5LP7) to 10 kg (27 Ah/type 5LP27).

In developing a standard size battery-case it follows that the smallest capacity battery contains a relatively greater reserve of electrolyte than the highest.

The table below, therefore, indicates conservative intervals for periodic maintenance for this range.

The battery box is made from high impact polystyrene, to give a low weight, high strength ratio. The design incorporates a choice of two 'mirror-image' lid layouts for inter-battery connections.

Chloride Alcad Limited, Union Street, Redditch, Worcs B98 7BW. Tel. Redditch 62351. Telex: 38116.

Application	*Float voltage per cell*	*Maintenance intervals* 5LP7 7.5 Ah	5LP12 12.5 Ah	5LP15 15 Ah	5LP27 27 Ah
Close voltage applications with 6-monthly boost (1.65/1.70 v per cell)	1.42	14 yrs	9 yrs	7.5 yrs	5 yrs
Fully automatic operation without boost	1.47	8 yrs	5 yrs	4 yrs	2.5 yrs

Electronically-operated Water Mixing Valve

Meynell Valves Limited, of Wolverhampton, have introduced a water mixing valve — designed and made in Britain — the Meynell Magishower. It is operated by means of an electronic device so that it can be switched on by the user placing a hand or foot over two small beams of light in a little box which may be installed flush fitting into the floor or wall. By placing a hand or foot over the beams they are effectively joined together and a circuit is completed which will activate a solenoid which operates the Magishower. There is a time setter or breaker which will normally be set for 30 seconds, after which time the shower will shut off until a hand or foot is placed over the beams again.

Further information from: Meynell Valves Ltd, Bushbury, Wolverhampton. Tel. 0902 28621.

Planning Passenger Lifts

A 28-page Passenger Lift Planning Guide has been published by Otis Elevator Company Ltd. The Guide offers information covering the ISO and CEN recommendations for passenger lifts and also details the comparative British Standards extracted from BSS 2655 Part 3.

The Guide discusses level and quality of service, location and arrangement of lifts, control and signal systems, power systems, roping arrangements and various entrance configurations.

The rear section of the Guide explains in detail the implication and advantages apparent in the new International Standards and illustrates both these and British Standards in diagrammatic form.

For further information: Barry Wheeler, 01-735 9131, Otis Elevator Company Ltd, The Otis Building, 43/59 Clapham Road, SW9.

Classified Advertisements

APPOINTMENTS AND SITUATIONS VACANT

Energy Conservation Engineer

HILLINGDON AREA HEALTH AUTHORITY

to be directly responsible to the Area Engineer for the evaluation of all energy requirements in the Area. The work includes the investigation and implementation of schemes for the control and utilisation of all energy resources and the development of statistics and management information.

Candidates should preferably be Chartered Mechanical, Electrical or Electronic engineers or hold qualifications recognised for membership, the minimum being an HNC. A sound knowledge of mechanical and electrical plant operation, simple heat transfer theory and instrumentation and control is required. Familiarisation with project management and evaluation techniques would be an advantage.

Salary is £4,371 x £177 - £4,902 x £180 - £5,262 plus Stage I and II supplements plus £354 London Weighting per annum.

Application forms from: Area Personnel Officer, Cromwell House, 43 High Street, Ruislip, Middlesex HA4 7BA, to be returned by May 26, 1978.

COMMONWEALTH SECRETARIAT

(Commonwealth Fund for Technical Co-operation)

invites applications for a

Two-year assignment in Swaziland as

Lecturer in Medical Engineering Technology

for the

Swaziland College of Technology

The Lecturer will be a member of the teaching staff of the Electrical Engineering Department and will provide instruction in Medical Engineering Technology according to Course Syllabus; advise and correlate teaching of related subjects; adjust and amend the syllabus for meeting the objectives of the Course and advise on improvements; prepare detailed lists of equipment and training aids to supplement the existing training equipment and advise on the acquisition of such equipment.

Applicants should have a degree or Higher Technician Diploma in Mechanical and Electrical Engineering or equivalent; thorough knowledge of medical equipment and extensive experience in the maintenance and repair of such equipment.

Basic salary, inducement allowance and gratuity negotiable in the region of £8,000. All emoluments free of tax in Swaziland. A housing allowance, installation grant and education allowances are also provided plus allowances for shipment of personal effects.

Application form and further details from Commonwealth Secretariat (CFTC), Marlborough House, Pall Mall, London SW1Y 5HX (01-839 3411, Ext 76).

HAVERING HEALTH DISTRICT

Hospital Engineer

(Based at Warley Hospital)

We are looking for an engineer to be responsible for the efficient maintenance of engineering services at Warley Hospital, Little Warley Lodge and community properties. The successful candidate will supervise mechanical, electrical and building maintenance staff ensuring that maintenance work is carried out to a satisfactory professional and technical standard. There will also be opportunities for carrying out surveys and preparing plans for the improvement of services and assisting in the design and execution of minor capital work throughout the district.

Applicants, male or female, must be qualified to HNC level in mechanical or electrical engineering and have several years' post qualification experience. The ability to work effectively as one of a team and to establish good working relationships with staff and outside contractors is essential.

Salary scale £4,489 - £5,440 per annum inclusive. New entrants to the Health Service commence at the minimum.

Application form and job description available from District Personnel Office, Warley Hospital, Warley Hill, Brentwood, Essex. Telephone: Brentwood 213241, Ext 97.

KENSINGTON & CHELSEA & WESTMINSTER AHA (T)
N.E. DISTRICT
Horton Hospital
Epsom, Surrey

ASSISTANT ENGINEER

Required at this large Psychiatric Hospital pleasantly situated in Surrey and adjacent to Epsom. The successful candidate will be responsible to the Hospital Engineer and be part of the works team maintaining the services, and assisting with some of the minor Capital projects currently being carried out.
Candidates should hold the Ordinary National Certificate in Electrical or Mechanical Engineering or a recognised equivalent qualification.
Salary scale: £4,242 - £4,731 inclusive of all supplements and allowances. Detached family accommodation can be made available if required.
Application forms can be obtained and informal discussion may be held with Mr. Henry Stanley, The Middlesex Hospital, Mortimer Street, London W1N 8AA. Telephone: 01-636 8333, Ext. 7566.
Closing date May 19, 1978.

DEVON AREA HEALTH AUTHORITY
AREA WORKS ORGANISATION

ASSISTANT AREA ENGINEER

Applications are invited for the above post to assist the Area Engineer in the implementation and management of the Area Capital Programme and Regionally Delegated Capital Schemes. Other duties are enumerated in the fuller job description.
The minimum technical qualification required is an appropriate Higher National Certificate together with an approved administrative qualification if this was not taken as a subject in the technical course.
Salary Scale (currently under review) £4,870-£5,761 per annum inclusive of pay supplements.
Application form (returnable by May 19) and further details from: Area Personnel Department, Devon Area Health Authority, Renslade House, Bonhay Road, Exeter, Devon EX4 3DE. Tel. Exeter 52181, Ext. 219.

QUEEN MARY'S HOSPITAL FOR CHILDREN
Carshalton, Surrey

ENGINEER

For Medical Engineering Unit, to work on the design and manufacture of special purpose electro/mechanical devices for disabled children.
Age range 23-35.
Apprenticeship or similar experience essential.
Must be pleasant person who can get on well with children.
Salary according to age and qualifications.

Please write to Mr. W. Bond, Medical Engineering Unit B.6, at above address.

To place an advertisement in the next issue of **HOSPITAL ENGINEERING**, appearing on **June 2, 1978,** please contact: **EARLSPORT PUBLICATIONS,** 17 St. Swithin's Lane, London EC4, 01-623 2235/8, by **May 19.**

Closing dates

Recruitment advertisers are requested to set closing dates no earlier than three weeks after publication date of the Journal. Monthly publications do not receive preferential treatment by the Post Office and circulation lists in hospitals also delay receipt of the Journal by many potential applicants.

Warwickshire Area Health Authority
South District

Planning Manager

To control the Incentive Bonus Scheme only for the direct Labour Staff.

The person appointed will be responsible to the District Works Officer, and have close liaison with other District Technical Officers.

Travel within the South District will be essential.

Applicants (male or female) must have served an apprenticeship, and be qualified to ONC standard or equivalent, in Electrical or Mechanical Engineering.

Some experience of Work Study or training in Bonus Schemes is desirable but not essential, as any necessary training will be given.

Salary Scale: £3,063 pa plus 15% rising by annual increments to £3,507 pa plus Stages I and II (review pending). If a Hospital Engineer is appointed to the post he/she will receive present salary plus 15%.

Any enquiries for further information telephone District Works Officer (Leamington Spa 30421).

Job description and application forms are available from the Personnel Officer, 50 Holly Walk, Leamington Spa CV32 4JB.

Closing date for applications: May 26, 1978.

MANCHESTER AREA HEALTH AUTHORITY (TEACHING) — SOUTH DISTRICT

Sector Engineer

Salary £4,371-£5,262 plus Phases I and II — non enhanceable supplements
(salary currently subject to review)

Due to promotion of previous post holder, applications are invited for the third-in-line post based at Wythenshawe Hospital. The Sector with 980 beds provides a District General Hospital service for the Wythenshawe area. This is an ideal opportunity for an experienced engineer, as the principal duties will include managerial responsibility for all engineering aspects and minor works within the Sector. The successful candidate must be able to demonstrate a sound knowledge of electrical, electro-medical and mechanical maintenance, together with estate management experience within the National Health Service.

For further details, contact Mr. John Gill, District Engineer, on 061-445 8111, Ext. 2220.

Jop descriptions and application forms from the District Personnel Dept.; Withington Hospital, Nell Lane, Manchester M20 8LR (061-445 8111, Ext. 2125).

Closing date: May 18, 1978.

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