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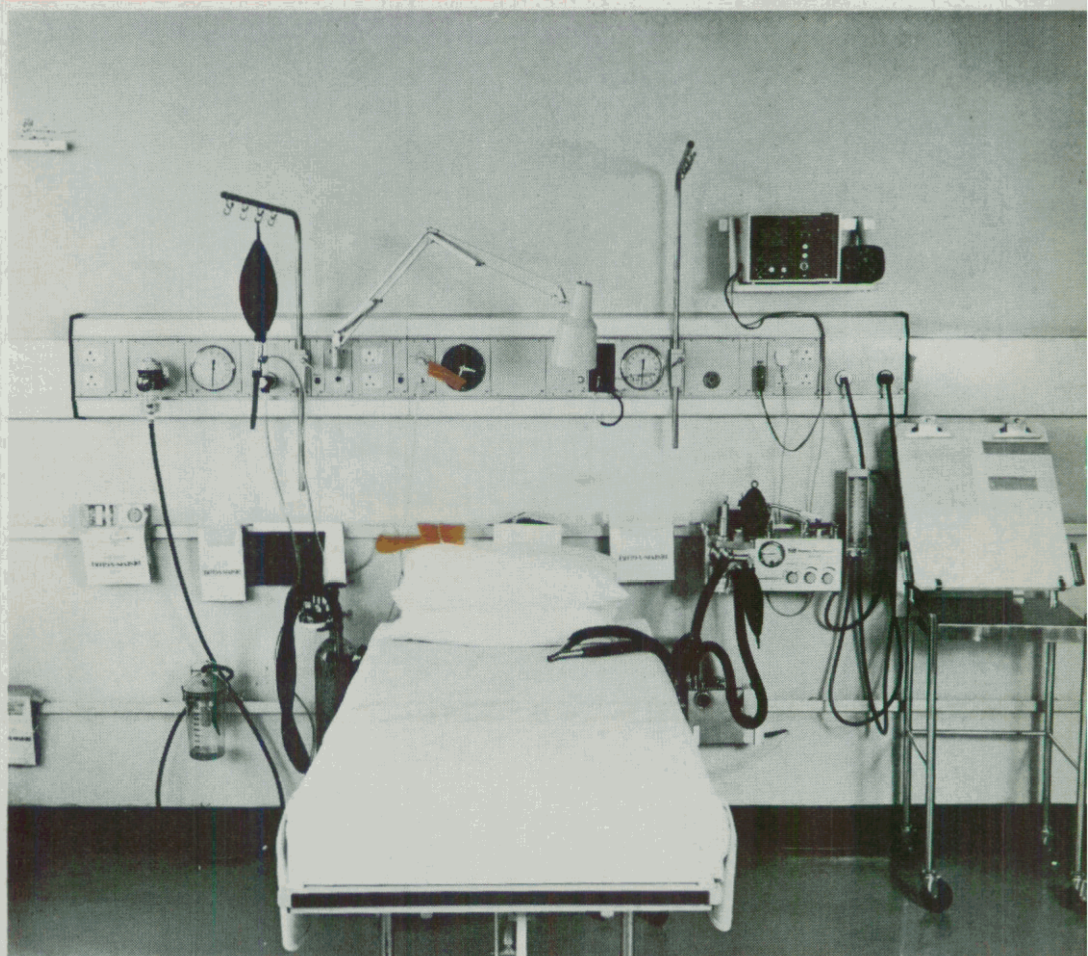
Hospital Engineering

MARCH 1976



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Hospital Engineering

Vol 30
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Computerised data base as a fabric and engineering system control aid for a hospital complex

by A. H. CHRISTER

A format for a computer-based data-recording and retrieval system is discussed along with its uses as an aid to management decision making relating to the control of the engineering services and fabric of a hospital complex.

Introduction

An Engineer responsible for the maintenance of a hospital complex or group of hospitals may consider his function to be one of control. Here, there is a system to be maintained in a satisfactory state by means of the selection and adjustment of control variables, where the state of the system is measured in terms of performance variables. Should the state of the system as measured by the performance variables be deemed unsatisfactory in some respect, the control variables are modified to produce, hopefully, a beneficial change in the performance measures. This situation is represented diagramatically in Fig. 1.

Dr. Christer is with the University of Strathclyde, Department of Operational Research, Livingstone Tower, 26 Richmond Street, Glasgow G1 1XH, Scotland. This article is based on a paper delivered to the 10th Scottish Conference of the Institute of Hospital Engineering.

Control variables are those factors for which the value, level or type is fixed at the discretion of the Engineer. Here, control variables are manpower level, degree of technical training of staff, tooling available, stores and inventory policy, management systems operating, data-recording system etc. By 'management system' we mean the means of deploying available resources to maintain or control the system. Most likely, this will consist of a mixture of planned preventive maintenance, replacement maintenance, repair or replacement on breakdown only, or perhaps a delay system which will be discussed later.

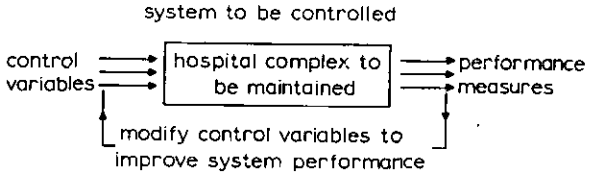

Fig. 1

Performance measures are dependent upon the outcome of the interaction between the selected control variables and the system. Numerous performance measures are available, either directly or after analysis of data, e.g. the downtime of various parts of the hospital system, the cost and consequences of such downtime, the reliability of certain components, the maintenance budget, energy consumption, the number of complaints by building users etc. Clearly, it is unlikely that there should be a single quantity by which performance can be adequately measured.

In practice, the control process is more complicated than presented here since changes in control variables must be expected to produce changes in more than one of the performance measures. Also, the manner in which control variables influence performance measures is often highly complex and dependent upon chance events. Further, the actual trend in performance measures is probably not known in any detail for a manually operated data system, because of the laborious data problems associated with the size of the problem.

This article considers how a computerised data-recording system can assist with two types of problem. First, is an engineer who feels his system is 'under control' but would like to investigate further the opportunity for becoming more efficient on a cost-benefit basis. Secondly, we consider the problem of an engineer who considers his system is to some extent 'out of control' because of a mixture of, perhaps, rapidly rising maintenance costs, a high level of failure, poor availability of certain equipment, being swamped with information and requests for work etc. In both these cases the potential exists for a computerised data base to provide a framework for management information to assist in understanding the relationships between control and performance variables in a specific situation and thereby assist with the associated decision making. The application of computers to maintenance problems has been discussed recently by A. P. Smith[2].

Computerised data base

A computerised data base (c.d.b.) is a bank of pertinent information relating to maintenance activities. Such information is presumably coded for numerical handling and then fed into the data store of a computer. Requests for numerous forms of analysis of this data can be made by reference to a computer program.

At any maintenance activity, there is a considerable amount of information that is relevant to the performance of the system but which, with manual recording, cannot be recorded because of the demands upon clerical time. Even the crudest form of data analysis places considerable demands upon labour resources. The following is indicative of both the obvious and perhaps less devious type of information available at certain moments of time which could conceivably be coded and recorded:

Analysis of maintenance activity

1. Area identification

   W3 = ward three, K1 = kitchen 1, T3 = theatre 3, L = laundry etc.

2. Hospital

   different code for each hospital if a group of hospitals is being considered

3. Equipment identification

type/item number

   1 = sterilisers, 2 = extractor fans, 3 = cooker etc.

4. Date
5. Time of commencement of activity
6. Foreman in charge
7. Type of activity

   1 = electrical, 2 = instrument, 3 = mechanical 4 = planned maintenance, 5 = building fabric.

8. Duration of activity
9. Downtime on equipment
10. State of equipment during activity

    1 = operating, 2 = down shift, 3 = down awaiting completion of activity etc.

11. Action

    1 = routine maintenance, 2 = permanent repair, 3 = temporary repair, 4 = modification, 5 = adjustment etc.

12. Trades used

    1 = plumber, 2 = toolmaker, 3 = joiner, . . .

13. Delay because of nonavailability of certain trades

trade	delay

14. Performance/function of the area reduced because of activity?

    Yes/No

15. Performance of other area

    1 = not influenced, 2 = reduced, 3 = at risk, . . .

16. Symptom

    1 = planned activity, 2 = noise, 3 = vibration, 4 = water leak, 5 = abnormal temperatures, . . .

17. Cause

    1 = human error, 2 = oil deficiency, 3 = wearout, 4 = design error, . . .

18. Labour cost of activity
19. Material cost of activity
20. Priority of activity

    1 = normal, 2 = urgent, 3 = emergency.

The majority of this information is readily supplied by the foreman or chargehand responsible for the maintenance activity, with the remaining information, such as costs, being appended later by the appropriate department. It has been found by Steedman and Whitaker[1] and Steedman[4] that such information can usually be supplied by the foreman in two or three minutes.

Use of c.d.b. in problem identification

Having accumulated data over a number of weeks, and possibly in several hospitals, one is in a position to utilise it as a basis for analysis for management information. A full-bodied analysis of all aspects of the data would likely be almost useless because the resulting avalanche of information will swamp any would be beneficiary. It seems better here to 'sample' the information to ascertain whether or not the situation is deemed satisfactory or not and then proceed on the basis of the answer.

Typical of the simplest information the computer would print out is a distribution of maintenance costs across various cost headings during a specific period of time, such as shown in Table 1.

Table 1

	Total costs over one month periods								
	Wards							Theatre	
	1	2	3	4	5	Kitchen	Laundry	1	2
January	—	40	—	—	—	330	30	70	70
February	10	25	20	—	100	25	20	—	—
March	—	—	—	30	—	50	85	140	—
April	60	120	5	10	10	170	—	360	60
May	—	10	—	—	6	90	—	—	—
Total for 5-month period	70	195	25	40	116	665	135	570	130

Once a computerised data base exists, analyses such as that shown in Table 1 can be obtained very quickly with little further effort. Such information highlights both areas of apparent trouble and excellence. For example, in Ward 2 there are very high costs whereas Ward 3 is low. The explanation for both these extremes will be of interest to the engineer.

Should an area be associated with high maintenance costs or some other irritant, or, should there be a desire to investigate the necessity for a certain level of expenditure even though it may not be considered to be extreme, further and more specific information can again be quickly obtained from the computer.

Planned maintenance

Suppose that despite a planned maintenance system, the maintenance costs associated with a steam-generating plant, say, is particularly high. The analysis in Table 2 is readily available from the c.d.b.

Table 2

Total	Maintenance activities over a specific period: Steam-generating plant	
	Planned activity	Unplanned activity
Number of interventions	n_1	n_2
Average duration of activity	h_1	h_2
Average downtime	d_1	d_2
Average cost	c_1	c_2
Intervention due to human error	e_1	e_2

Observing this information, the engineer could ask whether or not the associated aspects of the system were within acceptable control limits. For instance, if d_1 is very much greater than h_1, the planned maintenance could be inefficiently programmed timewise, or there would be a lack of communication with the stores resulting in timely delays for spare parts at critical times. Depending upon the mode of operation of the maintenance organisation, other possibilities could arise; but, eitherway, the phenomenon, once highlighted, requires explanation. Again, if d_2 is much greater than h_2, there could be, amongst other things, a stores problem, a labour-availability problem, or both.

If the number of breakdown activities n_2 is far greater than the number of planned activities n_1, several questions must again be asked. Is the planned maintenance performed too infrequently? Are the planned maintenance activities related to the type of breakdowns occurring, that is are the problem-generating components attended to within the planned maintenance strategy? Should more preventive activity than breakdown activity be found, it is possible a degree of over maintenance is in operation.

In the event of e_2 being large compared with n_2, a large proportion of unplanned activities are due to human error. The error could be due to the equipment user, the fitter who installed it, or perhaps the maintenance engineer himself. Either way, the nature of the errors highlighted requires further investigation and a suitable remedial action decided upon. In this instance, it will possibly be a training problem.

Table 2 provides a higher degree of detail than Table 1, and this could itself sufficiently define the true problem to lead to is resolution. If this is not the case, the opportunity exists to go into still greater detail to clarify the situation.

Should there be doubt as to the effectiveness of, say, a p.m. system, answers to the following questions could be recorded either within the c.d.b. or as an appendum to it:

At a planned activity;

(i) is there any evidence of a potential fault which would lead to breakdown ☐

Yes/No

(ii) if yes, estimate when the fault might be expected to arise ☐ ☐

minimum time   maximum time

At a breakdown activity;

(i) should the p.m. system have prevented this fault

☐ Yes/No

(ii) could a modified p.m. system have been reasonably expected to prevent this fault

☐ Yes/No

(iii) if yes to (ii), how long ago could the fault have reasonably been expected to be recognised

☐ minimum time ☐ maximum time

The analysis of such data by an operational research analyst or statistician could lead to a mathematical model of the p.m. system which would indicate the necessary changes, if any, in the p.m. system required to improve the expected performance as measured by downtime, costs etc.[5].

So far, we have discussed the use of a c.d.b. as a problem diagnostic aid whereby a particular output of data analysis is subject to judicious and considered interpretation and, if necessary, further analysis performed. Once the problem has been so defined with some degree of confidence, the c.d.b. can again be called upon to help with its solution.

Use of a c.d.b. in problem solving

The replacement problem

In the event that no improvement is to be expected by modifying the p.m. system, and n_2 is still greater than n_1, then if either the downtime d_2 or the costs c_2 are unacceptably large, a replacement policy might be considered. Here, a troublesome component would be replaced at a regular age to reduce the chance of failure in use. Planned replacement of a component usually results in less downtime and inconvenience because it takes place at a suitable time when the spare parts and labour are already at hand. This contrasts with a breakdown replacement which tends to occur inconveniently when the component is in use.

It may be obvious to the engineer which components should be replaced and at what age. Should this not be the case, the c.d.b. can provide directly the input data to an operational research model of the replacement situation from which the best replacement age is determined. Input data would be relevant average costs, the time distribution between component failures etc. As an example, if the engineer wished to select a replacement age t_p, one method based upon a criteria related to both cost and downtime is to select that t_p which minimises the ratio of the expected cost per replacement cycle to the expected replacement-cycle length, which is given by the expression

$$\min_{t_p} \left[\frac{R(t_p)(C_p + C_d d_p) + \{1 - R(t_p)(C_f + C_d d_f\}}{R(t_p)\, t_p + L(t_p)} \right]$$

where

$$R(t_p) = \int_{t_p}^{\infty} f(t)\, dt$$

$$L(t_p) = \int_{0}^{t_p} t f(t)\, dt$$

$f(t)$ = probability density function of time to failure of component

C_p = average cost of a preventive replacement

C_f = average cost of failure replacement

d_p = average downtime for a preventive replacement

d_f = average downtime for a failure replacement

c_d = average cost per unit of downtime

For the derivation of similar expressions, see Reference 2. The particular assumptions incorporated in this model or alternative models are not important here. What is important is the notion that, if desired, by using the c.d.b., it is possible to formulate and use a quantitative model (equation) of a specific problem which has been previously highlighted and to some extent quantified by general data analysis.

Delay system

So far, attention has been given to the analysis of engineering-type problems. A similar data bank could, however, encompass to possible advantage, the corresponding problems of building maintenance. Planned preventive maintenance, inspection systems, replacement systems etc. all have their place here and a similar analysis will help spotlight and resolve associated maintenance problems.

The considerably longer characteristic time scales associated with building maintenance, coupled with a correspondingly greater geographic spread of activities, justify consideration of alternative management procedures, such as a delay system. Suppose the following additional information is collected, coded and fed into the computer's data bank:

Time to get to the location ☐

Duration of activity at location ☐

Is the repair urgent ☐ Yes/No

A printout of the analysis of such information would appear as in Table 3.

Table 3 indicates a considerable amount of time is spent by the tradesmen in moving between activity locations. This in turn suggests a delay system might be used where nonemergency repairs are accumulated

Table 3

Analysis over a specific period		
Trade	Joiner	Plumber
	min	min
Average time between locations	28	36
Average duration of activities	50	20
% of nonemergency activities	80	65
Average number of activities attended to per man day	5·4	7·6

in various areas over, say, an N-day period with the pertinent tradesmen being dispatched to rectify the defects on a regular N-day cycle. With this system less time will be consumed travelling between locations, and consequently more actual work can be completed in a working day. Here we have an example of a management system designed to enable the labour force to function with greater efficiency. Clearly, there exists a relationship between the number of man jobs per day completed and the delay N, see Fig. 2.

A knowledge of such a curve is necessary if a delay system is to be beneficially implemented where there are complications due to an existing bonus/incentive system. Suffice it to say that, given the sort of data

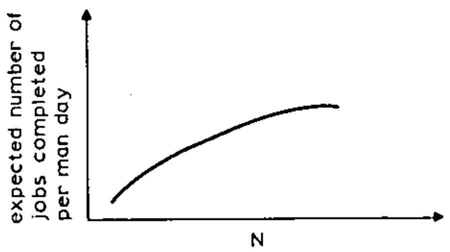

Fig. 2

bank discussed here, the pertinent analysis to obtain this curve may be speedily obtained from the computer.

It is interesting to recall the findings of a particular hospital that implemented such a scheme on a weekly basis, whereby each ward and building was visited at a specific morning or afternoon each week. The switch enabled a reduction in staff to take place by natural wastage and extra time was available to implement a planned maintenance system. Here, however, the maintenance expenditure, although reduced, still cost the hospital group concerned more than was really necessary because the previous bonus system was adopted without modification within the new management system. Any bonus scheme needs to be related to the system under which maintenance is managed. If the system changes, there is a need to reconsider the pertinent bonus rates.

Setting up a c.d.b.

It is not necessary that a hospital group own a computer to operate a c.d.b. Numerous companies operate a computer-time-sharing system by which computing time can be purchased as and when required. Considerable thought needs to be given to the form of data to be collected and its expected use. This will necessarily relate to the extent of current quantitative data available and the type of problems and solutions thought respectively to exist and be viable. Before a c.d.b. is established on a large scale, both a feasibility study and a pilot study are recommended. This will enable the type of data collected to be modified by a feedback mechanism and consequently to be in greater accord with the decision problems subsequently identified.

Concluding remarks

For most purposes, a relatively rough and crude analysis of the data should prove sufficient as a basis for decision making, but if there is a need for further refinement or to formulate a model based upon an analysis of the data, advice and assistance is usually available concerning operational-research model building and techniques of analysis and programming.

An engineer would only operate the data-recording system (or part of it) until satisfied with the general feedback of the performance variables. At this stage, it is suggested the minimum and cheapest recording system consistent with basic management needs be used until such times as the operational efficiency of the system becomes in doubt, or simply until there is a desire to check the state of control of the system.

Perhaps the main characterising feature of a computerised data base is that management information at a variety of degrees of sophistication becomes available with relatively little outlay in labour. A c.d.b. is justified provided the savings or improved performance obtained with the resulting information is considered to offset the computational costs and the program development costs. Suffice it to say that, within an industrial context, Steedman[4] considers such a computerised data base to have proved cost beneficial.

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Articles on hospital engineering

Articles on subjects relevant to hospital engineering are always welcome from members of the Institute of Hospital Engineering and others with an interest in the field.

The maximum length for articles is normally about 2 500 words. Three copies of the manuscript should be supplied, neatly typed in double spacing on one side of the paper only. If possible, the article, should be illustrated with four or five photographs or line diagrams, each referred to in the text, with a typed list of Figure captions at the end of the article.

The illustrations themselves must be entirely separate from the text and must be clear and neat. Clear diagrams in indian ink on tracing paper or board of line diagrams, and unmounted black-and-white glossy prints of photographs, permit the best reproduction.

Every article submitted should be accompanied by a 75-word summary and SI units should be used throughout. References should be indicated by a super-script number in the text and should be given in the fullest detail in a typed list at the end of the text.

The manuscripts and illustrations should be sent to the Editor, Hospital Engineering, Peter Peregrinus Ltd. PO Box 8, Southgate House, Stevenage, Herts. SG1 1HQ. The author must state his name, title, degrees, qualifications etc., the address and telephone number at which he can be reached, and brief details of the post that he holds.

Postbox

Dear Sir,

In 'Scheme for a planned preventive maintenance system' in the November 1975 issue, the author's reference to Fig. 1 of his paper states that the plant engineer's aim should be to the point where the curves cross.

In my use of this particular curve, the significance of the crossover point is that equal amounts of money are being spent on the alternatives, the sum of which is not necessarily the lowest.

The Figure also shows B as being an amount greater than A. If this was the case, the *c* curve would touch at the crossover point.

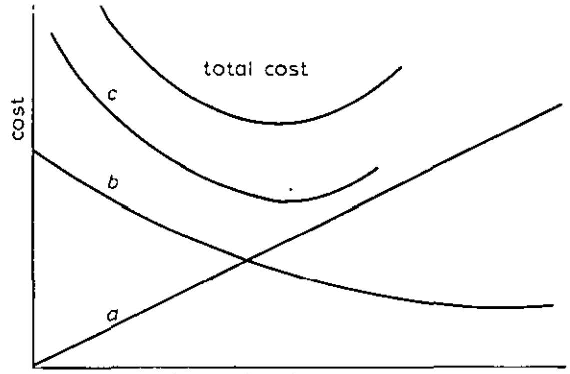
Should B not be an amount from base added to A, an amount from base, to give amount C from base, thus forming curve *c*.

Yours faithfully,
W. Gormley, C.Eng.

4 Inchmurrin Drive
Wardneuk, Kilmarnock KA3 2JD, Scotland

Dear Sir,

In answer to the comments from Mr. Gormley, may I say that the original thesis from which this paper was compiled was some 25 000 to 30 000 words, and the original graph is reproduced here. As you can see line *c*, which represents the indirect maintenance costs, has been left out of the graph published. I found it necessary to leave this line out as the paper submitted contained no explanation of 'indirect maintenance costs'. I further decided that in a hospital application this feature was not as important as the effective control of a p.p.m. system.



Indirect maintenance costs being due to loss of output, excess production costs, etc.
a **P.P.M. costs** *b* **Breakdown maintenance costs** *c* **Indirect maintenance costs. Total costs** $-a+b+c$

However, I accept the criticism and can only say that the error has occurred when re-arranging the modified graph.

Finally, I would like to pass on my thanks to Mr. Gormley for the interest shown.

Yours faithfully,
D. J. Bragg

Engineer's Department
Cardiff Royal Infirmary
Newport Road, Cardiff CF2 1SZ, Wales

Dear Sir,

In the November 1975 issue of *Hospital Engineering* you published an article by Addison and Edwards entitled 'A boilerhouse safety alarm'. We had already been asked to produce such an alarm commercially by one of the area health authorities.

The circuit of Addison and Edwards was known to us through our friends in the hospital-engineering profession, but we have always considered that any alarm system should be designed on fail-safe principles. This cannot be achieved 100%, because, in the end, there must be some viable power to raise the alarm. On the other hand, with a remote alarm, it is possible to ensure that if power to the transmitter is lost, or if there is an open or short circuit on the transmission line, at least a fail-safe false alarm is raised. (We do have a future development whereby a true alarm could be distinguished from a fault.)

A description of our 'lone attendant's safety alarm' is given below which we hope you will find interesting. We believe that the price is competitive—even with a 'do-it-yourself' circuit for hospital electricians. I cannot reveal details of the circuit which is currently the subject of a provisional patent application.

Pre-alarm transmitter: This should be situated at a convenient position in the attendant's normal place of work. It is intended to monitor his safety and will energise an output relay to operate a bell or klaxon giving a pre-alarm signal at fixed intervals.

The attendant must press the reset button on the transmitter within 2 to 5 min. (adjustable) of commencement of the pre-alarm or else a full alarm will occur at the receiver.

The transmitter also has an emergency button which the attendant may press at any time to raise a full alarm at the receiver.

Whenever it is convenient the attendant may reset the pre-alarm timer before a pre-alarm occurs by pressing the reset button. This allows the full fixed time before the next pre-alarm for doing essential work.

Full-alarm receiver: This should be mounted in a relatively safe 24 h manned position, such as a telephone exchange, control room or security lodge. It monitors a signal continuously received from the pre-alarm transmitter. Any loss of this signal, either because a pre-alarm has not been reset, or loss due to a fault condition, will raise a full alarm. The circuit is inherently fail-safe up to the receiver and loss of power to the pre-alarm transmitter or any open or short circuit on the alarm transmission line will result in a full alarm being raised.

Additional facilities: the pre-alarm transmitter and full-alarm receiver are the heart of the safety alarm system. In addition various other facilities can be added to suit individual requirements: these include a pre-alarm slave unit, a 7-day programme timer and a flashing alarm light.

Yours faithfully,
M. E. Filby, M.A., C.Eng., F.I.G.E., M.Inst. M.C.

Coleshill Automation
Fillongley Mount, Fillongley, Coventry CV7 8DS

Incinerator design—a case study

by G. H. SMITH

The increasing amount of plastics and other modern materials in hospital waste, coupled with increasingly stringent legislation on emission, has of necessity, given rise to a new generation of incinerators. This article illustrates the thinking behind the design and production of one such unit.

The disposal of solid waste from hospitals has become progressively more difficult over the years and many factors will contribute to make this facet of a hospital engineer's responsibility even more demanding in the future.

The amount and character of hospital waste has changed dramatically since the last war. The volume of waste has increased, owing to the advent of modern disposable aids associated with the operation of a medical care institution. The character has changed, owing to the various types of modern materials that have been developed and introduced by industry and, in this regard, plastics are of significant import. Many hospitals are larger and thus simply generate more waste.

The other important factors that have affected the disposal of hospital waste have been the increasing concern of the populace, promoted by the usual means of communication, over smoky emissions and odours together with increased vigilance by the environmental health officer.

In the pipeline there are proposals to the Department of the Environment which lay down far more severe standards for the operation of incinerators, with its teeth in the recommendation that only a limited period of dispensation be granted for incinerators which fall short.

Many hospitals are operating incinerators that will fall below these standards in some or all requirements. They are either overloaded, ill-designed for plastics, unable to cope with any liquids and/or have poor or non-existent antipollution features, not only to meet any new standards, but even to comply with the accepted performance of today.

Another problem is the character and performance of available labour to operate the incinerator. The incinerator of yesteryear design demands a sensitivity by the operator to bring out even a satisfactory level of performance. Unfortunately, it is difficult to get this interest with the labour of today, often because they are merely 'passing through'.

Because of the requirements of the Health & Safety at Work Act and its obligations on hospital authorities, at least in the larger hospitals, the machine should be fitted with a safe loader to remove the implications of loading a machine manually, with the egress of fume and the operator exposed to the firebed. In smaller hospitals the operator should also be afforded some protection from fumes and the firebed.

With the soaring price of fossil fuel, more hospital engineers will be looking for a contribution to the cost of steam raising from the recovery of waste heat generated by incinerators.

It has long been recognised that the breed of incinerators which met the needs of hospitals in less demanding times are unsuitable for the more advanced requirements of today and the future.

Range

To meet the needs of hospitals today, a manufacturer requires to have a range of machines sufficient to dispose of the waste from the largest establishments.

Design

The design of the incinerator has to be such that it can operate to a standard of performance better than that which is proposed as the new national norm, without the extra capital and operating costs of troublesome exhaust-gas cleaning. With water scrubbing there is that telltale white plume which attracts the attention of the public, and psychologically makes the incinerator responsible for every local smell and atmospheric anomaly.

The incinerator should be capable of smoke-free operation, even when burning the increasing volume of plastic in hospital waste.

Controls

The modern incinerator should have the same advantages as similar contemporary industrial processes which do not demand a skilled input from the operator.

A hospital incinerator should require no more than the touch of a button, without any need to fiddle with sensitive controls. The incinerator should not require the constant supervision of an operator always monitoring the progress of the last load.

Loading

The large incinerator, to protect the operator from the firebed, relieve him from the severe physical effort of loading and prevent the egress of fumes, should be fitted with a powerful, reliable, automated loader with a fail-safe operation and should be capable of withstanding the rugged demands of day-to-day operation with limited maintenance.

Mr. Smith is managing director with Robert Jenkins Systems Ltd., Wortley, Rotherham, Yorks. S61 1LT, England.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The smaller machines, when a loader is not selected, should have available a device to prevent any fume discharge and provide some protection for the operator from the firebed.

Liquid disposal

The hospital facility, especially if it is deeply involved in research, often has a requirement for the safe disposal of a limited amount of inflammable liquid. The hospital incinerator should have the capability of having a liquid disposal unit fitted.

Waste-heat recovery

Today more and more hospital engineers around the world are recognising that the hospital is generating free fuel, and as they have a requirement for both onsite destruction and steam, waste-heat recovery is a facility that cannot be ignored, especially with the price of fuel accelerating at the present rate.

Although the desirability of waste-heat recovery has long been recognised, there have been a number of drawbacks which have worked against its universal adoption. The waste gases from a conventional incinerator are relatively contaminated and therefore put any normal recovery boiler at risk from corrosion and clogging. On the other hand, with a water-wall incinerator, you have the problem of providing and operating a cooling tower when waste heat is not required.

Thus the hospital incinerator of today should be capable of providing clean hot-gases to a heat-recovery unit which should be responsive, and with no requirement for a cooling tower in periods of off-steam, but with no high maintenance costs.

In the late 1960s in the USA the Consumat incinerator was developed and is now being introduced into countries all over the world.

The design was based on the conception of starved air, which is often known as practical pyrolysis. The clinical performance was obtained by designing the main combustion chamber, effectively, as a distillation section. The chamber has no grate and the waste is reduced to a sterile ash by a process involving a mixture of pyrolysis, volatilisation and gasification, with a small amount of burning. The air supplied to this chamber is only sufficient for the needs of this process, quiescent conditions are therefore maintained and the gases are transferred to a second chamber at extremely low velocities, less than 30 cm/s.

The burners in this first chamber can be either gas or oil, and only operate until conditions are autothermic, which usually means they are off except for the first 30 to 60 minutes in a day. The temperature in the primary chamber is maintained at approximately 800°C by a water spray, which operates to an on/off principle, being activatd through the main panel according to the registered temperature.

The gases transferred to the second chamber are pierced by a flame and the temperature is elevated to approximately 1200°C where the oxidation process is completed and the smoke particles burnt out. The air introduced into the oxidation chamber is preheated by passing through an annulus ring round the burner.

The burner itself is temperature controlled, and only operates if the temperature falls. It oscillates between high and low fire and off, according to conditions, and falls into a matrix operation with the air supply, which also modulates according to the conditions registered in the oxidation chamber. In average plants, the burner in the oxidation chamber only operates 50% of the time, as satisfactory conditions persist in the remaining period. The exhaust gases are then cooled to approximately 800°C by an air attemperator mounted after and on top of the second chamber.

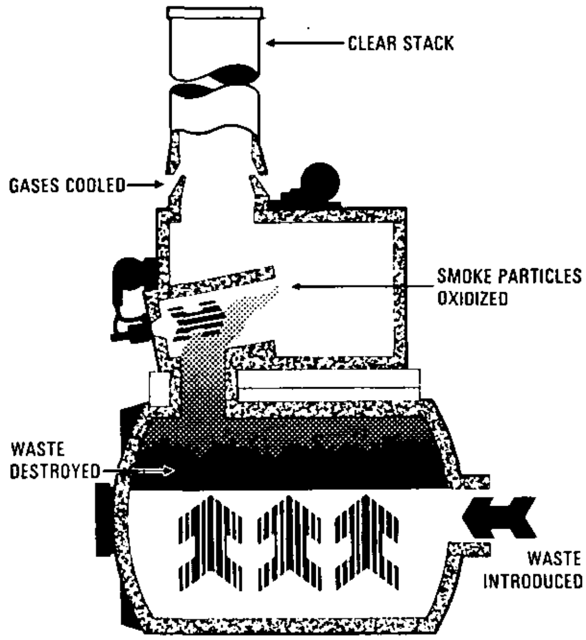

Fig. 1 Schematic of incinerator unit

The next stage in the development was to design a range of reliable peripheral equipment to complement this machine. The range included a powerful loader, with the controls integrated to the incinerator; a device for burning a proportion of liquid waste; an air curtain to protect the operator; hydraulic lift arms for hospital waste trolleys etc.

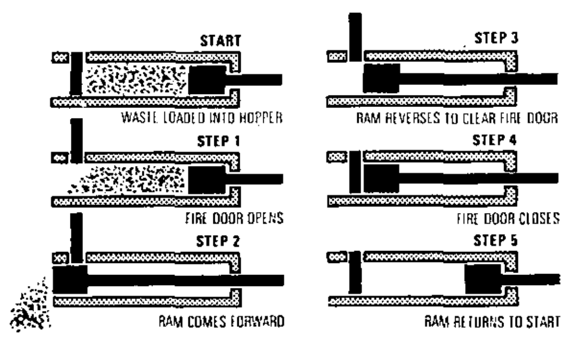

Fig. 2 Schematic of loader

The range of the incinerator units was extended to cover from as little as 22·6 kg/h to 1 000 kg/h.

At the beginning of this paper we reviewed the demands on an incinerator by a hospital in the UK today. The machine described above encompasses these demands for a range of up to 1 000 kg; accepts plastics without a problem; antipollution integral to the design without any requirement for gas cleaning, and a capability of meeting easily the new proposed UK emission standards; the availability of an adaption unit for burning waste liquid; complete automation, which means an operator has only a button to press; a power loader to ease the operator's job, together with the alternative of an air curtain on the smaller plant which helps the Authority to comply with the Health & Safety at Work Act.

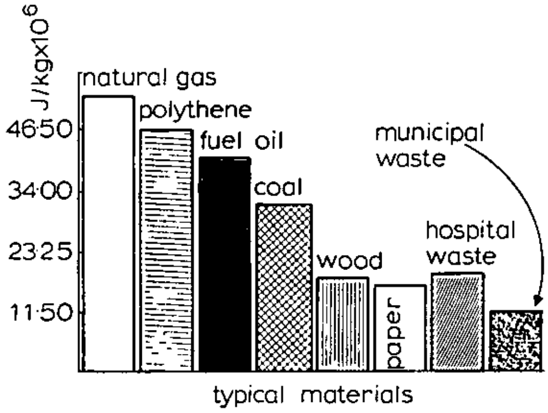

Fig. 3 Comparative heating values of waste

The only requirement identified earlier and not mentioned so far is waste-heat recovery, but it is in this regard that another development has been achieved.

When one considers Fig. 3 it certainly appears unfortunate that we are not recovering the waste heat from all the millions of tons of solid waste we are burning or depositing in holes in the ground all over the UK. We outlined some of the adverse reasons earlier for the slow growth of waste-heat recovery and these related to the problems associated with waste-heat recovery from older, conventional incinerators. As each Consumat is self sufficient, the manner of the development of the heat-recovery unit was logical because it was possible to use direct the same high-quality high-temperature exhaust gases which allow the unit to meet the strictest environmental standards.

The design policy adopted was to evolve a waste-heat recovery unit which would plug into an existing design and, at the same time, be flexible and reliable. The development was also structured so that the unit had to be capable of being added to any unit at a later date if the client wished.

Waste-heat recovery is true recycling—it does not depend to the same degree on forward market prices and does not demand the complicated segregation

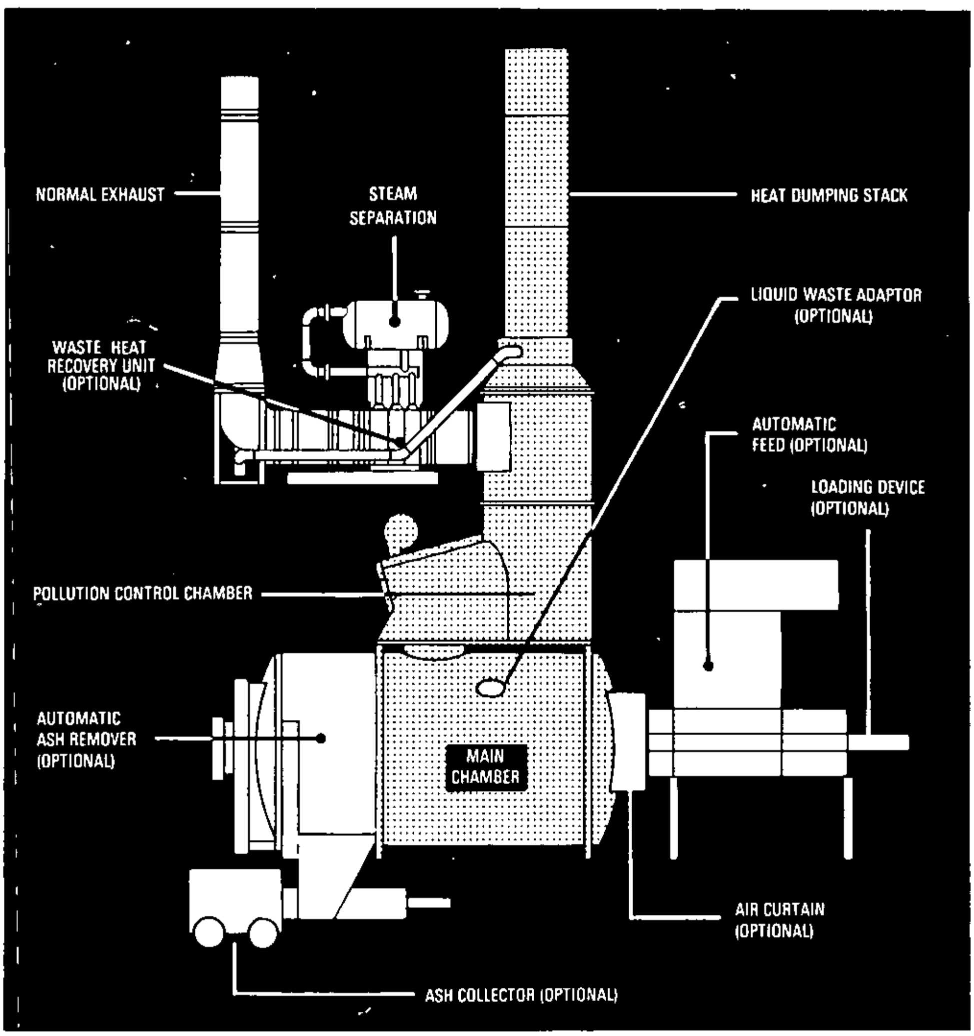

Fig. 4 Schematic of complete system

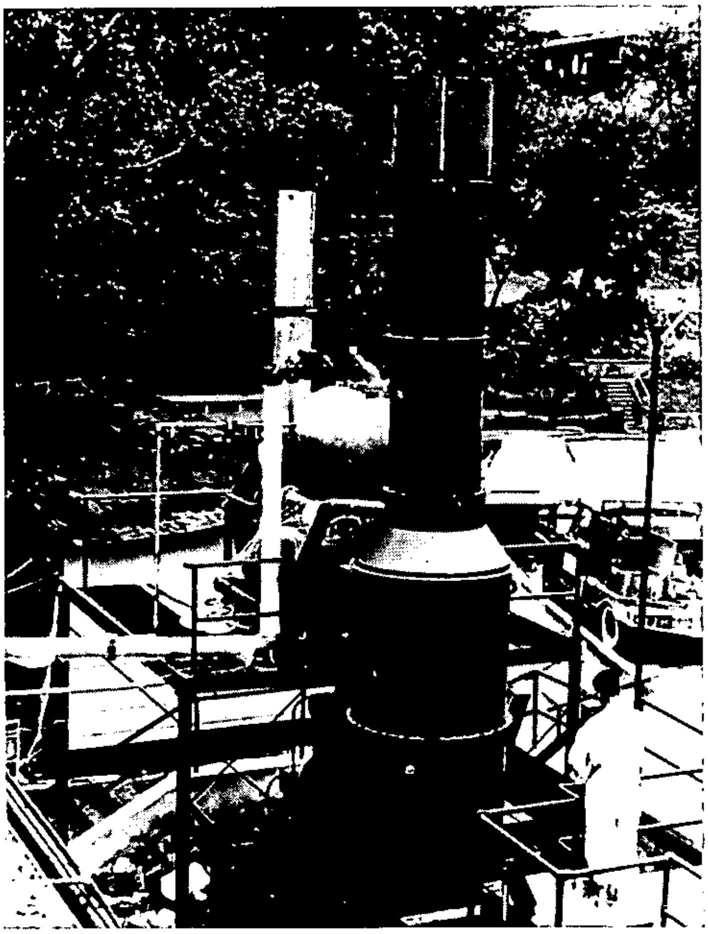

Fig. 5 Starved-air incinerator fitted with a waste-heat recovery unit contributing to the hospital's steam demand

processes involved with recycling selected materials. Waste-heat recovery in the present 'save it' climate can have a direct effect on hospital running costs and this country's balance of payments.

The waste-heat recovery unit takes the exhaust gases direct from the incinerator and can either reject them if there is no signal for steam, use them all, or even select a partial flow.

The unit sits on the top of the unit and uses aerodynamic valving to induce the hot waste gases to be drawn across the unit in the proportion required, or dump to atmosphere. Therefore, with aerodynamic valving, there are no mechanical devices in a high-temperature environment and maintenance is thus reduced.

The first unit with waste-heat recovery for the UK is being built at the moment to meet the needs of a large general hospital. In the USA where the first specialist-designed waste-heat recovery unit was fitted in a hospital in 1973, there are now a number of plants being built with this patented facility.

The system is failsafe; because, if there is a power or control failure, hot gases are immediately directed to atmosphere through the dump stack, there is no gas cleaning, no cooling tower and response to demand is rapid, in fact from full steam production to zero normally takes seconds.

The first of these incinerators in the UK was commissioned in the heart of London for the Imperial Cancer Research Fund in 1974 and there are now an increasing number installed or under construction.

IFSSEC '76

The International Fire, Security and Safety Exhibition and Conference—IFSSEC '76—will be held at Olympia on the 26th to 30th April.

The exhibition will provide visitors with a comprehensive display of equipment, materials and services associated with fire prevention, detection, extinguishment and fire fighting; security and crime prevention; industrial accident prevention and occupational health. Companies from the UK and overseas serving these industries will be exhibiting, in addition to exhibitors from the fields of risk management services and insurance. Government departments and official bodies will also be represented. Admission to IFSSEC '76 is free upon presentation of a complimentary ticket.

The conference will have three main themes: fire protection, security and crime prevention, and industrial safety and occupational health. Twenty-one seminars will take place in the specially constructed conference centre in West Hall, which is immediately adjacent to the exhibition in the Grand Hall. Simultaneous translation in English, French, Spanish and German will be available for both speakers' presentations and discussion sessions.

Several organisations are taking advantage of these facilities and holding their own national, or international, conferences during the week. Among these are the National Association of Hospital Fire Officers and the Institute of Municipal Safety Officers.

For further information contact the organisers, Victor Green Publications Ltd., 44 Bedford Row, London WC1R 4LL.

Equipment exhibition moves to NEC

The International Hospital Equipment & Health Services Exhibition is moving to the new National Exhibition Centre near Birmingham, where it is to be held from the 14th-18th June.

The exhibition and an accompanying conference are being sponsored by the weekly publication *Health & Social Services Journal.*

Since the exhibition was first held in London in 1958, it has become a recognised showcase for the many goods and services vital to the smooth running of hospitals and health services in all countries.

In the UK, some £4000 million a year is now spent within the health service. Approximately £1000 million of this is spent on equipment, materials and specialist services, but because the heaviest expenditures are on wages (about 70% of total), food and fuel, there is expected to be particular interest in equipment that can lead to automation of certain tasks, such as in communications, transport and laboratory techniques.

The exhibition and conference are being organised by Contemporary Exhibitions Ltd.

Interference, impertinence, and integration

A review of creative

Specialist skills, although very properly enabling progress to be made over one sector, may at the same time have a stultifying effect when viewed overall, primarily because of the development of our natural territorial defensive mechanism. To overcome this situation, it is suggested that everyone with a responsibility towards the end product (including both client and user), although retaining their sovereignty should respond in a lateral fashion and think of the whole product during the formative stages of a design. With present day English conventions, such free-thinking, truth-seeking attitudes may be construed as impertinence while attempts to integrate two multidisciplinary problems with one solution can be seen as interference. As a means of demonstrating how this deadlock may be successfully released, many detailed illustrations are given of the use (and misuse)of the concept of total planning within the building industry.

Introduction

Most people concerned with the design of building know of the objectives of integrated environmental design (i.e.d.)—mainly through detailed case studies of pilot buildings many of which are sponsored by the electricity boards and the forward-thinking thought-provoking building-science lectures given by certain eminent university professors and other educationalists.

I.E.D. is the optimising of three factors:

(*a*) the quality and consistency of the internal environment in relation to the functions of the building and the needs of the people using it

(*b*) capital costs

(*c*) running costs.

The task of optimising these factors in a multidisciplinary team, where often each discipline has an independent responsibility to the client, forms the stumbling block in the pursuit of this aim. Integrated design, more simply, is the optimisation of the many factors which apply to the timing, financing, aesthetics, construction, utilisation and maintenance of any building. Sufficient material is now to hand which show the advantages of considering the building as a whole—from client concept to 10 years of beneficial occupation.

The history of buildings in general, and habitable buildings in particular, however, is one of viewing the project from the outside looking in through the eyes of the originator. It is this attitude of mind which believes that the fundamental concepts of the building can only be derived from a single predetermined source that inhibits the free-thinking activities of the remainder of the design team.

Rather than dwell extensively on the architectural and engineering detail upon which the success of i.e.d. is founded, this paper endeavours to sow the seeds of this particular creative activity by enquiring into the fundamental reasons which cause us to behave parochially. Methods currently employed to overcome this apparent shortcoming are then briefly mentioned together with some detailed practical examples of lateral thinking in the building industry.

Parochialism—cause and effect

It is a fact of human behaviour that when a problem arises in the normal course of events and which we believe has been successfully tackled within our past experience, an instinctive urge demands the prescription of the medicine as before. On the other hand, when

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design within the building industry

by K. G. HANLON

Nottingham University Hospital and Medical School (photo: Building Design Partnership)

confronted within our professional areas with a problem which has hitherto proved intractable, we naturally tend to be ultracautious, but our remedy generally tends to be directed towards twice the amount of medicine as before.

Therefore it is usually only when all else has failed, and our experience has been fully researched, before we feel disposed to willingly accept a novel solution to a well-considered problem. The reason for this all too familiar failing is essentially one of social and intellectual convention—sometimes called conservatism—coupled with instinctive behaviour.

We are very much creatures of habit—by the time a person reaches 25 years of age experience of detail and society conventions begin to inhibit freedom of thought. All this is a very important part of our well being, because, together with instinctive reactions, the system forms the control part of our self-protective structure. (Incidentally this is the self-evident physical danger of psycomimetic drugs—by unlocking specially closed doors, and thereby opening new pathways in the brain, the body may be rendered vulnerable to everyday accidents.)

Thus our creative expression is inherently at risk in that by attempting to control our ideas for the sake of our own sanity, the control loop must be closed and positive feedback introduced. This means that in the analysis section of the brain increasing resource is made to the store of experience rather than the store of fundamental knowledge in the quest for a solution.

Without taking the analogies too far, it can be shown that the territorial activities of birds and animals performed amongst other things to preserve feeding grounds and protect their young can be directly related to tribal and nationalistic tendencies, medieval guilds, secret societies and, not least, to professional activities. There is an underlying need within every one to clearly define the extent of their responsibilities, to share with others those anxieties, and to mix in a society of kindred spirits. The situation is exacerbated within present-day society (as distinct from the isolated and independent stone-age family tribal life), owing to the many interlocking subactivities that are a natural consequence of any specialist development. The process of technical evolution shows that we develop our skills in isolation and that technology advances as a series of tentacles, with infilling periodically, and often convulsively, as economic pressures appear. The lead tentacles die and are replaced with others as technology advances without apparent order of direction.

As a typical example, by 1939 all the pertinent data concerning atomic physics had been assembled during a period commencing over 100 years ago (some in medieval times). World War II precipitated the integrated thinking which led to the nuclear-power industry of today.

Even though the need for change be felt, the opposing forces, both active and inactive, are such that only significant scientific or economic pressures can promote the necessary climate. Simply stated, whenever we have a well-defined status, we are not amenable to any change of our adopted identity. Thus, what is often offensively termed parochialism is built from the bedrock of age converging brain power and social convention. Integrated design primarily demands diverging thought. From contemporary history alone, it is not unreasonable to assume that once having established a new mode of thinking, social convention will adjust accordingly. It is in an endeavour to promote such lateral thinking that this article is written.

Lateral thinking

Lateral, or divergent, thinking is alien to the very roots of our teaching, where we were told to concentrate on the subject in hand to the exclusion of all others, and where all thoughts had to be logically derived one from another. Yet everyone is equally capable of contributing an original solution—the only factor distinguishing one person from another (given suitable conditions) is the interval of time in arriving at the solution.

Many books and articles have been written on the subject of creative design and problem solving. Brainstorming and encounter groups, think tanks, synectics etc. are all particular methods of overcoming our intellectual and social inhibitions, and thereby reducing the time interval. They all have as a common basis:

free response (for projecting ideas)
analytical mind (for interpreting ideas)

They all demand that one thinks constructively in the first instance, and that a truth-seeking attitude is formed.

Each method endeavours to promote, in its own way, the 'free-wheeling' approach ('feet on the handle bars') and whatever system of recording, sorting and analysing the output that may be appropriate.

In simple terms, however, the objective is to jump the boundary hurdles (of experience, politeness, discipline etc.) which cause us all to restrict our thinking to narrow paths, and then to allow our minds to run largely, but not totally, untrammelled, as the limits of the problem are gradually fed in.

As everyday examples of our limited approach to life, we take our holidays in the harvest time although it is now possible and indeed preferable that we take winter holidays. We work set hours, although, in many cases, this is no longer necessary and on several grounds is socially and economically undesirable. Artificial light is now cheaply available yet who thinks of society taking their leisure during the day and working during the evening? A reduction in crime would surely follow the advent of the cashless society. To really succeed one has to determine to be as far out (in terms of convention) as possible. (Incidentally, it is surprisingly difficult to invent the truly ridiculous solution.)

For instance, if given the objective of improving productivity together with, say, the detail problems of how to anchor and connect a battery, how many people would consider it unfair (because a full statement of the situation had not been given) if the answer to this problem was to do away with the battery! And yet this is really the situation designers always find. Problems are rarely fully stated, but we try to make up for this deficiency by inventing the limits of the problem.

In practice, it is very easy during a formal (paradoxically) think-tank session to engender the climate that enables ideas to flow. Outside the formal think session, however, our concern is not to appear foolish. We attribute wisdom to those who (usually speaking slowly) pronounce on the ideas of others. A newly formed design team therefore should have a shakedown 'social cruise' which will enable some inhibitions to be removed. Thereafter the demand is one of mutual trust. The social cruise will also help to overcome the second problem, the one of status—or pecking order, by allowing recognition of the individual for what he is, rather than the social position he occupies.

Yet everyone, regardless of his upbringing, is able to contribute ideas. Take for instance the Rolls-Royce motor car. Who can imagine that anyone could offer anything further towards the basic development of the car. And yet who can really condone a design which requires a car to be jacked up and the front wheel removed before the spark plugs can be changed, or the door taken off before the blower motor may be serviced. Imagine yet again a man metaphorically clad (to some members at least) in an oil-stained boiler suit seated at the high-level meetings called to discuss development, struggling to get a word in on behalf of the maintenance fitter!

Lateral thinking and the building industry

To achieve any degree of success with free-thinking creative design, it has been shown that changes in both attitudes of mind and methods of design management are necessary. Buildings have generally been designed, in the past, to a system which I have called successive engineering—commencing with the clients functional requirements, each discipline is successfully required to accept an increasingly constrained situation.

This is shown in Fig. 1 with some of the principal design criteria (which are to be found irrespective of project control system employed).

If, however, it is accepted that everyone who is closely involved with the project should have the opportunity to contribute ideas then the conceptual flow diagram becomes as shown in Fig. 2.

After the necessary preliminary establishment of mutual respect for each other's abilities, one hopes to see the partial breakdown of interdisciplinary barriers during the common search for the optimum solution.

The concept team's primary tasks are:

(*a*) think the building through from first principles
(*b*) determine the penalties of any deviation from the basic concept
(*c*) specify the performance standards.

The psychology of group working demands that the objectives be set by common consent, with certain key decisions being successively made by the client.

After the basic concept has been derived, the individual members of the concept team set up similar discussion groups within their individual organisations to enable the specified design standards to be met in the most efficient manner within the agreed constraints.

The design-concept team meet at regular intervals thereafter to monitor the development of the design against the stated principles, and to decide the second order of magnitude interdisciplinary policy problems that arise on any project of size.

During the whole period of the project, every man and woman engaged on the work should view the task as a series of successive objectives spanning the entire spectrum of activities. The most necessary discipline is that of adhering to a converging programme of decision taking points of no return. Up to those points, lateral thinking should be given full play.

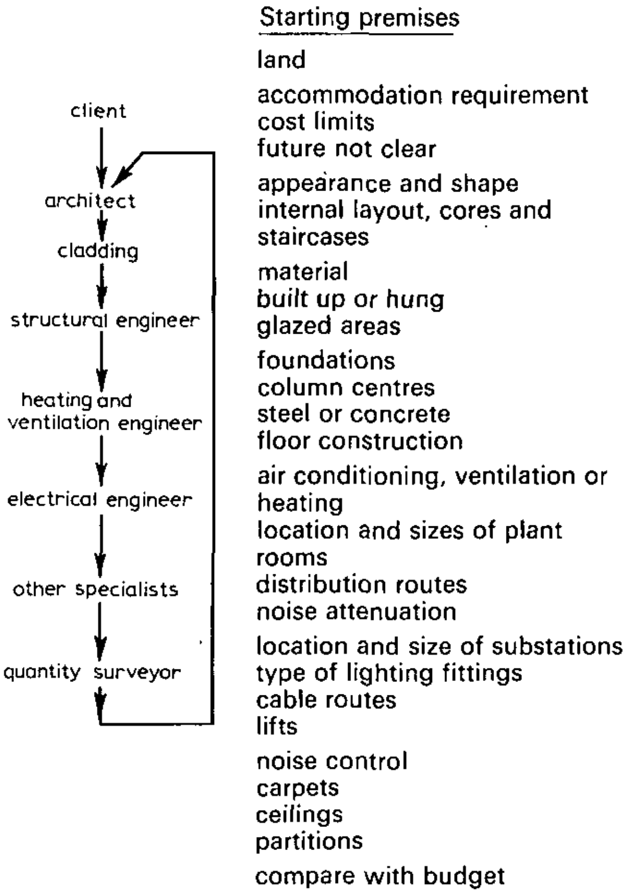


Fig. 1 Conceptual flow diagram for successive engineering

Some examples of integrated design

Before describing some small examples of integrated design, it is necessary to dispel the myth that such an approach is in itself stultifying. For instance, it is believed by many that i.e.d. buildings are all cubic in shape and lacking in 'form', but, as many examples will show, this is far removed from the truth.

The fundamental scientific design may well be a cubic shaped building (or indeed, in the extreme, spherical), but, as the other design factors are quantified and weighted according to some arbitrary scale, the design by common consent will slowly change as the optimum solution is evolved. The next point to be made is that lateral thinking is rarely carried out to the extreme; rather the opposite, the following examples show that integrated design is really the science of common sense.

Example 1: In landscaped offices, for reasons of privacy, it is necessary to have a reasonable noise-level threshold. Rather than electronically inject special noise into an otherwise quiet building, it is nearly as effective and certainly there is a reduction in costs if the air-condi-

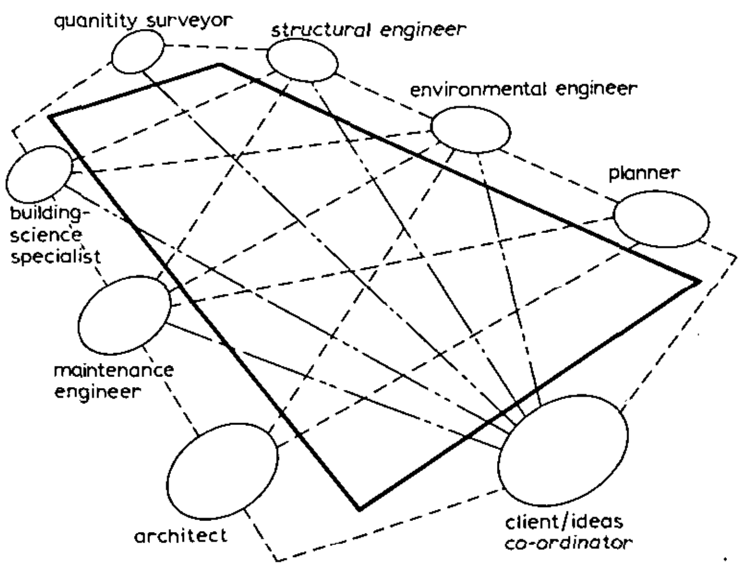


Fig. 2 Modified flow diagram

tioning equipment be designed to give a higher noise-level output than might otherwise pertain.

Example 2: As it is necessary to periodically remove the solids that accumulate in the ponds of cooling towers, by supplying the water to the toilet flushes from the cooling-tower ponds a continuous blowdown is achieved, thus the savings in water consumption, the cooling effect of the raw water and the warming of the toilet pans provide an additional bonus.

Example 3: Very often it is possible to partially justify ornamental ponds, by discarding some of the building heat through simple spray fountains.

Example 4: The ponded roof is usually employed to keep the top floor cool by evaporative cooling. In addition, it can also provide:

(*a*) a 'fail-safe' fire-fighting reservoir

(*b*) an ornamental or swimming pool

(*c*) thermal reservoir (either when linked to a cooling tower or simply as additional mass to the building).

Example 5: Discharge of vitiated and noisesome air extract from the building through spray cooling towers—thereby washing the air and simultaneously improving the efficiency of the tower.

Example 6: Efforts were to be made to stop vapour being seen rising from a prestige office block. Certain reasons prevented the use of closed cooling towers. Instead it was decided to site the cooling towers immediately below the 15 m long by 4·5 m high, 10 r.p.m. rotating radar aerial which effectively fans all vapour away.

Example 7: Building regulations demanded ventilation of the carpark; by ducting the air discharge from the air-conditioned offices immediately above, the requirement was met, the cars kept from freezing, the office floor warmed and the chances of air recirculation diminished.

Example 8: The development of the building structure around the services is probably of most significance. Both columns and beams formed as hollow sections to form air ducts and luminaires thereby enabling the floor-to-floor heights to be reduced, metalwork ducts dispensed with and lighting loads reduced.

Example 9: Spacing the two leaves of continuous horizontal double glazing sufficiently far apart to allow a man to clean the insides of the panes from within (n.b. an access door is fitted every 30·5 m).

Example 10: Probably the most commonly known aspect of i.e.d. today is the development of the deep-plan building, derived from an operational requirement of ease of communication leading to the secondary opportunity of immediate layout flexibility of departments. The advantages that gradually unfold are many:

(i) Because of shared facilities, the area given to each office worker may be reduced from 9·3 to 7·4 m^2.

(ii) Because of the reduction of corridors, the building utilisation factor is improved from an average of 0·75 to about 0·85.

(iii) Because of the tendency towards a cubic shape in the building, perimeter lengths, and hence construction costs, are reduced.

(iv) Deep offices require artificial light, rendering windows as light sources superfluous. Reduction of glazed area means a considerable reduction in construction costs.

(v) reduced perimeters and less glazing mean improved thermal efficiency and lower plant capital and running costs.

(vi) By considering the building as a shell (and the internals as the scenery) long-term flexibility is improved.

Deep-plan design demands that particular attention be paid to the working environment, better lighting, thermal comfort, furniture, physical comfort and visual relaxation and often a reduction in capital costs is the result of this endeavour.

Conclusion

In diffidently suggesting that attitudes and methods in the design of buildings be nearer that of modern industrial technology, it is appreciated, as mentioned at the outset, that the building industry has a long and coruscated history. Architects and engineers of outstanding ability, leadership and stature dominate this history and epitomise the sense of duty that designers continue to have towards the world in which we live.

The problem facing most design teams today, however, is that no single person can adequately span all disciplines. It is very evident that the rapid development of new building materials, adopted (if not accepted) techniques, and indeed environmental standards, are straining both credibility and the trained resources within the industry.

In such a climate, free-thinking truth-seeking public attitudes by relative newcomers, often trained in another discipline, may easily be construed as *impertinence* by the recipients who have often spent many years learning the history of buildings before being allowed to apply to art. Attempts to bridge inter-disciplinary problems by a single novel solution are again often seen as *interference*.

Successful integrated design therefore depends upon two primary factors:

(*a*) Acceptance, by the entire design team, that the opportunities within every design activity may very well register much more sharply to a member (or anyone else) who is not trained in the discipline than one who is. He is not, in fact, beset with the difficulty of knowing the details of his proposal.

(*b*) The adoption of a suitable methodology, based on free-ranging frank conceptual discussions, the object of which is to think the project through as a whole and not as a series of loosely connected parts.

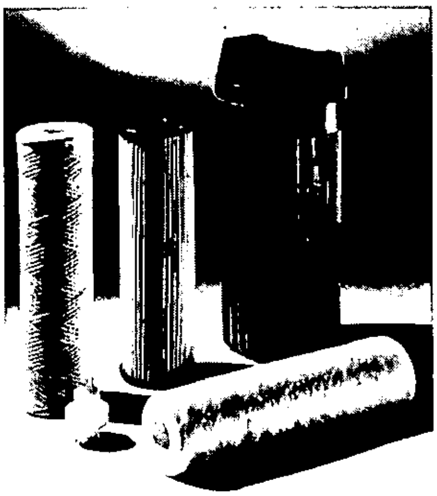
Mutual trust and respect between all members is indeed a big advantage and is especially necessary over a long-term project. In the short sharp encounter, however, it need not be present.

Taken out of context, and viewed with hindsight, all the details of any integrated design may be considered common sense. It is in the cultivation, cutting and mounting of these brilliants of simplicity from contributors of widely differing backgrounds that is the unique problem facing the building-industry design teams today.

HE Product news

Filter units

Intended primarily for the filtration of water and liquids, these pleated polyester cloth and polypropylene elements may also be employed for air and gas filtration. Over the range they have filtering rates of 1, 5, 10, 25 and 50 μm. The screw-fitting parts of the housings are positively sealed by means of a single 'O' ring, a construction that allows for rapid servicing. Installed by connecting to 20 mm (0·75 in) threaded pipe, the two housings have external diameters of 132 mm and



lengths of 313 and 581 mm. Fibre-reinforced walls and effective sealing permit working pressures of 9 km/cm² at 35°C or 5 km/cm² at 65°C. Housings and elements are nonrusting and resistant to corroding chemicals at elevated temperatures and may be sterilised, if necessary, by autoclaving at temperatures up to 125°C or with saturated steam at 100°C.

Schumacher Filters Ltd., 69/71 Wilkinson Street, Sheffield S10 2GT, Yorks

Generating sets

A 4-page leaflet describing the recently introduced range of 292–735 kVA generating sets powered by the Cummins 'K' range diesel engines is available. The leaflet, covering electric-start, automatic mains failure; fully enclosed and mobile generating sets, includes technical and performance data and installation details. Optional accessories are also listed.

Petbow Ltd., Sandwich, Kent CT13 9NE

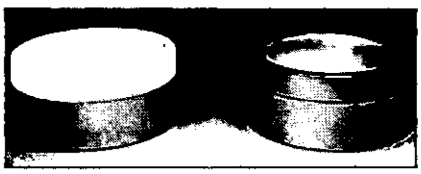
Starter

The KU12BT starter, rated at 5600 W (7·5 h.p.) incorporates the K12 contactor introduced recently and consists of this contactor plus the same thermal overloads incorporated in the existing KU16BT type. The starter is enclosed in a compact metal enclosure, having approximate dimensions of 160 × 78 × 100 mm. Both contactor and overload are removable by a single screw, allowing easy access for wiring and mounting of the enclosure.

B & R Relays Ltd., Control Gear Division, Temple Fields, Harlow, Essex CM20 2BG

Emergency luminaire

This unit can be used as a single-point emergency luminaire or installed in overall lighting schemes. Three 2·4 V, 1A tungsten lamps are carried in the front of the gear tray, all underrun on mains supply, and two of these lamps are switched to full brightness if the mains supply fails. The reverse side of the gear tray carries a 2-way terminal block, in addition to the mains terminal



block, to facilitate remote switching at low voltage if required; there is also a power pack consisting of two sealed nickel-cadmium cells giving a minimum of 3h emergency operation. A choice of flat clear quismatic or white opal-glass diffuser is available and the luminaires can be installed on 20 mm conduit or BESA boxes.

C. M. Churchouse Ltd., Lichfield Road, Brownhills, Walsall WS8 6LA

Shelving

Dexion Ltd. has introduced a new range of long-span shelving components known as Spandex. The range consists of three basic components: frames, beams and shelves. Clear shelf spaces of 2·75 × 1·2 m are possible, with a loading capacity of 1225 kg. A 6-page brochure describing the entire range is available.

Dexion Ltd., Dexion House, PO Box 7, Empire Way, Wembley, Middx. HA9 0JW

Hydraulic gauges

A range of six hydraulic gauges, covering pressures from 3·4 to 344 bar (50–5000 lb/in²g), is available from Schrader. The gauges have vertical scales, calibrated in lb/in²g and bar, and operate using a direct-action spring-loaded piston principle which withstands severe shock loads with no damage to gauge mechanisms, and is claimed to give a long and dependable operating life. The piston can also be used to operate limit switches or safety devices. Built-in snubbers dampen pressure surges and prevent indicator flutter, with an accuracy maintained to 3% of full-scale reading.

Schrader Pneumatics, Walkmill Lane, Bridgetown, Cannock, Staffs WS11 3LR

Smoke detector

Photain Controls Ltd. has introduced a smoke detector with an operating range up to 3 m. The system consists of a solid-state gallium-arsenide light source mounted in a flanged steel housing complete with optical system and suitable for fitting on one side of a duct. A photocell and optical system are mounted in a similar housing for fitting on the opposite side of the duct. The infrared light beam is projected across the duct on to the photocell, thereby providing a monitoring system for the whole width of the duct. The light source and photocell are connected to a control unit which can be mounted remotely, up to a distance of 50 m away. The control unit contains the power supplies, indicator lamps, variable-sensitivity control and outputs for operating alarm bells, plus contacts for switching fans or dampers. The sensitivity control enables the operator to set the alarm point from minimum smoke (equivalent to a 0·1 Ilford neutral density filter) up to maximum smoke (equivalent to a 2·0 Ilford neutral

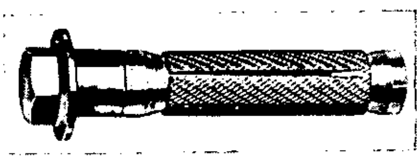
HE Product news

density filter). The system can be provided for operation from 230/250 V 50 Hz, 12 V d.c. or 24 V d.c.

Photain Controls Ltd., Unit 18, Hangar No. 3, The Aerodrome, Ford, Sussex

Sleeve anchor

This expanding bolt-fixing system is designed to provide parallel grip along its length. The fixing consists of a bolt which passes through two cones at the top and bottom of a steel sleeve, which is milled for grip and slotted for expanison. As the bolt is tightened, the cones compress the sleeve causing it to exert full and equal pressure within the hole. It is a same-size-hole fixing, offering additional benefits for on-site installations for which it is not necessary to premark the positions of equipment being secured. It is self-contained, with its own bolt and washer, and, once the hole is drilled, it requires only to be inserted and tightened. A special feature is that it does not depend upon material strength at the back of the hole, as with many traditional anchors; it can, therefore, be installed in walls and panels of relatively narrow dimensions. The sleeve anchor is available in diameters from 6 to 21 mm and in a range of lengths to suit most applications.



Impex-Suprafast Ltd., 435/7 Great West Road, Hounslow, Middx. TW5 0BY

Filter regulator

The type FR920 filter/regulator combines high-efficiency coalescing filtration with a high-quality pressure regulator in a convenient piggyback unit. The product is designed for cleaning and regulating compressed air for sensitive pneumatic systems, and may be used in place of separate regulator and filter combinations. Dirt, oil and water droplets are removed by the replaceable filter cartridge before the air passes to the regulator section, and flow direction through the filter is arranged to allow the liquids to collect in the filter bowl and be drained manually or automatically. High-performance coalescing filtration and proper drainage can only be achieved when air flow direction is from the inside of the filter element to the outside. The FR920 is available with either see-through polycarbonate filter bowl or in an all-aluminium construction, and with three alternative control pressure gauges.

Balston Ltd., Springfield Mill, Maidstone, Kent

32nd Annual Conference, Royal Hotel, Norwich, April 28th-30th, 1976

Membership of conference

There will be a Registration Fee of £18 (eighteen pounds) permitting attendance at the entire Conference, with a daily fee of £9 (nine pounds) allowing attendance at the two sessions on any one day and a sessional fee of £5 (five pounds) which allows attendance at any one session. Lunch is included in these fees.

Visitors from other societies and organisations, and *from the hospital service, are welcome to attend any* session of the Conference, Registration fees as above.

Payment of expenses—Hospital Service Members. In accordance with the authority given in Circular HM (54) 55, officers may be granted special leave with pay to attend conferences on work with which they are concerned. Travelling and subsistence allowances at the usual rates may be paid to officers, provided that approval to attend has been obtained from the employing authority.

The conference dinner dance will be held at the Royal Hotel, Norwich on the evening of Thursday 29th April.

Conference programme

Wednesday 28th April

10.00 a.m.
Coffee

10.30 a.m.
OFFICIAL OPENING of the Conference by JOHN BOLTON, LL.B.(Lond.), C.Eng., F.I.C.E., F.I.Mech E., F.Inst F., Hon.M.I.Hosp E., FRSH, F.I.Arb.,
Chief Engineer, Department of Health and Social Security

10.35 a.m.
'THE USE OF RELIABILITY TECHNIQUES IN THE DESIGN OF MEDICAL ENGINEERING EQUIPMENT'

Speaker: B. SAYERS, B.Sc., A.M.C.T., C.Eng., M.I.E.E.
Project Leader, UKAEA, Systems Reliability Service

Chairman: F. H. HOWORTH, F.R.S.A., F.Inst P.I., F.I.I.C. F.I.Hosp E.
President, The Institute of Hospital Engineering

2.30 p.m.
'HEALTH AND SAFETY AT WORK ACT, 1974'

Speaker: A. D. D. JENKINS,
H.M. District Inspector of Factories

Chairman: B. A. HERMON, C.Eng., M.I.C.E., F.I.Mech E., F.I.H.V.E., F.I.Hosp E.
Regional Works Officer, South West Thames Regional Health Authority

Evening
CIVIC RECEPTION given by the Lord Mayor in the City Hall, Norwich

Thursday 29th April

10.00 a.m.
Coffee

10.30 a.m.
'ECONOMIES IN DESIGN AND OPERATION OF HOSPITAL ENGINEERING SERVICES'

Speakers from the Department of Health and Social Security will present the latest thinking on this subject

Chairman: W. S. WILLIAMSON, C.Eng., F.I.Mech E., F.Inst F., F.I.H.V.E., F.I.Hosp E., MRSH, M.B.I.M., M.Cons E.,
Consulting Engineer, Oscar Faber & Partners

2.30 p.m.
AS ABOVE (continued)

7.30 p.m. for 8.00 p.m.
CONFERENCE DINNER DANCE

Friday 30th April

10.00 a.m.
'THE CONSULTING ENGINEER ABROAD'

Speaker: J. RICHARD HARRISON, C.B.E., C.Eng (Fellow)
Consulting Engineer,
J. Roger Preston & Partners

Chairman: W. A. G. SANIGAR, C.Eng., F.I.Mech E., F.I.E.E., F.I.P.H.E., M.I.Plant E.
Regional Works Officer, East Anglian Regional Health Authority

12.15 p.m.
CONFERENCE CLOSURE by F. H. HOWORTH, F.R.S.A., F. Inst P.I., F.I.I.C., F.I.Hosp E.
President, The Institute of Hospital Engineering

Ladies' programme

A special ladies' programme has been arranged. An introductory ladies' coffee party will be held in the Royal Hotel on the first morning of the conference.

Hotel accommodation

Special arrangements have been made with the conference hotel, the Royal Hotel, Norwich, in regard to accommodation for delegates and wives.

Tickets for the Conference and the conference dinner dance, and registration for accommodation at the Royal Hotel, should be obtained by application to: The Secretary, The Institute of Hospital Engineering, 20 Landport Terrace, Southsea, Hampshire PO1 2RG.

Institute news

WEST OF SCOTLAND BRANCH

On the evening of the 18th December 1975 a small party of members from the branch paid a visit to the studios of the Glasgow & West Hospital Broadcasting Service, Glasgow. We were welcomed by Eric Simpson, the administrative director and Ian McDougall, the technical director.

The station, which uses the call name HBS Glasgow, is on the air to eight Glasgow hospitals seven evenings per week. The programme service, it is hoped, will be extended to cover other Glasgow hospitals in the near future. Programmes are broadcast between 7.30 and 10.00 p.m. Sunday till Friday and 6.15 and 10.00 p.m. on Saturdays and are relayed to the hospitals concerned over a landline system rented from the Post Office.

The Organisation, which is registered as a charity, is run on an entirely voluntary basis and draws its members from all walks of life. The aim of the Service is to provide a supplementary local radio service which will bring Glasgow into the wards of its hospitals. The therapeutic value of the service has been particularly evident in long-stay hospitals such as Foresthall Hospital and Home and the plastic-surgery unit at Canniesburn Hospital.

In addition to broadcasting programmes to the hospitals, members of the organisation pay regular visits to the wards of the various hospitals concerned in order to collect request material and also to talk to patients about the programme service and its content. Both these visits and the programmes which follow are most warmly received and the members consider the hospital visits to be as important as the actual broadcasts.

Facilities at HBS Glasgow are extensive for an organisation of this nature and include a continuity studio which is the final control point for the station output. In addition to being used by the continuity announcer, this studio also acts as a control point from which discs and tapes can be played into a programme by a technical operator.

A double-glazed window separates the continuity control room from studio two, in which the announcer/disc jockey may, if he chooses, use a self-operated system which allows him to have complete control over the playing in of discs and tapes during programming.

The service also maintains a multi-purpose recording studio (studio one) and associated control room which houses a 16-channel sound-mixing console. The professional standard of equipment used is mainly due to donations from the BBC and Scottish Television and many of the HBS Glasgow personnel are employed by the broadcasting organisations. Studio facilities permit the recording or live broadcasting of beat groups, small bands, chamber groups, solo performers plus backing groups, both vocal and instrumental. The service has also expanded into drama and short stories, written, produced and presented locally.

New members

In addition to studios and control rooms there is office accommodation, a record library and a small lounging area which provides HBS Glasgow members with an assembly area for the compilation of programme material without causing interference to live broadcasts.

The service always welcomes new members and can offer an interesting, rewarding hobby for those with an interest in broadcasting, whether it be in terms of production, presentation of programmes, operation of technical equipment, electronic engineering in the maintenance of equipment or the social aspect involved in hospital visitations.

During our visit we were treated to coffee and everyone was extremely keen to tell us of his or her part in the organisation and answer our questions. Finally our Chairman Alan Gray thanked everyone for their hospitality and commented that most of us had been totally unaware of the scale of this service prior to the visit.

Annual dinner and dance

The branch held its annual dinner and dance on the 23rd January in the Burnbrae Hotel, Bearsden, near Glasgow. As usual, the occasion was well supported and members and their friends had a most enjoyable evening. Guests included F. H. Howorth, President of the Institute and Mrs. Howorth, S. C. Agnew, Chief Engineer of the Scottish Development Department and Mrs. Agnew, Prof. A. Stewart of Strathclyde University's Department of Environmental Engineering and Mrs. Stewart, and W. Carson of Glasgow University's Building Services Research Unit and Mrs. Carson.

At the branch meeting on the 29th January, in the offices of the Greater Glasgow Health Board, M. Bloxwich and B. V. Chapman of the Static Switching Group presented a paper on 'Solid-state communications for hospitals'. First Mr. Bloxwich dealt with the subject of solid-state nurse-call systems. He began by describing the function of a simple system using only a thyristor and developed from this to include the additional circuitry necessary to provide stabilisation, power, tone generation, etc. Mr. Chapman then took over for the second part of the talk which dealt with a new concept in fire-alarm systems. This is a system employing a time division multiplexing method of transmitting many pieces of information over an inexpensive screened twin cable which can be looped around all zones. Mr. Chapman dealt at length with the methods employed to code and transmit the signals and highlighted the advantages of the system such as reduction in the amount and size of cable required and the ease with which the system can be extended.

The members were very impressed by the standard of the equipment and component circuits which the speakers had on view and after a break for coffee a lively question time followed.

EAST OF SCOTLAND BRANCH

The following programme of visits and meetings has been arranged for 1976:

27th March
AGM at Montrose

24th April
Ninewells (it is hoped to have meeting with the area maintenance manager)

29th May
Visit to Aberdeen (to be arranged)

26th June
Visit to see ventilation plant in the Seafield Colliery

21st September
Limb Fitting Centre, Monifieth

30th October
Aberdeen (to be arranged) also nomination of office holders

Further suggestions from members for visits will be welcomed by the branch secretary.

HE News

New association

At a meeting in London in December, five major British manufacturers of medium-sized generator sets started a trade association, to be called the Association of British Generating Set Manufacturers, to serve this branch of industry.

The five founder members are: Auto Diesels Braby Ltd., Dale Electric of Great Britain Ltd., Dawson-Keith Electric Ltd., Grahame Puttick Ltd. and Petbow Ltd. The meeting established the main aims of the Association as: formulating and maintaining a common basis of relevant technical standards and services; representing members' interests in discussions with public authorities and other bodies; examining opportunities for improving exports; and representing members' interests in establishing reasonable minimum technical standards with principal supplier. The Association also intends to publish a trade journal to be called *Power Generation Industrial.*

Further meetings will be held in the near future to establish terms of membership and draw up a list of companies who may be invited to participate.

IHVE President comments on district heating

'The conflicts impeding progress' was the title of a paper presented to the District Heating Association after its annual general meeting on the 3rd February by J. M. Cooling, B.Sc.(Eng.), A.C.G.I., C.Eng., F.I.Mech.E., F.I.E.E., President of the Institution of Heating & Ventilating Engineers.

Conflicts

The areas of conflict identified by Mr. Cooling were technological, environmental, economic, statutory and strategic. The technological conflicts were seen to be related mainly to the use of combined heat and power stations, whose primary purpose would be the production of heat, with electricity as a byproduct. Another problem is the difficulty of obtaining balanced loads; correcting the imbalance by using the generated electricity for controlled topping-up was suggested as a way of overcoming the problem.

Environmentally, district-heating networks present fewer problems than overhead power lines; but there is conflicting evidence on the economic viability of district heating which is not easy to analyse.

The statutory limitations on the sale of electricity were seen as a major stumbling block for any combined schemes that might be considered, although this could depend on the findings resulting from the study now being carried out by the CEGB on the use of a number of existing power stations.

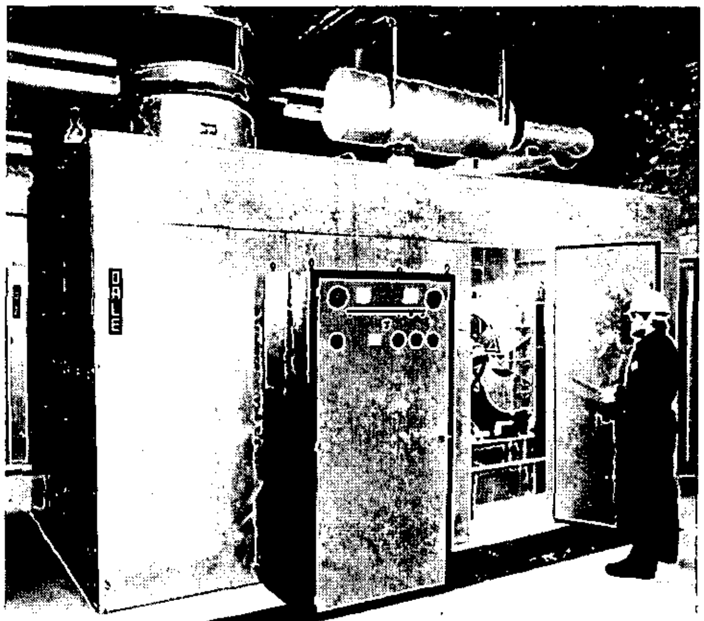
Energy policy

The overriding factor in present circumstances, in Mr. Cooling's view, is to reduce fuel consumption, particularly oil, any extra cost involved being borne by general taxation, the traditional method of funding deficits in nationalised-industry accounts. A fundamental necessity in overcoming the conflicts impeding progress is the early introduction of a national energy policy.

Summing up he suggested that:

- Good technologists should judge the various conflicts from an engineering standpoint and produce the best engineering solutions regardless of their own particular interests.
- They should use their ingenuity to preserve as much of their heritage as can be afforded and determine to afford as much as is needed.
- They should obtain facts rather than opinions as to the economics of energy conservation schemes. Mr. Cooling said that be believes that a considerable amount of this information must now be available.

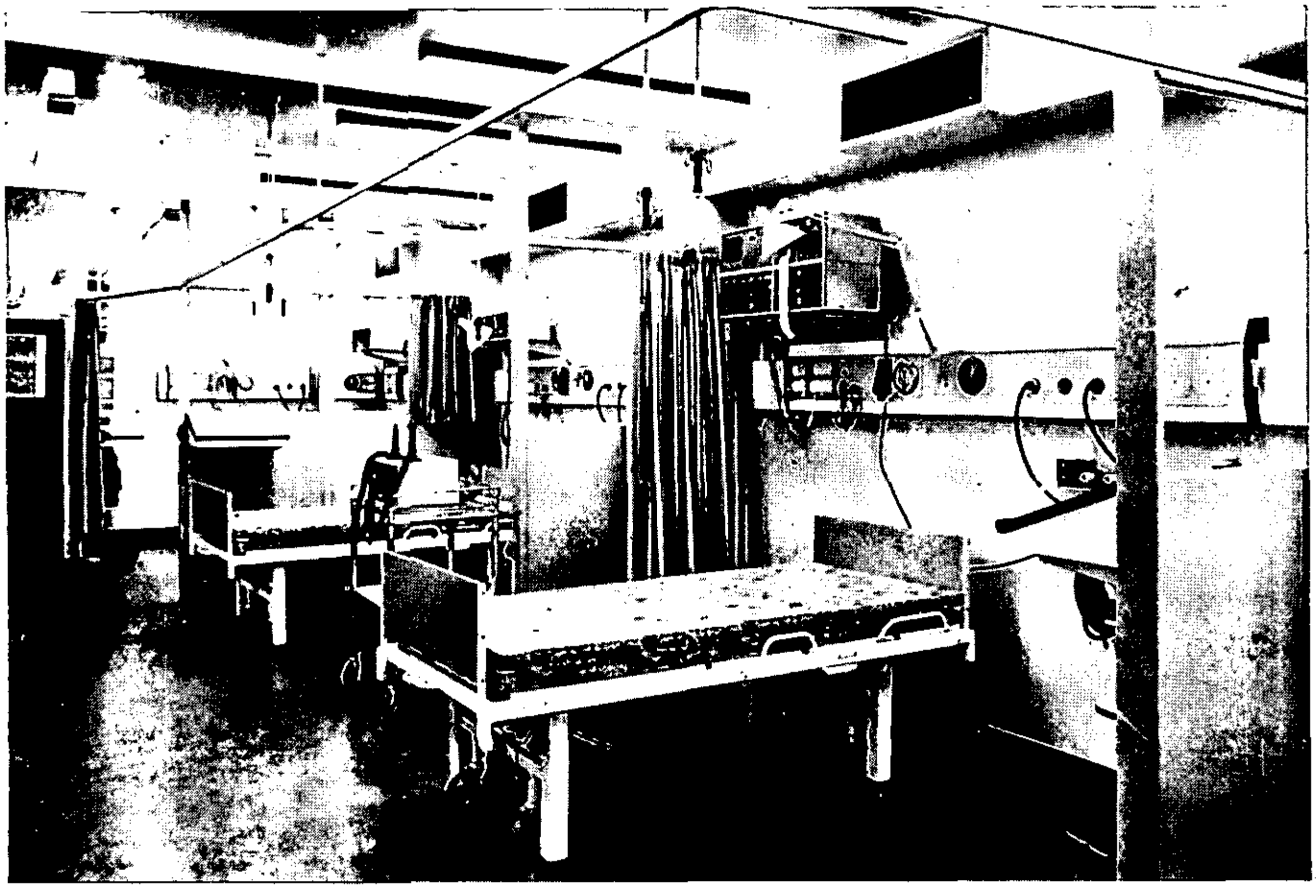
Quiet generating sets at York's new d.g.h.



The generating sets, with sound-reducing equipment, at the new York hospital

Two custom-built Dale 323 kVA standby generating sets, with sound-reducing equipment, supply emergency power for the new £10 million 1000-bed York District General Hospital, which, when opened, will replace seven existing old hospitals in and around the city. The generating sets are housed in sound-deadening enclosures to reduce engine-room noise level and have attenuators and acoustic louvres to meet the noise-level criteria of 45 dB at 1202 m (40 ft) owing to nearby residential property.

In an emergency, the Dale sets, powered by Dorman 6QTCA diesel engines, will supply the hospital's 14 operating theatres, one-third of the corridor lighting, 50% of the boiler plant, one main lift in each block, fire-escape lighting and a percentage of power points and lighting in all wards.



Hospital engineering services—an overall viewpoint by G. C. BUSHILL

It is unfortunately often true that, in the design of health-care areas, scant attention is paid to the needs of the engineering services. The author points out some of the pitfalls to be avoided and provides some guidelines to minimise the cost and increase safety and efficiency in the hospital engineering services.

Design

When planning health-care areas, ergonomists consider the layout of bed, locker, chairs, wash-hand basins and the like, and generally the results are practical in that, for instance, the basin is installed in such a way that it will hold water, and at such a height that the hands of normal people may be washed in them! These things we take for granted. Unfortunately, not so much consideration is given to the other essential items, particularly the engineering services.

Mr. Bushill is marketing planning manager with Hospital Engineering Systems, Medishield (Harlow) Ltd.

For each activity there is a band of acceptable operation. Outside this, the operator has to adopt a posture that is unnatural or which is not suited to the task in hand. For some time now the recommended height for gas-terminal units has been approximately 1500 mm from the floor, and those that insert and read flowmeters, suction controllers or the like into the terminal unit find the tasks easy. Not so fortunate is the cleaner fitting plugs into socket outlets at skirting level! There is therefore an activity to be considered for each service provided in a given patient environment, and this activity should determine the quantity, type and position of all service terminals in that particular situation.

Since the human engineering aspects often demand that other equipment, such as sphygmomanometers, drip booms, clocks etc. be mounted at 'services' height, then it is logical that these should also form part of the services system. A properly positioned equipment support-rail system completes the requirement to ensure that both services and equipment in any area can be easily changed to suit the changing activities within that area.

The author was recently in a new single-roomed maternity unit where the 'in-labour' patient was provided with a hand set to select the programme and volume from the radio system. The one thing she really needed—the nurse call—was a button on the wall behind the bed that was virtually impossible to reach!

Lighting, too, is often very attractive to look at, but not so good to see by, and we all know about limit stops on adjustable reading lamps (put on with the best of motives) that are broken off so that the clinician can use the lamp for his first-line examination.

The first rule in the design of engineering services should therefore be that all service terminals and related items are to be, in both function and position, suitable for the use to which they are put within each activity area.

Safety

Having established the human engineering criteria, the next question to ask is 'is it safe?' There is great enthusiasm, in some parts of the world, to introduce the most elaborate and expensive systems to ensure patient and operator safety. The draft standards of the IEC bear witness to this. We in this country have for so long installed to the IEE regulations that sometimes we may be in danger of assuming that they are outdated for hospitals in view of techniques introduced since they were written, such as cardiac catherisation. Our safety record shows that this is not so, the BS1363 square-pin 13 A socket outlet, with its guaranteed neutral conductor, and the use of transformers to provide isolated extra low voltage have, in practice, achieved remarkable results. There is really no need to go beyond these regulations, since the associated equipment should be (and will have to be once the IEC's standards are published) safe in its own right. Patient equalisation, isolating power transformers, and the 'everything connected to protective earth' syndrome are not necessary, are very expensive, and indeed in the latter case can be positively dangerous.

Medical gas-pipe runs, now that HTM 22 has been brought into line with the IEE regulations, can be either effectively bonded to, or alternatively isolated from, protective earth, and the former is the only practical course of action. The pipe work should not, of course, be used under any circumstances as a protective earth conductor. Running pipework in the same trunking system as the electrical services presents no safety hazard provided that they run in separated compartments with pipework in the lowest section and freely vented to atmosphere. In the case of a faulty system, escaping gas should not cascade over electrical cables, or in any way have a low-impendance path into the electrical sections of trunking, bedhead services panels, or any other restricted space containing electrical cables or equipment. This is logical and within the word and intent of HTM22, yet we still see systems with pipework and electrics within the same effective space and not even vented to atmosphere.

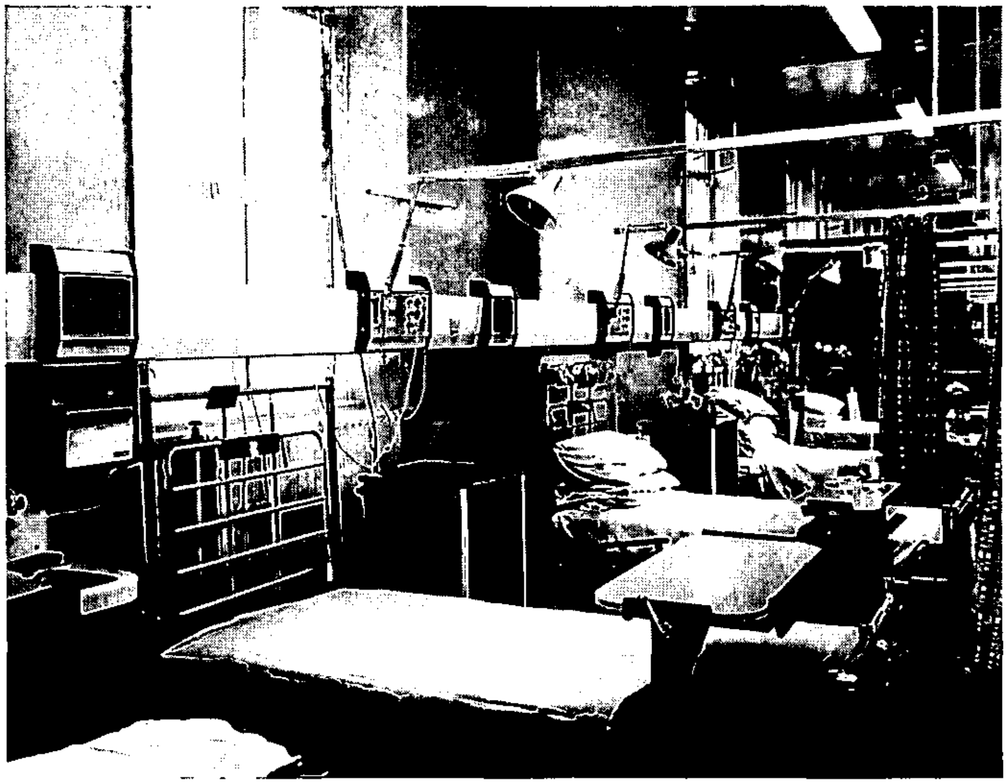


Fig. 1 Trunking spanning windows as part of upgrading of old wards

The second rule is therefore that all services should be effectively segregated from source to service terminal with gas pipework freely vented to atmosphere.

Ease of maintenance

If we are to keep on-going revenue costs of hospitals down, one of the ways this may be achieved is to ensure that bed occupancy is little affected by maintenance of the services. The first and obvious approach is to ensure that all services are easily accessible, particularly within areas used for patient handling. Today we have demountable ceilings for the corridors that leave the corridor · free for traffic, yet totally accessible for services without the clutter of support grids. The revenue savings of such a system far outway the initial capital cost. Within the wards, the services may be run in a trunking system so that again all services are easily accessible, whether surface or flush mounted. One ongoing expense of such systems that is not often considered is the ability or otherwise of servicing or amending the medical gas pipework without calling in the electrical trades, and vice versa. With costs as they are, the fewer people called to site the better.

Service units at the bedhead should, whenever possible, be separated into smaller units that can easily be removed for maintenance. Some composite bedhead units when removed from the wall are still anchored to it by various electrical connections that invariably then part company; so servicing tends to be a continuous process! The design of all ward services, particularly those integrated into a common system, should therefore be considered from the on-going maintenance viewpoint rather than first appearance—like all pretty faces they tend to be expensive to keep!

The third rule is therefore to make sure that the whole system is readily accessible, so that maintenance is as simple as possible and causes the least disruption to patients or staff.

Flexibility

Today's hospitals face many changes in both technique and use. Moving beds in or out, adding wardrobes and the like may be achieved with little effort or disruption. Adding the additional socket outlet, however (and what ward hasn't needed one within two months of commissioning), results in noise, dust and spoiled decorations with the possible addition of surface-mounted conduit disappearing through a ceiling that now has grubby fingermarks!

Any system that is fitted into hospitals must be capable of easy modification without these attendant problems. The cost saving over the life of the hospital in labour, materials and disruption would probably pay the initial capital cost of a good system.

Modifying the services within an integrated system should not result in a safety or other hazard being created even by relatively unskilled operators over the lifetime of the equipment. It is therefore essential that the mechanical design and construction of such a system be examined closely on this point.

The flexibility of fixed services and equipment should of course be met by positioning movable items such as shelves, drawers, holders for instrument trays or bowls, monitoring equipment, ventilators and the like, on a properly positioned equipment support-rail system. There is at least one system available which will also span windows and mount from the ceiling, so that an effective layout need not now be prevented by the building structure.

As a fourth rule, we might well ask ourselves the question 'can the activity within a given space be updated easily, safely and quickly to suit the changes in health care that we must expect in the future?'.

Costs

We have seen that considerable revenue savings can be made by the use of systems that are designed for their specific use, easy to maintain, and flexible enough to meet the changing requirements. The capital costs can also often be reduced on new works by considering the services system at an early enough stage. For instance, the thickness of blockwork, numbers of vertical service ducts and access panels in ceilings can often be reduced by the use of a well-designed system integrated into the building design. The use of trunking-mounted diffuse ward lighting can often eliminate the necessity for any lighting services in the ceiling void in ward spaces, thus making considerable savings on installation and maintenance costs.

Upgrading old Nightingale wards can be a problem, owing to the size and shape of the window. The ward can be modernised and the services system simplified by taking the trunking system straight along the wall across the windows. The system has of course to be sufficiently strong to enable the recess to be spanned, and 2 m of unsupported trunking is not uncommon.

Fully modular systems, when used throughout a hospital, effect further savings, due to the stock-holding requirements of spare parts. This is minimised since the components at any bedhead area will be selected from the range of standard interchangeable parts.

Fig. 2 An example of low-level services

The rule for cost saving is therefore to consider the the whole system from every aspect.

A new viewpoint

Like the apostle Peter, who wrote to the early church to the effect that he was 'reminding them of things they once knew but now had forgotten', there is nothing new in these rules but merely the restatement of the fact that to achieve the greatest benefit to the nursing and engineering staff, and to minimise the capital and revenue costs of the engineering services system, it is essential that the total design be considered and equipment consistent with that design installed. If this article achieves nothing else than make people think along these lines, then cost and working-condition benefits are sure to follow.

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