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INTERNATIONAL FEDERATION ISSUE

No. 20

Hospital Engineering

Incorporating 'The Hospital Engineer'

Vol. 30
November 1976

The Journal of The Institute of Hospital Engineering

Contents

Neither the Institute nor the Publisher is able to take any responsibility for the views expressed by contributors

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The Design of Security Units

Timely Seminar

The provision of Security Units within the National Health Service has been given a high priority. Their prime intention is to care for patients in the difficult category of those unsuitable for admission to existing psychiatric hospitals, and who until now have had to be left largely untreated, or sent to prison.

The Institute held a well-attended one-day seminar on the design of these units in London on October 20. The topical nature of the subject matter need hardly be stressed.

The recommendations of the Butler Committee on Mentally Abnormal Offenders have led to the National Health Service being required to provide special units which can offer secure conditions. These units are to provide a greater degree of security and control than in existing hospitals, but not at the level provided at the Special Hospitals. It is essential that the new units are planned as part of a service to the community of which they only form one part.

The Type of Patient

The first paper given to the seminar was by Dr. Robert Bluglass. It is reprinted on pages 5, 6 and 7.

Our Next Issue

The December issue of *Hospital Engineering*, to be published on Monday, December 6, will contain all the other papers given. These were:

Nursing Policies
Speaker: C. Lake, RMN RNMS SRN Nursing Officer, Department of Health and Social Security.

Architectural Considerations
Speaker: John Ingham, FRIBA, Regional Architect, South West Thames Regional Health Authority.

Engineering Considerations
Speaker: A. Williams, C Eng MIEE, Acting Assistant Regional Engineer, Trent Regional Health Authority.

Copies of this issue will be available to non-members of the Institute for £1.50 per copy direct from Subscription Department, Station Approach, North Lane, Marks Tey, Essex.

Engineers' Registration Board

Registration Renewals

The Engineers' Registration Board is considering the introduction of a simplified procedure for the annual renewal of registration.

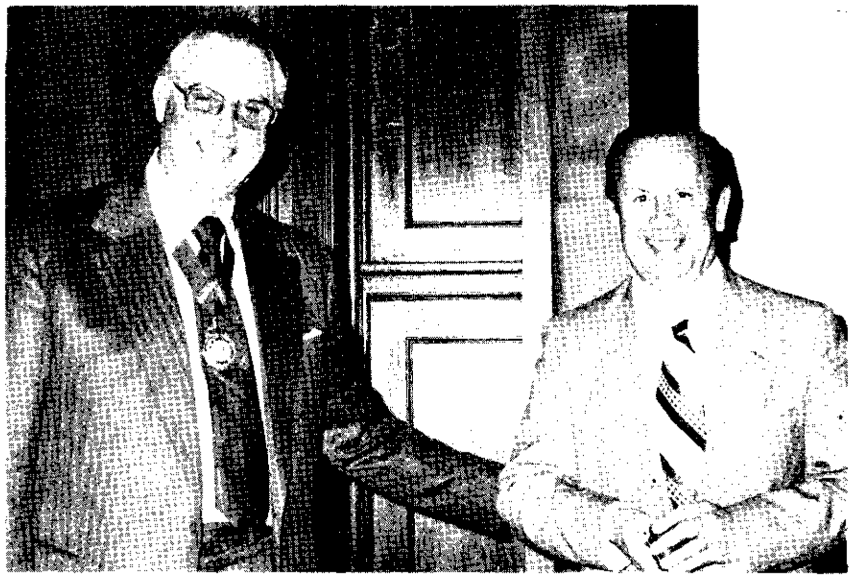
It is unlikely, however, that the revised system will be anounced until later in 1977.

Meanwhile, it is not intended to issue the usual renewal slip in 1977, but the renewal slip valid to the end of 1976 will be considered re-validated for 1977 so long as the registrant remains a paid-up member of his sponsoring Institution.

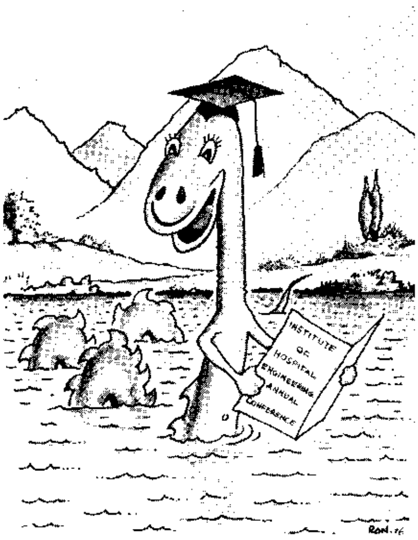
Medal Winner

Our photograph shows Mr. George Tuson (right) being congratulated by the President of the Institute, Mr. F. H. Howorth, after being presented with the Northcroft Silver Medal Award for 1975. The award is given for the technical paper considered to have made the best contribution to engineering.

Mr. Tuson's winning paper was on *The Art of Public Speaking*, and was reprinted in our July 1975 issue. He seems to be making a habit of excellence, since this is the second year running he has won the prize!



Annual Conference Pitlochry



The 33rd Annual Conference will be held in the Atholl Palace Hotel, Pitlochry on April 27, 28 and 29.

The Conference will be formally opened by Mr S. C. Agnew, Chief Engineer, Scottish Development Department.

There will be a Scottish Ceilidh in the hotel on the evening of Wednesday, April 27 and the Annual Conference Dinner Dance will be held on the following evening, when the principal guest, and speaker, will be Mr. Harry Ewing, Parliamentary Under-Secretary of State at the Scottish Office responsible for Health matters.

Specially reduced all-inclusive terms have been agreed with the Atholl Palace Hotel and if the total present reaches 150 the entire hotel will be reserved exclusively for the Institute.

We know that we can count on the loyalty of Scottish members, who regularly support the biennial Joint Scottish Branches Conferences so well to the tune of almost 100.

Let us hope that a similar number from south of the border will choose to enjoy a Conference/holiday amongst some of the most splendid countryside in the United Kingdom.

Then we can enjoy the hotel to ourselves and, what is more, celebrate a record Conference.

The usual Conference literature will be distributed at the turn of the year.

Remember attendance is NOT restricted to Members of the Institute. As usual there will be a special Ladies' Programme.

International Union

Basil Hermon, who represented the United Kingdom Institute of Hospital Engineering on the Council of the International Federation of Hospital Engineering from the time the Federation was formed in 1970 until January, 1976, has decided to retain his international interest for the rest of his days by forging a personal link with Australia.

Basil, a widower, is to be married on 13 November, 1976 to Miss Moya Thomas from Melbourne, Australia. Moya will be known to many of the members of the Institute of Hospital Engineering because she was Basil's secretary at the South West Thames Regional Health Authority from the time he first joined the Region in November, 1974 until Moya returned home to Australia in September, 1975.

Moya has also had interesting international experiences having worked in Norway and travelled throughout Europe, visited Russia and, when returning to Australia last year, she went partly overland through Turkey and India.

The wedding will take place at 2 p.m. at the Headington Quarry Methodist Chuch, Oxford and readers would wish to join with us in offering our congratulations to them both.

Announcement

Alan Marshall and Partners, Consulting Civil and Structural Engineers, announce that Mr. A. M. Macfarlane has returned from Saudi Arabia and resumed his duties in the Birmingham Office. Mr. D. A. Humberstone is now the Resident Partner at our Riyadh Office, the address of which is PO Box No. 3730, Riyadh, Saudi Arabia, telephone Riyadh 38097, telex 20138 SUDAIRI SJ.

Southern Branch

The 176th meeting of the Southern Branch was held at Queen Alexandra Hospital, Portsmouth on September 18.

There was no speaker, it being a business meeting only, but a report was received on the recent Branch "visit" to IBM, Portsmouth.

Mr. Dennis Wilson, who has so thoroughly carried out the duties of Branch Honorary Secretary for several years, has indicated that he hopes that a successor may be nominated to assume the office as from the 1977 Annual General Meeting.

London Branch

Date (Tuesday)	Subject	Arranger
November 30, 1976	Engineering Functions in Hospital Architecture.	G. Bushill

West of Scotland Branch

The Branch's first meeting of the 1976/77 syllabus was held on Thursday, 30th September 1976. The Chairman commenced the proceedings by congratulating Mr. J. Crawford on his retirement from the post of Hospital Engineer at Belvidere Hospital after 40 years in the Service, 32 of which had been spent in Belvidere. The Members wholeheartedly endorsed the Chairman's congratulations.

The paper presented at this meeting was "VHF Radiotelephone Communications". L. H. Stanley and K. Armstrong of Pye Telecommunications Limited led the Members gently into what is a highly complex subject by tracing the history of VHF radio communications from the early 1940s in a lively and informative presentation.

After coffee, the Members asked a wide range of questions on a variety of aspects related to VHF Radiotelephone Communications and peripheral equipment until the Chairman reluctantly called for the last question, and finally closed the meeting with a vote of thanks to the speakers.

Date	Event	Venue
Thursday December 16, 1976	**Pneumatic Controls with Emphasis on Fluidics.** Mr. C. Steele, BSc CEng MI Mech E, Scottish Pneumatic Supplies Ltd.	GGHB, Sauchiehall Street, Glasgow.
Friday January 21, 1977	**Annual Dinner and Dance.**	Burnbrae Hotel, Bearsden, Glasgow.

The first of several papers presented at the Institute's symposium The Design of Security Units, *held at the Institution of Mechanical Engineers in London, on October 20, 1976.*

The author sets the scene for the papers which followed, and which will be reproduced in the December issue of Hospital Engineering. *He is Consultant Forensic Psychiatrist to the Midland Centre for Forensic Psychiatry and to the Home Office, and Senior Clinical Lecturer and Postgraduate Clinical Tutor at the University of Birmingham.*

The Design of Security Units

The Type of Patient and Behaviour Patterns

ROBERT BLUGLASS, MD FRCPsych DPM

Background

The hospital care of the mentally disordered patient twenty years ago was a very different matter from the situation that exists today. Every mental hospital had at least one locked ward for each sex, and probably more, and nursing staff were skilled in the techniques of caring for difficult patients with simple drugs and therapeutic aids. They had a professional tradition and experience that extended back over very many years. The last two decades have been a period of enormous change in method and philosophy of psychiatric treatment and care, and also in the organisation and management of psychiatric hospitals. An increase in medical, nursing and other staff has led to the development of multidisciplinary teams in which doctors, nurses, social workers and psychologists work together, increasingly on a basis of equality, to care for smaller groups of patients within the total institution. Improved treatment and new drugs have resulted in increasing numbers of patients returning more rapidly to the community, and the numbers of patients resident in the hospital at any one time has fallen. Equally the number who stay for long periods of time has reduced or changed in character so that they now increasingly tend to be in the older age groups. The fabric of hospitals and the facilities within for staff and patients have improved enormously. In particular, the need to have locked wards for most of the patient population is a thing of the past so that most psychiatric hospitals have come to adopt an "open-door" policy. This is partly the result of the therapeutic revolution, but is also due to a change in outlook. It is considered that it is bad policy and antitherapeutic to lock wards or provide physical security measures for a small number of patients. The presence of locked wards is sometimes seen as a threat on the part of other patients; inducing an undercurrent of fear that they might be moved there in certain circumstances. Locked wards are also considered by many to be inappropriate when 80% or more of the patients in psychiatric hospitals are there informally and voluntarily.

No-one would dispute that these improvements in the care of the mentally ill over the years have been anything but desirable, and they have led on to further progress in the shape of smaller psychiatric units based in general hospitals and to the development of an increasing trend towards caring for the mentally disturbed in the community, as far as possible. All these movements can be expected to continue into the future.

For most patients then, the quality of care continues to improve, and has been given extra impetus by the recent policy documents issued by the Department of Health, *Better Services for the Mentally Ill* and *Priorities for Health and Personal Social Services in England*. There are, however, a relatively small number of patients who present new problems of management, partly as a result of these changes in organisation and structure of the psychiatric services. They are patients who present more difficult problems of behaviour as a result of their illness or personality structure, and for whom the methods of management in open-door wards or in a district general hospital are unsuitable. Some of these patients present to the Service directly from the community, by referral from family doctors or are brought to hospitals by social workers, police or other agencies. Others, partly because of their behaviour problem, present by way of the courts, charged with criminal offences of varying degrees of severity. In essence, these two groups of patients are very similar, the main difference between them being the mode of presentation. It is well known that a high proportion of people who are in prison are people who at other times have received psychiatric care or are people who will require it in the future. Many require it at the present time. Other patients at one moment in a psychiatric hospital are people who at other times have been in trouble with legal agencies because of their disturbed or unpredictable behaviour.

During the past few years the patients in this small but difficult category have often been refused admission to existing psychiatric hospitals and units because insufficient measures of control and security have been available to care for them and because the open facilities are unsuitable. They have not infrequently been sent to prison inappropriately. Otherwise they have been discharged into the community untreated to be handled by whatever resources are available, by the social services and voluntary agencies, or else they have had to fend for themselves. They are often found sleeping rough, presenting to emergency services, casualty departments or appearing in church crypts and the like. A significant number of them have had to be accepted by the Special Hospitals, Broadmoor, Rampton, Moss Side and Park Lane, the hospitals that provide conditions of maximum security, as they may be all that is available even if that level of security is not really required. A further problem arises from this. As patients in the Special Hospitals respond to treatment and need to be rehabilitated back to their own communities there is often a need for a halfway stage, to admit them to hospital near their home prior to their release and supervision outside. It is now very difficult for Special Hospitals to find local psychiatric units willing to take their patients and this is a group that is likely to require the help of the new security units.

Proposals

In response to the accumulating difficulties that all this has generated, the Department's internal Working Party on Security in NHS hospitals (the *Glancy Report*) and the report of the Committee on Mentally Abnormal Offenders (the *Butler Report*) have advocated the provision in the National Health Service of special units on a regional basis designed to provide a greater degree of security and control than existing hospitals, but not at the level offered at the Special Hospitals. These units would be provided for carefully selected patients who clearly require a high degree of special care. Others, including some who may have been offenders and some who may have been disturbed only briefly, would still be accommodated as they are at the present time in most areas in existing psychiatric facilities. The Department has not withdrawn from existing psychiatric hospitals the requirement to provide facilities for all categories of patient up to the level of maximum security. The new units, however, will relieve them of the most difficult groups for whom an intensive degree of control and care is required. Many of us feel the emphasis in the new units should be upon this intensive care rather than on the security aspects, even though basic security is necessary. For this reason more than one planning group has decided to talk about "Intensive Care Units" rather than "Regional Security Units", the term originated by the two Reports.

Provision of a Service

One essential is to note that from a functional point of view the new units must be planned as part of a service in the community of which the unit is only one part. The role of existing hospitals and units, of penal institutions, social services and probation services in relation to the units has to be fully worked out and mutually understood. The provision of supporting out-patients, day hospital and other supporting services has to be considered as part of a total policy plan. It would be a mistake to plan a secure building in isolation without first carefully planning a regional service as a whole.

The Patients

The patients for the new unit will therefore be individuals suffering from mental disorder who require intensive care and control.

But what categories and types of patients might we expect to admit?

First, the problems we are concerned with apply to men more than they do women. Although more women than men are referred to ordinary psychiatric out-patient clinics the more serious problems of disturbed, anti-social or deviant behaviour occur in men. There are, however, a small number of women who would probably require these new facilities. The *Glancy Report* considered that about a fifth of the available beds might be for women, and our work in the West Midlands Region leads us to similar conclusions.

There is also a need to consider whether any accommodation should be made for children and adolescents. There is a small provision in some regions for the in-patient care of these groups, but occasionally a child or adolescent does present very difficult behaviour problems for which a more secure setting is required. It is doubtful whether a special unit for adults should also attempt to accommodate children, even in a separate subdivision. Such a unit would require its own separate facilities, isolated from the adults, and this would be expensive in terms of building and staff, and undesirable administratively. A secure children's unit should be sited separately adjacent to other types of child accommodation. Despite this, a separate facility within the whole for a young people's unit for 17- and 18-year olds may be necessary.

We now come to the diagnostic categories that might be suitable for the type of care that we have in mind.

The *Glancy* recommendations exclude three principal categories that would not be suitable for a secure unit, even though a more secure setting in an ordinary psychiatric hospital might be desirable from time to time for some of them. Those excluded are elderly patients who are inclined to wander away from the hospital or ward, very severely mentally handicapped patients who are destructive, highly disruptive and over active, and patients suffering from mental illness who are only a very difficult problem of management during a brief acute phase of their condition.

The patients who might be considered are rather more difficult to define, and none of the Reports go into much speculative detail about them.

Certainly, mentally ill patients whose illness is accompanied by difficult behaviour would be considered for admission. They would be likely to include the more unpredictable patients including those with delusions of persecution, people with unusual types of more serious depressive illness, or some with physical ailments associated with mental illness and leading to behaviour problems. For instance, a man in his 40's who believed that he was plagued by a conspiracy against him on the part of anyone in uniform resulted in his making threats towards a variety of uniformed services sometimes causing a fear that he might behave violently. He was refused admission to hospital because of his potential dangerousness. He might have been a suitable case for admission to a secure unit. Another case, a woman, depressed and frightened, attacked her daughter to prevent her being taken away by imaginary kidnappers. Her unpredictable behaviour and the one episode of minor assault made her a difficult case to manage in an ordinary psychiatric hospital and hers is a case at present difficult to place which would have fitted well into a secure unit, where her condition could have been treated relatively easily. In comparison, in another case, an Asian gentleman who was totally mute and was thought to be schizophrenic, stole a minor item from a store. In court, on medical evidence, he was found unfit to plead to the charge against him, and he was ordered to be detained in a hospital which would be nominated by the Home Secretary. For him, a secure unit would not have been suitable because his schizophrenic condition was not difficult to manage and he showed no signs of dangerousness or behaving in a seriously disruptive or disturbed way. He would have been managed in an ordinary psychiatric hospital and in fact he was ultimately accepted into one where he resides at the present time. One of the important factors in considering suitable cases for admission to such a unit is treatability and likelihood of response to treatment. Patients who can be predicted to need a very long period of years within a secure residential setting would not be suitable because no-one would wish a treatment unit of this kind to become a chronic hospital simply providing long term care. This is one of the reasons why careful selection is so important, and why a close liaison with the other security services, the Special Hospitals on the one side and the less secure service on the other, is imperative.

Mentally handicapped people whose condition is not severe are another group for consideration for admission. Those suffering from higher grades of mental handicap can be treated reasonably well with patients suffering from other conditions. But the much more disturbed and subnormal groupings require to be treated together as they present special problems of their own. A young man, mildly handicapped, who suffers from periodic bouts of depression and irritability, tends to molest small girls during this time. His condition is a hopeful one for treatment and he might be a suitable case for admission. A young woman whose unpredictable temper tantrums make her a problem of management in an ordinary ward might for a limited period benefit from treatment in this unit. Another man with an IQ of 68 repeatedly exposes himself sexually and is constantly being arrested, appears in court and sometimes is imprisoned. Such a patient requires the attention of people who are gaining extensive experience in dealing with such cases and who can follow him up in due course in the community. He is another possible candidate.

Patients with personality disorders are a third important group. In many ways this is the more difficult group to treat. In many cases treatment is of doubtful value, and psychiatrists are tending to feel that those with the more serious problems are better treated in special units in prisons, or by other social, rather than medical, measures. There are some, however, who respond well to the efforts of concerned, interested doctors and nurses who can make a good relationship with them and influence their bad patterns of behaviour. Some suffer from isolated deviations of behaviour which frequently get them into clashes with the public or with the police, but which can respond not infrequently to psychological and psychiatric measures of treatment.

Assessment

In the final analysis, it is not so much the diagnostic category as the patient's behaviour, its seriousness, manageability and dangerousness which must be taken into account, having considered the history and the possibilities for a therapeutic programme. This must all be weighed against the characteristics of those people already in the community and the likelihood of such a patient "slotting in" and responding to treatment within a group. The patient must be able to benefit from the treatment programmes available in each unit, and this means a careful selection procedure and a period of assessment.

Ideally a variety of treatment programmes should be constructed within the total institution.

The need for accommodation and facilities for assessment procedures is important. There will probably be requests for admission to these units from many sources but each case must be considered carefully. The *Butler Report* (and now the DHSS proposals for amending the Mental Health Act, 1959) suggest a new provision, to allow a court to make an order to send a patient to hospital or to a secure unit for a period of assessment of up to three months in the first instance, with a possibility of a further three months if necessary. This would mean that if in the end the patient is considered unsuitable for a treatment programme in the unit after a period of assessment, then an alternative sentence can be considered by the court. It would prevent patients being admitted after too short an assessment, with regrets afterwards because he was wrongly placed and the doctors are unable to move him anywhere else.

Conclusions

In general terms then, we can say that adult men will be in a majority of those who will seek admission to a regional secure unit, with a small proportion of women and of young people. They will require assessment facilities, and after admission a variety of possible therapeutic units, depending upon the conditions and preferences for treatment. The units offer a possibility of developing experimental methods of management, comparing one treatment mode with another and for continuously monitoring the regimes and management within the unit as the service progresses. Treatment will be likely to include medical (including drug) treatments, psychotherapy in groups and individually, and behavioural treatments. The patients are thought to be medium-stay and will require facilities for work, recreation, exercise and leisure. Most will be people in the working age groups who will require a variety of work for therapeutic as well as occupational reasons. Physical fitness and exercise are an all-important aspect in the running of any secure institution as those vastly experienced in the management of Broadmoor patients will be quick to remind us. The tensions and difficulties that can arise where insufficient exercise opportunities are available are considerable. Equally, constructive use of leisure time is one aspect of therapy and this must be considered. Many too will have educational difficulties which are part of the total problem and these must be provided for. The need for constructive and well thought out aftercare arrangements will mean that social workers and community nurses will be important members of the teams. The behaviour problems involved will include, as I have indicated, some who are potentially violent, others potentially destructive, and some variable difficulties in forming and sustaining stable relationships.

One of our difficulties is that we have no established unit to guide us about the range of behavioural problems and patterns that are likely to seek admission. For this reason, and to allow changing patterns of treatment to develop, flexibility in design seems to me essential. The first units will be basically experimental, and will provide an exciting challenge and opportunity to designers and planners unique in the National Health Service.

Management Development -The Way Ahead

This article gives a comprehensive survey of one of the most neglected subjects in management today — the planned development of the next generation of managers. Mr. Buckley is District Works Officer for the Merton, Sutton and Wandsworth Area Health Authority (Teaching)—Roehampton Health District, in South-West London.

R. D. BUCKLEY, DMS TEng(CEI) MIHospE MIPlantE AMBIM

There are several ways to develop staff within an Organisation. There is a considerable amount of academic and other literature on how this process may be carried out. Briefly, some methods currently in use are:

Management development by indiscriminate and unplanned training based on, or resulting from, crisis management;

The autocratic or Theory X approach by an individual at the head of the Organisation. The "we know what is best for you" approach;

By planned training — unrelated to a manpower approach;

By systematically looking at the Organisation's manpower requirements, and then training and developing the individual to meet the Organisation's objectives;

By systematically looking at the individual's desires, wishes, aspirations, hopes and needs, and reconciling them or harmonising them with the existing and forthcoming requirements of the Organisation within which he or she is expected to work.

This paper is not intended to help the specialist training officer, but to assist that larger number of Works Staff Managers who want to know about Management Development.

Management Development should embrace all staff through from Job Specification, Recruitment and Selection, Managerial and Technical Development and Evaluation and Appraisal Systems. The process begins at initial entry to the Service and continues until eventual retirement. It is not exclusively for junior and middle management, it should apply to each level of line and functional management. For the purposes of this paper a single grade of staff has been chosen, i.e. Assistant Hospital Engineer. The principle embodied, however, can be applied to every grade through to Regional Works Officer and above.

In management terms the young manager at the bottom of the promotional tree does not only require technical ability (although very important) he requires the management tools to implement policy which, to a large extent, is imposed from his line management above in District, Area, Region and the Department of Health and Social Security. In order to learn and practice these skills a formal system of development is required, if he is to progress within and contribute to the Organisation.

The processes involved at the present time in the selection of Engineers leaves, in many cases, much to be desired. Experience has shown that it is not always the best technically qualified personnel who perform well when placed in the job.

It must be understood that a Hospital contains many other professionals of which many are highly qualified and, at the same time, individualistic. In order to obtain the very best results from the limited resources available, management has to take these factors into account. The very best decisions taken from a purely technical point of view are not always in the best interests of the Service.

Unlike industry, the National Health Service does not have a profit motive. However, it should not be concluded from this that no objectives are set. On the contrary, since its reorganisation in April 1974, the health care pattern is now based on teams of management from differing disciplines, i.e. medical, nursing, general practitioner services, administration, financial and engineering/building, the latter being generally re-titled Estate Management Functions. The whole emphasis has now been placed on interdisciplinary exchange of ideas with collective management decision making. This emphasises that it is now more important than ever that a young manager should be selected and developed through his career to meet these objectives.

At the present time the standard method of selection is the interview. The normal procedure is:

Draft and agree advertisement;

Advertise in local and National press;

Send out job description and application form;

Select shortlist of candidates for interview;

Interviews — one panel, interview of approximately half an hour;

Select successful candidate from interview;

Inform candidates — successful/unsuccessful.

In drawing up the advertisement the Personal Specification is taken into consideration. The advertisement is generally concise and informative, and is not unduly reticent about difficulties commonly experienced by people in the job. The publication of the advertisement is looked at in detail on a national and local basis through media likely to receive the attention of suitable candidates.

The prepared application form should elecit relevant information about an enquirer's record, and throw some preliminary light on his chances of surmounting the difficulties and problems of the job (particularly important with personal matters).

In addition to the application form, further information, in the form of a job description, is usually sent.

The returned application forms are scrutinised and a list is made of those candidates considered suitable for interviewing. The interviews themselves are usually carried out by a panel or board consisting of the departmental head, personnel officer and one outside assessor, and normally last for one half hour.

Notification of the decisions made about all applicants, and the appropriate scrutiny of the application forms of unsuccessful applicants who might be worth further consideration is then carried out.

Interview Content

The basis of these interviews is to try and match each candidate as closely as possible to the Personal Specification — although in practice it is found that no one person matches these requirements precisely.

In the main, interviews are split into two main sections: Technical, and Personal.

Because of the high technical content of the job it is found that most of the questions will be based from a technical view point. These questions are usually relevant to the Hospital environment. Basic technical and craft knowledge are the main questioning topics, examples of these being:

What is a steam trap used for?

What type of pipework would you use for cold water services?

How would you test a three-phase electrical motor?

The second, and perhaps least important part of the interview at present, is the general aspects of background — career to date and promotion prospects.

In many cases the full potential of what an Engineer actually thinks in a given situation is missed. Questions in this section do not tend to be too open ended. After all, at this stage, the interviewer is usually looking for technical expertise and "a good Engineer".

Training

On entry to the Service the young Assistant Hospital Engineer finds that the most commonly used training method is "standing next to Nellie". In other words it is on the job training which is not programmed or formalised.

How much is learned in this situation is difficult to evaluate except to say that effective Hospital Engineers sometimes turn out effective Assistant Hospital Engineers.

From the technical point of view there are two good methods of training. Firstly, there is the Department of Health and Social Security Training College at Falfield. This specialises in those technical aspects of training in which the new entrant to the Service may not be familiar. This is generally referred to as Specialised Training. Secondly, there are the Day Release Courses at Colleges of Further Education so that technical academic training may continue to Higher National Certificate level or full Technological Certificate level.

Finally, there are one or two course specialising in Hospital Works Department Management at the DHSS Engineering Training Centre at Falfield. These usually last two weeks.

Training is not programmed at the present time, it is generally left to each Assistant Hospital Engineer to sort out his own training programme although encouragement to attend courses is always given. Failure to attend courses could mean that promotion is slow. No career guidance is given on a formalised basis, although the Regional Engineer's Department may sometimes have a career counselling service. Occasionally, job rotation and training schemes do appear (a good example may be found in the Wandsworth and East Merton Teaching District[1]) but such schemes may only embrace one grade of staff. It is the development of the whole man which is essentially important and which has to be catered for if both he and the Organisation are to benefit in the long term.

The Case for Change

It is particularly interesting to note the report submitted by Sir Leslie Tyler on the grading, training and qualifications of Hospital Engineers in 1964 has still to be implemented from a Management Training point of view. In particular, paragraph (1) 52 states:

"The young man who has only just completed his basic engineering training and obtained his ONC will not be a fully effective member of this staff. He needs comprehensive instruction coupled with opportunities or practical experience in all aspects of engineering appropriate to the Hospital service. He should, in fact, continue his engineering education focussed on the specific field of Hospital Engineering. He needs to acquire a knowledge of management and administration and we would expect his training to include visits to and/or attachment to other hospitals. Training should also include a short period in the Regional Hospital Board Engineering Department".

It is obvious from this that the Engineer needs to acquire a knowledge of management and terotechnological principles. It also points out that training should include attachments to other hospitals and Regional Hospital Boards. In today's context perhaps this should now read Regional, Area, District and Hospital attachments.

It has been suggested by the Chief Engineer at the Department of Health and Social Security that training log books could be introduced to formalise the present system[2]. A system of training must be evolved which not only takes into account the provision of academic and practical professional skills but also management development skills. They should ideally be co-ordinated to form a training programme.

The selection techniques presently used do little to resolve the long term manpower policies. Little account is taken of the behavioural aspects of the candidates' performance past and present. It can be seen from the interview procedure that no scientific methods are used to determine the characteristics required for the job It seems strange that we spend a large amount of time, as professional people, evaluating systems and selecting the correct use of plant and equipment that may only last ten or 15 years. Yet, at the same time, we are willing to employ junior management that may be in the service thirty or forty years in a half hour interview! An organisation can only be as good as the people which it employs.

A recent development in this area has been an attempt to "put people on the balance sheet" — in other words to assess, in financial terms, the worth of the individuals who make up an Organisation. This is known as Human Asset Accounting[3]. It is worth considering that an individual's worth to an Organisation may be several times his salary; in such a case a management development programme would be invaluable. Human Asset Accounting could be used in an informal way by assessing people on their training, qualifications, skills (technical, administrative and social), scarcity value, etc., and programming the career development for those who most need it.

It is perhaps worth noting at this particular stage that now more specialised personnel officers are being employed with Area and Districts, expertise is becoming available to carry out these tasks in a professional manner.

It has been suggested that many Asistant Hospital Engineers in post at present are being by-passed on the promotion tree by outside candidates on interview boards. Perhaps this is one indication of the present effectiveness of management in the Selection and Management Development of this grade of Engineer. We are also seeing, at the present time, many early retirements of Senior Officers.

Promotion for middle management will mean that vacancies for new entrants will be plentiful. Therefore, is the time for change now?

Typical Specification for the Grade of Assistant Hospital Engineer

The following Personal Specification has been drawn up based on the requirements thought to be relevant at the present time[4]. It includes the following main points:
Physical make up;
Attainments;
General intelligence;
Special aptitude;
Interests;
Disposition; and
Circumstances.

In considering the attributes required for successful performance in this particular job, however, other factors, listed below, are taken into consideration.
The necessary educational achievement;
The training and experience required;
The level of physical skill required;
The physical effort involved;
The nature of temperament required;
The social skills required;
The age group;
Sex.

The significant consideration that was given in constructing the specification was that the minimum requirements for adequate performance should satisfy the needs of the Organisation.

Personal Specification

Job Title — Assistant Hospital Engineer

1. Initial Requirements

The Engineer should have completed a full Engineering apprenticeship. This may be either craft based or technically based, the latter being carried out in many of the larger public bodies and corporations. Many apprenticeships are now based on modular training schemes specialised to suit the individual organisation's requirements. In this respect it is desirable that some emphasis should be placed on Hospital Engineering/ Plant Engineering.

The completion of the apprenticeship stage will generally mean that the youngest age at entry to this grade will be 21 years. From an academic view point it is a requirement recommended from the Department of Health and Social Security that an Ordinary National Certificate or City and Guilds Engineering Technicians Part 1 is the minimum technical qualification for entrance to this grade.

2. Duties and Responsibilities

Physical Aspects
From this particular respect, although the physical efforts required will not be as great as perhaps a craft apprenticeship in Heavy Engineering, there will be some physical effort required in checking, operating and inspecting plant and equipment. In an emergency situation periods of high physical effort may be required.

Mental Effort
In particular it is important that a high degree of intelligence is required. This is an important aspect of the selection process. It must be remembered that there will be times when high levels of stress will be placed on young shoulders. Leadership qualities will be required to direct teams of skilled craftsmen working against fixed time factors. In some cases mistakes could involve loss of life to a patient or member of staff. In the modern Hospital there are many other professionals with requirements of a high standard. In order to understand these needs, which in some cases are highly academic, intelligence and commonsense are primary factors.

After an initial period of time many of the jobs undertaken become routine. The effective use of planned preventative maintenance techniques and the planning of Revenue schemes, although in some respects routine, require initiative if the labour and materials that are available are not to be wasted. Most hospitals have limited resources and, in this respect, the Engineering Department is no exception. Professional judgement will, of course, play an important role in these matters. A poor technical decision will lead to poor utilisation of resources in any case.

Responsibility for Resources — Staff, Materials, Equipment, Cash
An Assistant Hospital Engineer will be responsible for perhaps up to thirty craftsmen together with stores, and materials as previously stated. There is a wide range of plant and equipment that the Engineer may be given responsibility for from time to time. This may either be on a permanent or temporary basis. In most cases there will always be an officer at a higher level to ask for guidance.

Difficulties and Distastes
Difficulty will be found at times when the Engineer has initial control of complex plant and equipment. The difficult and distasteful parts of the job as seen by the incumbents are discussed in some detail later where reasons for failure are considered.

3. Environment and Conditions of Service

Physical Surroundings
Generally these will be good when compared to building sites and parts of the Heavy Engineering Industry. The vast majority of time spent on the job will be indoors. There may be periods outdoors during winter months, however, to supervise projects.

The job itself is clean and the working temperature and humidity are normal. There may be departments, however, that can cause distress to the young Engineer, but this will mainly be in restricted clinical departments (e.g. mortuary, animal houses).

Accident Hazards
These are no greater than any other similar professions in a Hospital. There are perhaps some additional hazards which are not usually found in a similar job in industry (i.e. infected materials, airborne bacteria). Most operational procedures involving any hazard from a safety point of view are generally carried out under supervision.

Remuneration
Salary is paid monthly. The level is basically determined by the relationship with the craftsmen employed in the service. Overtime is not generally

paid, although hours of employment tend to be long (minimum 38 hours). Reward for additional effort is given at the present time, either by payment or by time off in lieu.

Prospects of Advancement
These are very good indeed. There is almost a one to one ratio between boss and subordinate at the bottom end of the promotional tree. It must be understood, however, that not all junior engineers will become the Chief Engineer at the Department of Health and Social Security!

Provision of Employee Services
Most hospital sites now have staff associations and staff clubs. Canteens are provided in order that employees may be nourished 24 hours a day. Protective clothing is provided where necessary.

4. Social Background

Departmental Size
This will vary according to the size and complexity of the Hospital.

Job Isolation and Teamwork
The degree to which an individual will be allowed to work in isolation will depend to a large extent on the Hospital circumstances. In general, however, Hospitals rely on team spirit to see them through. From an Engineer's point of view this is essential. There will be very few times when an individual in the Engineer's Department works on his own.

Categorisation of Work People
These will tend to be professional and technical people from a user's point of view. Most staff in the department will however be at craftsman and foreman level. It is essential therefore that an Assistant Engineer is able to get on with people at all levels. This is a very important factor in the selection process.

Supervision
In many respects it is thought that the better way to motivate managers is to set them realistic and agreed objectives to achieve. This will mean that general progress and discipline will be a regular feature of supervision at this level. Normally, the Hospital Engineer for a Unit or Hospital will closely monitor the performance of an Assistant Hospital Engineer in the initial period of employment.

Hospitals, however, are large places and people must be trusted to a certain extent.

Assessment of the Status of the Job
The position of the Assistant Hospital Engineer in a Hospital is vital. As a first line manager he is, in many respects, similar in status to the Assistant Hospital Secretary, except that he does have direct line management functions to carry out. Traditionally over the years the job has, to a certain extent, been abused. This has been due mainly to the quality of senior management employed. In some circles it was thought that these people should go around with overalls on. However, we are now living in more enlightened times and this position has now changed, so that this Management Grade may be used as such.

It will be seen from the Personal Specification that the role of the Assistant Hospital Engineer is vital to the basic recruitment function and perpetuation role in this section of the service. The young Assistant Hospital Engineer of today is the potential manager of vast resources of manpower, material, plant and equipment. If Selection and Development does not take its proper place the long term comfort of the National Health Service patient will suffer. It is the basic level of "will the light work?", "is there enough hot water?" or "is the operating theatre available?" that the modern Health Service is all about. Long range plans and hierarchical management structures are fine but if the basic functions fail the Service has failed.

Selection for Management

"To spend a lot of money and time choosing a machine of which the average working life is, say, ten years and little of either on selecting men and women who may be with the firm forty years is short sighted, to say the least, of Industry and Commerce."

(Sir Miles Thomas)

We now need to consider the selection procedure. In this section we will examine some methods currently in use. It has been seen previously that, generally, no scientifically based methods are currently in use. In most cases selection may be on a hit or miss method giving no indication of future performance. In many instances the procedures can be unbalanced between the technical aspects of the job and the future managerial potential and aptitude.

In order that the manager may be able to undertake his personal responsibility for selection and development of management he must have available criteria to work from. It must be understood from the outset what we are selecting for.

Selection should not be isolated from the rest of the Organisation's Personnel policy, and to this end every endeavour should be made to integrate it with the selection, training and development programme of other staff within the Service.

Most Assistant Hospital Engineers commence their career in the National Health Service during their early twenties. It is generally accepted at the Department of Health and Social Security[5] that these Engineers require a more formalised career structure coupled with a National Training Policy. Despite this, the post of Assistant Hospital Engineer is not, at the present time, officially recognised as a training post. This grade of Engineer is expected to perform his duties and take a good deal of responsibility quickly. To this end the selection process described here has been designed around this criterion. If, at some future date, National Policy changes then revision of methods may be necessary.

The following is a brief account of how some academic models and research may be applied to improve the selection procedure.

The Academic Approach

In approaching a selection procedure we are now, necessarily, assuming certain ideas, concepts and theories. We have already looked at the Personal Specification based on a detailed job analysis and to this extent some views have already been expressed about what work and human personality are all about, including the present problems involved.

In deciding what steps should now be taken we should consider if other relevant research work in the field has been carried out. On investigation it can be found that considerable work has been carried out by the National Institute of Industrial Psychology (NIIP) and others. For example, a study was carried out on Airport Manager Trainees in a large transport organisation[6]. It is of interest that this investigation actually aimed to find out first hand what the problems were. In particular, they tried to identify those areas where the Trainee Airport Managers failed in the job. From this study selection procedures were modified to reduce the risk of appointing unsuitable candidates. In the same way similar work has been carried out for Assistant Hospital Engineers.

Taking into account all the information that could be obtained from this small sample obtained the following seem to indicate the main causes in job failure.

Most of those who proved unsatisfactory were unable to cope with paperwork systems (although pro-forma systems had been introduced to eliminate most of these problems);

Among those interviewed some were unable to write clear letters or memos; Most found it difficult to communicate their technical requirement in exact detail to their subordinates;

Most found it difficult to deal with other professional departmental heads and administrators;

Some proved unsatisfactory because they did not carry out their commitments on time;

All found it difficult to motivate their subordinates;

A minority found the job a mental strain when under pressure;

Most had technical knowledge difficulties for specialised equipment.

In identifying the important problem areas the following were highlighted:

Communications;

Organisation; and

Specialised technical knowledge.

Considering these deficiencies, specialised technical knowledge is not a problem area of selection as such; post-entry training may correct this if the development programmes are used correctly. With regard to communications and organisation, however, these were two areas where some selection techniques could be usefully employed.

The most important failure area that was observed and commented on was communications. It is well known that it does not matter how good you are at the job technically — if you cannot sell your ideas or develop good relationships with other colleagues then failure is imminent!

Having identified some of the main problems in relation to criteria for selection a definition of what we understand by the term criteria must be provided. Rodgers[6] has suggested that there are three basic criteria for a selection or any selection techniques; they are:

Technical soundness;

Social acceptability;

Administrative convenience.

From the previous personal specification it was seen that the criteria were broken down into the following sections:

Initial requirement;

Duties and responsibilities;

Environment and condition of service;

Social background.

It has been suggested by Dubois (1966)[7] that there are four characteristics of good criteria:

Pertinent;

Measurable;

Comprehension;

Consistent overtime.

These characteristics should be adopted not just because they are convenient but because they are relative. In this way we may relate criteria to the Personal Specification. Pertinent criteria will be concerned either with the individual and be about satisfaction and his personal aim, or with organisational objectives. It is with the latter that we will mostly be concerned in our selection procedure.

The second criterion is that we must be able to measure our objectives. We must also realise that comprehensiveness could be relevant but not adequate failing to cover all the dimensions of behaviour that are appropriate in the work situation.

It has been suggested that multidimensional criteria are most suitable in a selection decision. In this respect this would appear to suit our requirements for our Assistant Hospital Engineer. We should be looking at the whole man. But in stating this, the selection process must be subdivided to bring out the basic requirements that consists of the total make up required.

The Classical Model Approach

The classical model uses the construction and evaluation of a test or test battery in the framework of selection, and normally consists of the following:

Job analysis;

Choice of criteria;

Choice of a test or series of tests (these can be aptitude or personality tests, etc.);

Try out on an experimental group of subjects (Pilot Study);

Validation of the test or battery of tests;

Cross validation.

Although the classical model is an ideal given a large, multinational company recruiting centrally, the National Health Service tends to recruit locally. In this respect, each employing Authority does not have the resource allocation and time to select its candidates using such methods or to develop an exact procedure. All that can be expected at present is that a simple procedure should be introduced to eliminate some of the chance elements. It should be noted that if a National Training Scheme is introduced at some future date perhaps a National Selection procedure, developed and implemented on the classical model, could be of value. It should be noted, however, that even this model has its critics. Perhaps a good example of improved selection on similar lines can be seen in the studies carried out by Van der Giesse 1957[8] in his comparison of different predictors against criteria. (Air Force Pilot Testing).

Which Selection Method?

We must now summarise our thoughts to the every day situation. There are currently many ideas on how it is best to select candidates, these vary considerably, and are a psychologist's academic paradise.

In order to select we must choose the best practicable method. We have seen previously that there are at least seven stages, usually: prepare advertisement — advertise — send out job description and application form — interview — select candidate — inform unsuccessful candidates.

It has been suggested by Rodger and Cavanagh[9], however, that in order to carry out this procedure to best effect we should adopt the following nine stages, or nine stage plan. (This includes theoretical and classical models).

The Nine-stage Plan

- ☐ The preparation of a personal specification;
- ☐ The "distillation" from the job specification of an advertisement which is concisely informative and not unduly reticent about difficulties and distastes commonly experienced by people in the job;
- ☐ The publication of the advertisement through media likely to receive the attention of suitable candidates;
- ☐ The preparation of additional information with application form;
- ☐ The preparation and despatch of an application form which will elecit relevant information;
- ☐ The scrutiny of written applications and the listing by topping and tailing procedures;
- ☐ The administration of any tests;
- ☐ The interviewing of short listed candidates;
- ☐ The notification of decisions.

These nine stages will fit precisely the selection procedure that will suit the recruitment and placement policy required for all grades of Engineer in the National Health Service. In particular, it starts with a clear concise personal specification which will be built up from organisational requirements and objectives.

Following the steps through to the seventh — "The administration of any tests" — it is suggested this step and the next be combined so that candidates short listed complete a test before they are interviewed. This could be in the form of a joint group problem solving exercise or similar procedure.

Interview Procedures

In order to select our candidate it will be necessary to set aside *at least* one whole working day. This will be an important aspect of the interview procedure. It is felt that during a programme of one day (during which the candidate may gain an impression of the Organisation) some indication may be given of the communication skills and personality traits of the individual concerned.

The following programme could be considered suitable for this purpose.

Interview Programme

Time

10.00 a.m.	Arrival at Hospital — coffee and general discussion.
10.30 a.m.	Introductory talk by District Engineer and basic introduction to candidates.
10.45 a.m.	Visit to main Hospital complex including where candidates will actually work and items of technical plant and equipment that he will be responsible for.
11.45 a.m.	Initial interview to ascertain candidates' general interests, qualifications, personality, aspects — informal — relaxed. Each perhaps 15-20 minutes.
1.00 p.m.	Lunch — this will involve all candidates and members of the selection panel if possible.
2.15 p.m.	In depth interview of candidate from a technical point of view and personal point of view. Interview 30-40 minutes. *Selection of candidate.* Inform unsuccessful candidates.

In order to assess the candidates over the whole day a set of forms should be used and filled in at each relevant stage. These forms should cover the day in steps and be confidential from the candidate and other interviewing staff. It will normally be expected that once the successful candidate has been informed he will give a decision of acceptance. However, if the candidate is unwilling to do this 24 hours' grace may be given. In this type of situation the other candidates must be informed.

Each employing Authority will require to draw up its own specified job requirements. They should cover in depth topic areas:

Technical Ability Potential

Basic ability to identify with plant engineering together with relevant technical background. This may be obtained from the Personal Specification.

Management Ability Potential

In this area an overall assessment of both the environmental, behavioural and organisational aspects of the future work should be taken into consideration. In particular we have noted that the main failures identified from recruits presently in post are the behavioural and organisational areas. It is very important that the behavioural aspects are looked at critically and in depth, and in particular:

Ability to get on with others;
Ability to motivate staff;
Ability to sell technical ideas;
Ability to present unified departmental image.

The following pro forma is considered useful in the assessment process for the day's sections may be filled up at any time provided the interviewer is satisfied.

Assistant Hospital Engineer Interview Assessment Sheet

(to be read in conjunction with Personal Specification)

The following questions are to help you analyse the various qualifications of your applicant, and to determine, through unbiased consideration, whether or not to employ.

Section 1 — First Impressions

a. appearance	A B C D E
b. bearing	A B C D E
c. speech	A B C D E

Section 2 — Attainments, Previous Experience and Intelligence

a. educational level reached	A B C D E
b. occupational training and experience	A B C D E
c. occupational level reached	A B C D E
d. general intellectual ability	A B C D E

Section 3 — Special Aptitudes

a. mechanical aptitude	A B C D E
b. facility in use of words	A B C D E
c. facility in use of figures	A B C D E

Section 4 — Interests

a. intellectual	A B C D E
b. practicable constructive	A B C D E
c. physically active	A B C D E
d. social	A B C D E

Section 5 — Disposition

a. acceptability	A B C D E
b. influential	A B C D E
c. steady and dependable	A B C D E
d. self reliant	A B C D E

Section 6 — Circumstances, Comments

a. domestic circumstances
b. family occupations
c. unusual hours

NOTES:

a. Minimum acceptable gradings are in bold type.

b. Question 2a — An ONC and apprenticeship are the minimum criteria and as such would be graded at the "C" level. Anything over this would possibly be "B" or "A" — e.g. HNC/HND/FTC would be "B", and a degree "A".

c. Question 6c. — An applicant must show that he is willing to work unsocial hours at short notice if required.

Conclusion

You have now reached the point where it is necessary to decide whether or not the applicant should be employed. This can only be done through the exercise of judgement. You must recognise that no one is perfect, so, while you must compromise, be thorough. Weigh the answers you gave on each of the twenty questions in the above summary one against the other for the solution.

1. Have you devoted sufficient time to arrive at a conclusion?

   Length of first interview

   .... minutes.

   Length of second interview

   .... minutes.

2. What overall rating do you give this applicant?
   Excellent/Very Good/ Average/ Fair/Poor.

3. Do you recommend his employment? (Remember you should always replace one man with another as strong or stronger).
   Yes/No.

4. For what position ....

   Starting rate ....

   First interviewer's signature

   ....

   Second interviewer's signature

   ....

COMMENTS:

The above pro forma should be given to each panel member at the beginning of the day. Perhaps half an hour spent together before the start will mean that the panel are all looking for the same type of applicant!

The Membership of the Panel

This should consists of the following:
Departmental Head/Hospital Engineer (immediate superior);
Group Functional Head (District Engineer);
Personnel Officer;
Outside Assessor (Area Health Authority Representative).

At all times throughout the day it must be remembered that there are three purposes in achieving success:
For the employer to obtain all the information about the candidate necessary to decide his suitability for the post;
To give the candidate all relevant information about the post and the organisation in which it fits;
The public relations function of leaving the candidate with the impression that he has been fairly treated.

In all cases the final assessment should take into consideration the personal specification and personal judgement in conjunction with the pro forma. The interviews should be kept as short as possible. Most short lists should be kept to four or five candidates.

Much can be learned in the informal situation providing the interview panel and assessor realise this from the outset.

Management Development

In considering the management development of Health Service Engineers it is important to consider all the aspects of each man. We have seen previously that although we choose various criteria for selection purposes we must combine these criteria for an overall assessment of suitability of each candidate. In the same way the technical and managerial skills should be developed together. To give a brief example of what is meant here, suppose we give a small design job to an Assistant Engineer, for example, the installation of some sterilizing equipment. He will work hard preparing the technical specification and once this is complete it may be sent out to tender and that may be the very last he sees of it. He may not see the full implications of his technical decisions on the use of the equipment or the problems associated with its installation.

All Assistant Hospital Engineers must be able to take projects through from their initial conception through to installation under their personal direction until its completion. In this way responsibility may be built up in a similar manner to the modular training schemes used for craft and technician training.

Training

In January, 1975 there were a total of about 800 Assistant Hospital Engineers. The National Health Service ratio for promotion to the Hospital Engineer Grade is about a one to one ratio. It is normally expected that at this level it will take about three years from the date of initial appointment before promotion to the next grade takes place. This means that training and development will have to be fitted in not only to suit the organisation's requirements but also to match, where necessary, the academic year. These constraints may be split up over the environmental, organisational and behavioural conceptual model.

The following are thought to be some of the main constraints or activities that require some consideration.

Environmental

As previously mentioned the academic training or education will, at this stage, be determined to a large extent by the academic calendar. Assistant Engineers may be getting at least one day off per week for technical education. In order to gain promotion to Hospital Engineer, at least a Higher National Certificate or full Technilogical Certificate is required, together with a certificate in management.

Because of this external constraint it will not always be possible to send Engineers on Training Courses for specialised Hospital equipment or introductory management courses.

Organisational

In order to have some return for the staff establishment quickly, an Engineer will have to become involved in minor projects, or planning maintenance schedules. Depending on ability and the organisational pattern at the time of appointment, the initial placement of an Assistant will be determined by circumstances.

Behavioural

Perhaps in some respects this is the most important aspect. Each Assistant Engineer must quickly be made to feel that he is contributing something worthwhile.

An Engineer newly appointed must also feel that someone has an interest in him and that he has been properly consulted before being placed.

It can be seen from our EOB model that the development, both from a technical and managerial point of view, has to suit the organisational needs at that moment in time. If at any future time the terms of reference are changed then this pattern may alter. However, for the present, it is set.

Technical Training and Academic Education

It is expected that a new entrant to the Service will have completed at least his Ordinary National Certificate (minimum entry qualification).

This will mean that it will normally take him two more years to gain a Higher National Certificate or three years to gain a full technological certificate.

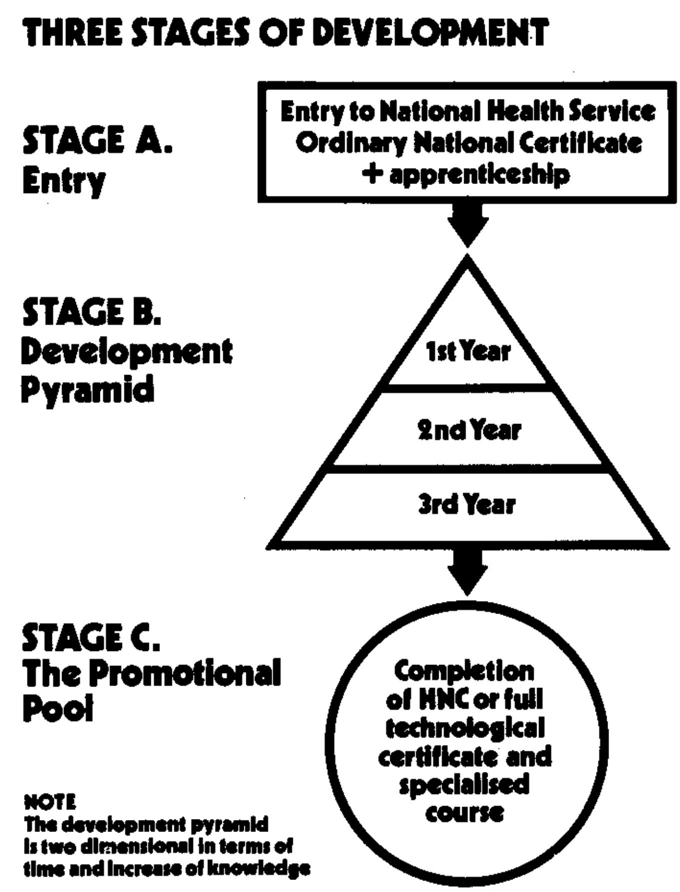
In order to fit this into a management development programme it will involve either block release or day release. As previously stated it is normally found that day release is preferable. It not only meets the organisation's needs but also means that academic study may be quickly related to the every day job. This proves useful for employer and employee alike.

We have identified at the selection stage that one cause for failure in the job was lack of specialised technical knowledge. To satisfy this need and to provide the basic framework the following scheme of implementation is recommended.

From *Figure 1* we will see that there are three stages of development.

Stage A Entry;
Stage B The development pyramid;
Stage C The promotional pool.

It is Stage B on which we should now concentrate our development plan. A pyramid structure has to be used in this context to indicate the various stages of development and training. Bearing in mind the work done by King in 1964 in which he states "training surely amounts to providing the condition in which people can learn effectively", it will be seen that in order to get the correct mix the following procedure should be adopted.



Stage B First Year

0-3 months

Day Release course planned and implemented if possible depending on the time of year. Basic introduction to Hospital technical complex.

3-9 months

Assess progress on Day Release course guidance where necessary.

9-12 months

After first 12 months check academic progress for success. If failure improve support and try again. Regular appraisal interviews at this stage may be helpful. Increase in responsibility for areas of work. Training by objectives to be introduced for longer projects.

Stage B Second Year

Continue Day Release supplemented with one or two residential weeks at the Hospital Engineering Centre for specialised training technically. Increase responsibility so that areas of functional responsibility are evolved. Deputising at other Hospitals in the absence of a Hospital Engineer can be good for morale at this stage. It can also give a good assessment of future ability particularly on the behavioural side.

Stage B Third Year

Providing academic studies are on time these will now be completed. Perhaps two or three specialised courses should now be undertaken. To complete any technical deficiency, responsibility for a smaller acute Hospital should now be possible, and given for final assessment. A project for planned maintenance or similar major installations should be carried out at the same time.

The programme above is suggested as it covers initial induction to the Organisation and follows a management by objectives approach (MBO). It must be under the direction of a qualified Hospital Engineer.

It will be seen that it is the intention to broaden out with knowledge and experience from a technical and academic point of view throughout the three years. As time elapses responsibility should increase, a review stage at the end of each year should be undertaken whenever possible, or more frequently if felt necessary.

Management Development

It can be seen from the foregoing that any Management Development programme must be run in conjunction with the technical/managerial and academic training.

From a technical point of view the pattern of training and development appears to be fairly straightforward. It is when we consider the management development that we are not so clear in our ideas. There are three main headings which should be considered. They are:

What needs to be taught;
How it should be taught;
How can it be assessed or reported on.

Due to the constraints from the environmental, organisational and behavioural aspects it is convenient to use the development pyramid as the framework for our management development. Generally, at Stage A, the entry stage, Assistant Hospital Engineers have very little or no managerial experience. For the purposes of this programme it has been necessary to assume none. If, however, an exceptional man is recruited it may be possible to shorten the time on the pyramid, or even to cut out a year altogether.

It has been identified from our selection procedures that it is the organisational and partially the behavioural aspects that we require to pay particular attention to at this stage of the programme. The pyramid in many ways is ideal for this purpose. It means that we develop our Engineer technically, and may also expand his managerial abilities at the same time. This meets with our criteria to look at the whole man.

We may now look at the management development programme based on the pyramid to match up with the technical and academic study constraints.

Stage B First Year

0-3 months
Introduction to management structure, basic paperwork systems explained, outline of communication system. Introduction to other departmental heads and administration and other colleagues. This may be summarised by calling this stage basic induction.

3-9 months
As the technical responsibility increases the Engineer will have to learn how to motivate and lead subordinate staff on small projects. It is suggested that a basic supervisory training course may help here.

9-12 months
Depending on technical progress some management objectives should be set by the Hospital Engineer for his Assistant. As technical areas are delegated objectives for time, standards and progress reports should be made.

Stage B Second Year

Now that the first year is over, a one week course at the Hospital Engineering Training Centre should be undertaken on Hospital Engineering Management. This will be invaluable (it has not been considered sooner because it takes about one year to fully appreciate all the activities of a large Hospital complex).
During the second year Managerial responsibility will increase. Exercises involving making decisions with other people should be given wherever possible. These should be monitored. Guidance from a Hospital Engineer at this stage is critical. Preparation of Departmental Forward Look Estimates could be a good exercise for such purposes.

Stage B Third Year

This is considered to be the most important year from the management development point of view. Complete managerial responsibility for a Unit Hospital or large functional area should be given. For possibly the first time the young manager will be on his own with a number of Foremen and craftsmen. A two week management course should be undertaken for selected areas for weakness (determined by Training Officer and Disrict Engineer, a joint exercise).
When the larger projects are allocated all the managerial skills may be applied. Objectives should be set and agreed. Performance should be measured by a Hospital Engineer/District Engineer.

It will be seen that if it is organised and planned correctly the technical aspects can provide a very useful springboard for management development. It must be made clear that every member of the management (and wherever possible the Foreman) should be aware of and feel committed to the programme. Meetings must be organised in order to monitor and control the process. It will be no good at all if drift and apathy creeps in from top management. If the programme is to be a success the example must be set by senior management down to the lowest level.

The Assistant Engineer must also feel committed, consulted and have agreed to the stages and objectives which are concerned.

Review and Correction

Following the three year cycle it should, wherever possible, be a policy to promote Assistant Engineers who are satisfactory to Hospital Engineer level. It is the Final Stage where this may be carried out.

Stage C — The Promotional Pool

In order to achieve the maximum benefit from the development programme it will mean that Assistant Engineers will have to move from one Hospital to another within their own Area Health Authority. The pattern is seen as:

First Year
Under the direct supervision of a Hospital Engineer at a large District Hospital (800 beds acute).

Second Year
Under the direction of Hospital Engineers but seconded on occasions to smaller Hospitals for relief duties.

Third Year
Accountable to a Hospital Engineer but in sole charge of a large functional area of work (Boiler House or Laundry) or small Hospital.

Following this special project work may be undertaken in specialist areas of interest if possible. This will mean that Engineers will move around. This should be made clear from the outset. In many cases promotion will be quick due to shortage of qualified staff. There is also the financial reward which tends to move assistants to promotion. This may, in many ways, be similar to the Maslow categories of needs, i.e. physiological, safety, social, ego, self-fulfilment — the latter two being the most important.

Appraisal and Evaluation of Selection/Management Development Programme

We have seen so far that it is possible to develop a training programme which incorporates both technical and managerial aspects. In order to assess the effectiveness of such a policy it will be necessary to identify specific areas of activity for study.

It has been seen that there are three main elements:

Academic Study
Carried out at a polytechnic or college.

Specialised Training
Carried out at residential training centres.

On the Job Training
Carried out within the employing Authority premises.

In the case of academic study, the evaluation may be seen through the examination results at the end of the year. Specialised Training is evaluated in a similar way and generally provides the manager with some guidance. However, some improved method of validation would be useful. It is when we look at on the job training that some overall appraisal system must be introduced and considered.

The on the job identification of the results of training can be achieved by direct observation, by asking questions of the trainee or his manager and colleagues, or by collecting data relevant to performance. The direct observation method is easiest to apply with craftsmen with whom it is possible for the trainer or other assessor to study whether they are actually carrying out the prescribed function in a prescribed manner. The collection of data is also most easily applied to craftsmen since it is possible to measure the quantity and quality of what it produced, as well as items associated with training such as accidents, absence, scrap rates.

With management it is much more difficult to carry out observation and more difficult to collect data. The questionnaire approach, therefore, tends to be employed more frequently. Observation in the management area is difficult because any task may stretch over a long time scale and observation of any individual task may be unrepresentative of the man or of the others. Managers are also much less used to being watched and are therefore more self-conscious which, in itself, affects performance. One of the peculiarities of a manager's life in comparison to that of the craftsmen is that he is rarely actually seen performing his job. His boss relies on casual reports from other people or on the general story told by results.

In this development plan we can create an opportunity for observing the man in the performance of tasks from objectives set, and projects taken from conception to completion.

In many ways the interview technique at the various stages is useful, and may be used as such at the end of each period of training.

Formalised Assessment

At the end of each year it may be convenient to have some form of Assessment Scheme based on an appraisal form. It has been suggested that this may fit into what the Department of Health and Social Security call Training Log Books. A good example is the assessment form used by nurses which is currently being revised.

However, before we commit ourselves to such a scheme we must first look at the advantages and disadvantages and the way in which they must run.

Most large organisations have developed procedures for recording and collecting information about the way their personnel perform. This is known as "management appraisal" or "staff reporting schemes" in many cases. The general idea is to ensure that the organisation makes the best and fairest use of its employees. Its overall objective may be subdivided:

1. The assessment of future potential.
2. Manpower planning.
3. Improving current effectiveness.
4. Salary increases and administration.
5. Providing information to employees.

Although systems differ between organisations, their objectives do not. They are therefore based on personal judgement. The overall judgements may cause difficulties and parameters need to be looked at carefully. In particular, each form needs to be assessed by:

The range of response allowed;
The reliability of judgements;
Differences between judges;
Relationship between scales;
The prediction of overall gradings.

Considerable work on this has been carried out by the National Staff Committee for Nurses and Midwives[10]. Statistical balance is always essential in these situations. It has also been suggested by Stochford and Bissell 1949 that development scales of the sort used in appraisal forms should be accompanied by careful training for the staff who use the form — I consider this essential.

If appraisal forms are considered, to evaluate the training and development schemes suggested in this paper, great care must be taken to ensure that they are correctly introduced. In my own opinion all schemes should be "open" to the candidate to ensure that they are completely fair.

Reports on Courses

It is recommended that when an Assistant Hospital Engineer is sent away on a course that a full report should be made by him on his return. In this way he will:

help himself to clarify what he gained from the experience;
aid the manager in discussing the course with him; and
provide information of the potential value of the course to other people in the organisation.

My experience is that people must be given guidance in order to meet objectives and that a form or list of questions will certainly include topics such as the relevance of the content, the quality of the staff on the course, the cohesiveness of course membership. It is likely that managers will also want to coment on the standard of administration and environment. It is useful to add to this review some forward-looking questions designed to make the Engineer think which parts of the course he will usefully apply to his job, i.e. "which parts of the course will you discuss with your colleagues?" and "do you intend to make any recommendations to your boss as a result of the course?"

The value of these reports in assessing courses is mainly subject to three major qualifications.
They do not show, or assess, what a man has learned, at best, they may show what he thinks about the experience;
They are affected by the written view of the reaction of the recipient;
They characteristically talk about "interest", "stimulation", and "enjoyment" — not about specific things such as difficulties and teaching standards or review methods.

At every stage information should be filed so that an overall picture may be built up on the main personal documents. As previously stated, these should be open. If any adverse report is to be filed then it should be shown to the Engineer before doing so and a signature obtained.

Although the old autocratic methods of management may have their place, in today's context of participation, and working atmospheres conducive to motivation and democratic action, considerable changes in attitude may be necessary from Senior Management. If Management Development is to be a viable proposition it must be seen as totally open, and the formulation of its programme must be agreed in full with those participating. The locked drawer or the confidential staff file is not compatible with modern management development procedure.

Some Final Thoughts

1. Organisations are increasingly recognising that whatever the innate talents of the managers, a systematic training and development programme will make them still more valuable servants of the organisation.
2. From experience of other organisations the more progressive suggest that a substantial effort over the years yields increasingly valuable results, those trained become trainers themselves.
3. Training and development schemes are only effective where there is a close collaboration between line managers at all levels and training staff.
4. The contribution of senior managers — by their interest, support and participation — is not only vital in itself, but reminds managers of their continuing responsibility to use every means of developing their staff.
   It is vital, if the schemes outlined in this paper are to be of value, that correct implementation must be carried out, and that all parties must agree to it, particularly the newly appointed.
5. The selection and development programmes that are developed are an ongoing exercise. In particular, they must take into account new techniques when they are appropriate. An example of such a technique which could prove valuable (validation studies yet to come will show whether they are or not) might be the group selection exercise which is designed to elecit leadership and communication skills in potential managers.
6. It should be stressed that in this paper each aspect is worthy of further in depth study, in fact, both training and development could form a paper on their own.
7. If the National Health Service is to improve its stock of managers it must change so that some scientific methods of selection are used. Training and development must be formalised and planned. In particular it should be the *District Works Officer's responsibility to monitor and control the programme suggested in this paper.*
   It is now the fundamental operational level within the reorganised Health Service.
8. With the increase in technology it will be more important than ever that training both technically and managerially is effective. National wealth is scarce and must be used effectively and efficiently.
9. If the reorganised National Health Service is to fulfil its main objective "to provide a comprehensive Health Care Service available to all people" it must be managed professionally by managers who are committed to the Service entirely.
   Selection, Training and Development are perhaps the most important criteria to achieve this goal!
10. The most effective definition of Management Development should take account of the employee and the organisation and may be summed up as:
   "By systematically looking at the individual's desires, wishes, aspirations, hopes and needs, and reconciling them or harmonising them with the existing and forthcoming requirements of the Organisation within which he or she is expected to work."

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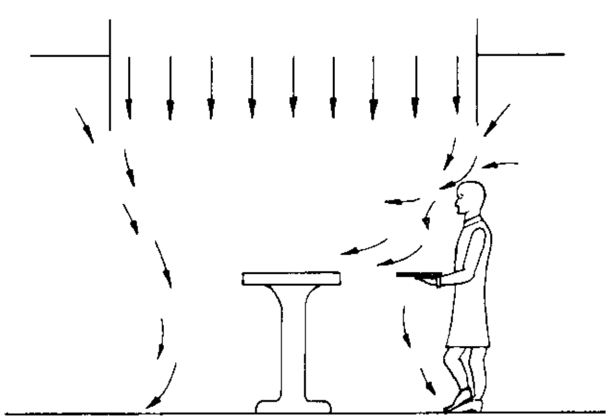
A description of the Charnley Howorth Exponential Flow. Clean Zone System Howorth Surgicair is a division of Howorth Air Engineering Limited, of Farnworth, Bolton. Mr. Howorth is President of the Institute.
From a paper given at the Institute's one-day Symposium held in London on June 23, 1976.

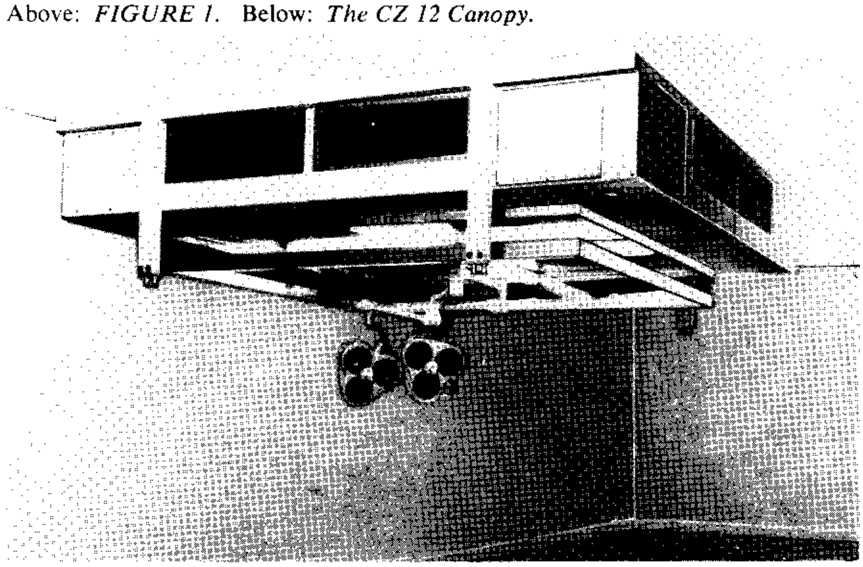
The Prevevention of Airborne Infection during Surgery

F. H. HOWORTH, FRSA FInstPI FIIC PIHospE

A significant conclusion drawn from our long experience in providing clean air enclosures throughout the world for the prevention of airborne infection during surgery is that they would have even wider application and acceptability if they could be made to work effectively without side walls, hanging panels or drapes. It is these that may impose irksome restrictions on procedures, and on the movement of personnel and equipment.



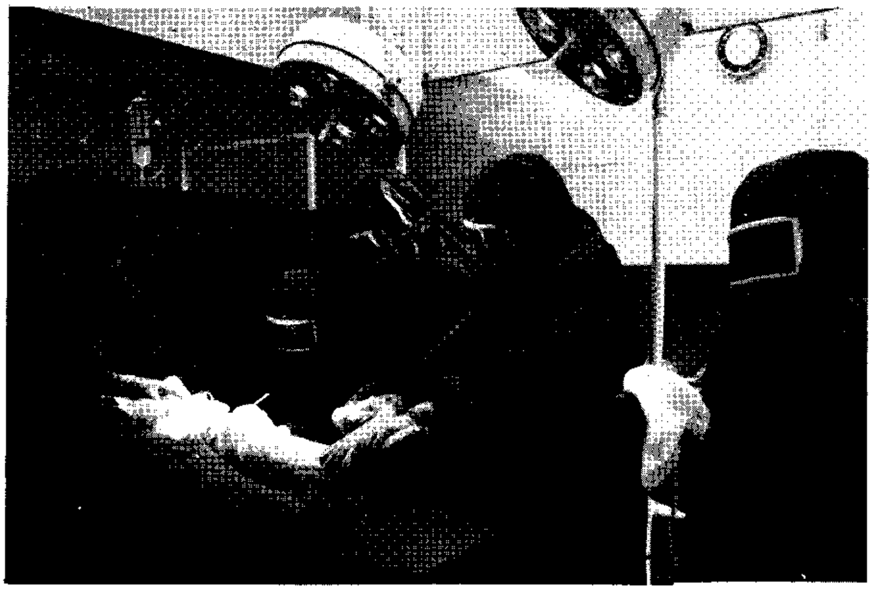
Above: *FIGURE 1.* Below: *The CZ 12 Canopy.*



Our research led us to evaluate alternative methods of producing a clean environment around the wound site. We discarded standard vertical and horizontal flow systems without side walls, because our trials confirmed what several other researchers had shown, that unacceptable entrainment of contaminated room air takes place due to induction, and also due to deflection of the air when personnel, equipment and instrument trays are passing through the perimeter of the air flow towards the wound area (*Whyte et al. Journal of Hygiene, Vol. 73, No. 1. 61*). (See *Figure 1*).

We reached the conclusion that the ideal air pattern would be to continue to have the very positive pressure and downflow over the operating zone, as in the past, but then to turn the air outwards so that it moved radially away from the operating zone; in fact, an *exponential* air flow pattern.

Research carried out, first at our laboratories and subsequently confirmed at the air and bacteriology research laboratories of the University of Glasgow, led us to the development and production of an entirely new form of air handling and diffusion system. This provides a contamination free *exponential* air flow pattern. This, in turn, establishes a clean zone of far greater size than the air diffusion canopy. (See *Figure 2*).



The Surgical Team using the Body Exhaust System.

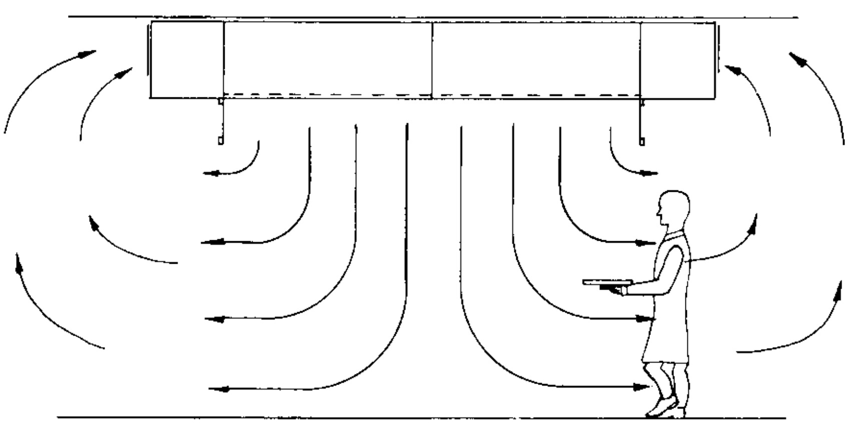


FIGURE 2.

Advantages

The specific benefits of the *exponential* flow clean zone are as follows:

There is clear access to the operating area to a height of over 2.1 metres.

The effective clean zone extends well beyond the perimeter of the 9ft. × 9ft. diffuser, giving an additional margin of safety.

Movement of equipment and personnel with the clean zone is always upstream of the air flow.

There can be no entrainment of room air.

When the members of the surgical team wear the total body exhaust, there can be no airborne infection.

Presentation

The Charnley Howorth exponential flow clean zone is available in one size, the CZ12 (the clean zone is 12ft × 12ft).

The CZ12 may be supplied with, the integral Charnley Body Exhaust System fitted at ceiling height, or it may be used in conjunction with the Howorth Surgicair MOBEX; this is a mobile floor-mounted unit designed as an alternative for use with the Charnley protective clothing.

Either of these combinations will provide the same contaminant-free environment as our previous systems, which have been proved in practice throughout the world over the past ten years.

For teaching hospitals 2ft deep discipline panels may be hung from the canopy down to a distance of 4ft 6ins from the floor — just to keep students and other emitters outside the operating area.

Economics

The installed UK price of the Charnley-Howorth CZ12 complete with the total body exhaust and (when required for teaching purposes) the audio communication system, is £12,000.

Add to this £2,000 to cover fitting the ceiling mounting frame and miscellaneous items in the theatre itself, then the total capital expenditure is £14,000.

Running cost, that is power and filter changing, is £1,000 per year. Taken over a three-year period the total of capital and running expenditure is £17,000.

For any major surgery such as orthopaedic surgery, neurosurgery, open heart surgery, etc., the cost of antibiotics varies between £27 and £30 per patient. When the complete Charnley-Howorth system is used, no antibiotics are given. (*Charnley et al*).

If we assume an average of 250 such operations per year, the cost of antibiotics is between £6,750 and £7,500 per year. Let us be conservative and say a mean of £7,000 per year for three years — £21,000.

Cost of purchase, installation and running of the Charnley-Howorth complete system, for three years, is £17,000. The cost recovery time is in fact just under two and a half years.

This computation is only possible when both the Charnley-Howorth Clean Zone or Enclosure is used with the total body exhaust system for maintaining the members of the surgical team non-emitters.

Other valuable benefits are:

To the hospital
- A short time (5 minutes) between operations with no possibility of cross infection, therefore, greater output of patients from the Clean Zone theatre.
- Shorter bed occupancy.

To the patient
- No antibiotics are needed.
- Minimal trauma.

These benefits are not so easy to quantify, but certainly add still further to the economic advantages of this system.

U.K. Patent Application Nos. 18303/74/76. Foreign patents pending.

The place of the engineer in the world of medical technology is receiving increasing attention nowadays and this article is concerned with the consideration of the role that the chemical engineer might be expected to play in the future. Limited contributions are already made by a minority of chemical engineering departments and industry but a close and more widespread involvement is considered viable in (a) psychological processes (b) prothesis (c) aids to medical activities external to the body and (d) hospital technology.

Each of these is discussed in some detail against the background of the special nature of the chemical engineering discipline.

This article is closely based on one which originally appeared in the journal Biomedical Engineering.

A Chemical Engineering Contribution to Medical Technology

P. A. F. WHITE, OBE BSc CEng FIMechE FIChemE

The role of the engineer in the world of medical technology is receiving increasing attention. Recently the discipline of biomedical engineering has emerged as a central umbrella for activities, at both the research and technological levels where engineering principles are applied to the solution of problems in the arena of medicine and health care. University courses in biomedical engineering, both at undergraduate and postgraduate levels are already available in North America and there is considerable enthusiasm for such opportunities in this country. The relatively advanced position of the United States in this area is to be expected if, as in other technological areas, we consider the relative proportion of the Gross National Product directed to health care and its associated research; in the USA, it is currently 6·9% compared with 4·6% in the UK.

It has long been appreciated that the hospital service in this country might benefit from a searching investigation leading to possible revisions in organisation and career structures for those employed in its service. This was the philosophy underlying the Zuckerman Report[1] which was published in 1968. The Report made many recommendations, and included in these were suggestions that engineers should play an increased role both in the hospital service and in medical research. Since the publication of the report developments have taken place, but these are clearly only a small indicator of the potential contribution of engineering.

At the same time that such areas of usefulness of the engineering approach are being described, members of the engineering profession are of their own initiative becoming increasingly interested in the social implications of their activities and in the possibility of conducting work in the biological and medical fields. It seems, therefore, that the time is ripe for careful consideration to be given as to the way in which the chemical engineer fits into this pattern — what are the special contributions, if any, he can make.

Currently there are many instances of a medical involvement of chemical engineers in the universities and industry. In the USA for instance there are some 200 senior workers in the universities in this field. A fairly isolated effort exists in the UK. Examples are the studies of haemodyalysis and the preservation of transplant organs at Leeds University; lubrication of articular joints and non-invasive flow measuring techniques at Nottingham University Chemical Engineering Department; organism growth in relation to artificial kidney machines at Exeter, membrane development in the biochemical engineering section of the Strathclyde Bio-Engineering Unit; haemoperfusion devices and oxygenators at Messrs. Smith & Nephew; the study of sterile environmental engineering at AERE Harwell. There are many more.

Perhaps we should first consider what are the special features that chemical engineering can bring to bear in biomedical engineering and it is useful to quote from the formal definition assumed by the Institution of Chemical Engineers.

"Chemical engineering is the branch of engineering which is concerned with processes in which materials undergo a required change in composition, energy content or physical form, with the means of processing, with the resulting products and with their applications to useful ends.

"Chemical engineering has its foundations in mathematics, physics and chemistry; its operations are developed from knowledge provided by these, the other branches of engineering and the applied, biological and social sciences . . ."

It will be seen that, so defined, it can almost be regarded as a prescription for the scientific study of medical processes. It is particularly concerned with dynamic systems, with flow patterns, the transfer of mass and energy across boundaries, and with control mechanisms in such systems.

Chemistry is the science of the elements and compounds and their laws of combination, behaviour and reaction with each other under various conditions. It is more concerned with equilibrium than dynamic conditions, or at least with rates of reaction rather than dynamic systems under change. The chemist has long been active in medicine principally as a help to the physiologist in understanding the chemical and physicochemical reactions and in the analysis of chemical constituents of body materials in normality and abnormality.

The biochemist, concerned with the study of chemical and physico-chemical products and processes involved in the life of animals and plants has also been an aid to medicine for a long time past.

While in general, therefore, it would seem arguable that chemical engineering, which is different from, though bordering with, both chemistry and mechanical/electrical engineering, could have an important part to play in medical technology, it is clear that in the UK at any rate a professional involvement is far less obvious or known.

To enquire into this as a worthwhile option in career development, the Institution of Chemical Engineers in the UK has recently set up a Working Group of which the author is the chairman, to consider the involvement of chemical engineers in medical technology, to investigate where these should be encouraged or augmented and to encourage participation in this field.

So what are the areas of medical technology to which the chemical engineer can contribute? At first sight it seems a far cry from a massive chemical plant to the operations of the body or the tools of the medical trade; but a closer examination reveals many areas where the chemical engineer is able, indeed uniquely able, to make a serious contribution.

A first analysis would give the following as the main areas in which the involvement of chemical engineers may be expected to expand.

Physiological processes;
Prostheses;
Aids to medical activities external to the body;
Hospital technology.

Each of these areas will be considered in more detail.

Physiological processes

In many ways we can consider any living system as the analogue of a chemical plant, and we can think of the physiological function of the organism as the counterpart of the chemical engineering processes in the chemical factory. Indeed, of all the branches of engineering, chemical engineering is arguably the best suited to help to solve problems posed by physiology[2]. Without doubt the chemical processes in living systems are incredibly complex and the environment is novel for chemical engineers. However, these are all under very strict control and are subject to the basic laws of physics and chemistry with which we are familiar. The laws of mass, momentum and heat transfer are all applicable, as are control and optimisation theories. In a few areas the chemical engineer is perhaps better equipped to study complex physiological processes than classically trained biological scientists; he is experienced in studying systems with a large number of variables many of which cannot be properly controlled, he is also used to handling dynamically balanced systems rather than treating them as steady state problems.

Chemical engineering may be involved in normal physiological processes at whole body, organ and even cellular level. These all involve metabolic processes of chemical change, energy balances and the transport of materials. A second area of important interest is that of disease. In this case the normal physiological processes are temporarily or permanently deranged and the normally acting dynamic balances are disturbed. The third area of importance is the study of how the body reacts to such insults as trauma and burns and how the intervention of medical techniques can help the body in its recovery. An excellent example of this is the problem of water loss in cases of severe burning; it is important to control the loss by artificial aids which will not cause further tissue damage.

It is important to avoid the limited approach of regarding the engineer as a tame adviser to medical colleagues or for the chemical engineer not to work in close contact with medical people. Thus at Imperial College there exists the Physiological Flow Studies Unit. This group consists of medically qualified research workers, mathematicians and engineers. Included in the Unit's activities have been extensive studies of laminar and turbulent flow in short bifurcating tube systems relevant to conditions in both the cardiovascular system and the airways of the lungs[3]. Following these investigations a new theory of the mechanism of atherosclerosis or hardening of the arteries has been developed[4].

Other work in the Physiological Flow Studies Unit is concerned with the mechanism of transport of metabolites through and across endothelial cells, from which it appears that one of the essential mechanisms involves diffusion of particles within a bounded medium whose size is only a few times larger than the diffusing species.

The rheological properties of blood are extremely complicated; blood consists of a very high concentration suspension of very flexible red cells. The behaviour of blood when flowing in narrow tubes of dimensions comparable to the red cell has posed interesting problems such as cell mixing and lubrication[5,6]. These have been mainly elucidated by the work of chemical engineers who have also been interested in the flow of non-biological suspension such as fibres and emulsions[7].

Pharmacokinetics, which is concerned with the dynamic action of drugs, is an area which has received the close attention of chemical engineers. Bischoff and Dedrick have developed many multi-compartment models capable of describing the absorption, action and subsequent breakdown of drugs[8]. They also developed models to enable scaling of action between animals and man. The development of controlled drug delivery devices arises from this. Decompression and thermal stress are other physiological problems studied by chemical engineers.

Prosthesis

This involves the substitution of diseased or deficient parts of the body by artificial replacements — artificial hearts, kidneys, livers, bladders, pacemakers, implant materials, and joints. All these may be considered either as small chemical plant in which complicated chemical and physical processes are carried out under extreme conditions; or as problems where materials of construction of many different types have to be developed and standardised to withstand aggressive chemical environments for very long periods. The replacement of these organs by artificial prosthetic implants is a long-term objective in which the chemical engineer will play a large part.

The true internal prosthesis will usually result from a deep knowledge of how external prostheses function and from the continual desire to improve efficiency and to miniaturise. At the present time however such developments are not very far along the road to success. As will be seen in the next section, the so-called artificial kidney or kidney machine which operates outside the body still has many problems, not least that of miniaturisation. However, we look forward to the day when a truly portable artificial kidney may be strapped onto the body for an indefinite period. In the work of the AWRE Aldermaston chemical engineers, this is regarded as the final stage in their present programme of artificial kidney machine development.

The artificial heart and heart-lung preparations are in an even less well developed state. In the United States, there exists a massive programme to develop the artificial heart. The usefulness of a heart-lung replacement for prolonged periods is well appreciated: it could be used in many cases of respiratory or cardiac insufficiency, such as severe chest injuries or a heart attack, where rest would greatly facilitate repair. However, the present day heart-lung devices can be used only for very short periods of time because of the destruction of plasma proteins. Oxygenators are massive in size because of the large surface area required to achieve sufficient gas exchange of oxygen and carbon dioxide. Indeed, it is the removal of CO_2 that effectively determines the necessary membrane area. Significant advances cannot be made in the development of small scale reliable artificial lungs until suitable membranes can be developed which will allow greatly increased CO_2 transport for the available driving force; these membranes must also be totally inert toward all the blood constituents. A totally inter-disciplinary approach by chemical engineers, polymer scientists and physicians will be required[9].

Artificial livers for prosthetic purposes are even further away, but chemical engineering principles of membrane technology, mass transfer, and ionic exchange are all involved. The modification of plasma constituents poses many fascinating problems of an enormous magnitude. One approach that is exhibiting some success is the use of micro-capsules circulating in the blood. These consist of activated compounds in solid form encapsulated in a membrane of chosen permeability characteristics[10]. Similar capsule techniques are also being investigated for use in long-term drug release.

In the field of biomaterials used as implants for various purposes, polymers, vitreous carbon, carbon fibre-reinforced materials, ceramics, glasses, and metals all have their applications. Not only is this a problem of selecting the right material for the appropriate physiological environment, but also of determining how to manufacture and convert it to the form in which it is needed with a rigorous degree of uniformity to the relevant parameters. This is a field in which chemical engineers are used to operating.

Aids to medical activities external to the body

Examples in this field include external kidney dialysis machines, heart-lung machines and other temporary by-pass arrangements, as well as anaesthetic equipment, sterilisation, automatic analysis equipment and cryogenic equipment. All of these can be considered as chemical plants with problems of fluid flow, mass and heat transfer[9]. The transport of materials through membranes, for example, is common not only to the artificial kidney and heart-lung machines but also in engineering applications. In the pharmaceutical, brewing, and food industries there is considerable expertise in the process of sterilisation which might be applicable to the health service. Automatic analysis equipment is used extensively not only as an aid to medicine but also to control complex chemical plants, while cryogenic equipment is used in such areas as steel making, pharmaceuticals and food technology. Experience gained in other industries may well be useful to the health service in such areas.

Artificial kidneys

To the engineers it is incredible that an organ as small as a human kidney is capable of ultra-filtering 100 litres/day of blood plasma using a pressure differential of only 50mm Hg, then recovering, against the osmotic pressure, the greater part of the fluid containing the essential nutrients, and finally excreting the remainder as a concentrate. In this way, not only does the kidney remove toxins from the body but, in doing so, it does not upset the delicate ionic balance necessary for life.

The machine which is used to dialyse the urea from the blood against a suitable isotonic salt solution is popularly called the "artificial kidney" although it is really a small chemical plant exterior to the patient. The "artificial kidney" has to remove 25g urea during each day's treatment without upsetting the composition of the blood. It should be simple and instrumented to fail safe, and it has to be easily cleaned and sterilised.

The essential feature of such a plant is that the patient's blood is passed through a dialyser, containing a semi-permeable membrane usually of regenerated cellulose film, which separates the flowing blood from a counter current dilute aqueous solution of dialysis fluid. Urea and other undesirable substances pass out of the blood stream into the dialysate.

Small, simple but reliable kidney machines could allow patients to be more easily self-treated at home with a commensurate saving to the community. The reduction in size of the kidney plant may be achieved by improvements in the techniques of dialysis. For example it may be possible to eliminate large volumes of dialysis fluid by removing the toxic products from the fluid with suitable absorbents possibly in beds or columns. An alternative approach is to ultrafilter the toxins from the blood through suitable membranes. Dialysis treatment has been used in other medical situations, such as the removal of poisons arising from excessive drug intake or from treatment of a particular organ with a drug which is poisonous to the body as a whole, and the removal of high ammonia concentrations found in the blood following liver malfunction.

Artificial pancreas

Interesting work in Canada has recently been reported on the development of an artificial pancreas to dose with insulin continuously in relation to sugar level in the blood, in a portable form.

The artificial lung

The artificial lung or oxygenator is widely used as an adjunct in cardiovascular surgery. Essentially the heart-lung machine consists of an external pumped circuit in which blood from the patient is passed through a gas exchanger where the dissolved carbon dioxide is removed and oxygen supplied, a heat exchanger and a clot catcher and bubble remover, and then back to the patient. Much work remains to be done with these machines, particularly if they are to be used as long-term substitutes for the human lung. This work would involve studies of the haemodynamic implications of pulsatile blood flow, blood pumps, and devices for high gaseous exchange rates.

Anaesthetics

The production, handling, and control of anaesthetic gases suitable for inhalation is clearly a subject for the concern of chemical engineers. But the relation of the anaesthetic to the patient is more complicated. The anaesthetist has to control accurately the flows of various gases according to the condition of the patient. The ultimate tool for the anaesthetist, in measuring essential parameters, is an anaesthetic machine with feed-back to control it, foolproof, accurate, and automatically self-tested.

Storage of transplant organs

The successful transplantation of organs has created the need for, and stimulated research into, storage systems for hearts and kidneys, etc.[11]

Kidneys may be stored for up to three days at around +5°C but for long-term storage it is considered necessary to store the organs at much lower temperature (—70°C with solid carbon dioxide or —196°C with liquid nitrogen). To prevent freeze damage to constituent cells of the organ it is necessary to use the correct level of cryoprotectant (eg dimethyl sulphoxide) and to lower the temperature at the optimum controlled rate. At best, preservation of organs at low temperatures must, however, result in some damage and a more fundamental understanding of biological dormancy is required. To achieve this understanding the engineer can assist with properly designed experiments and equipment.

The size and complexity of plant required for large organ storage becomes formidable, but only when accurate, reliable perfusion and cryogenic plant is available will the systematic evaluation of the many biological factors involved be possible — a true fusion of the skills of biologist and chemical engineer.

In all these examples it is clear that the problems are similar to those met in many other chemical engineering fields and the contribution of the chemical engineer can be substantial.

Hospital technology

In hospital operation, the role of the hospital engineering department is usually separate from the scientific and technical establishment of the hospital. The engineer is concerned with services, design, operation and maintenance, usually with equipment maintenance and sometimes with providing a workshop service for medical and nursing staff. The engineer is not usually concerned with medical research or direct assistance in development of the medical or nursing techniques, although admittedly practice varies widely in different hospital groups. While this may be regretted in some ways, it still leaves a large area where special opportunities can occur for the useful involvement of chemical engineers.

Clean air

The provision of clean, even sterile, air occurs as a requirement in many aspects of hospital design. The most obvious is in the operating theatre where design is necessary to avoid wound infections by pathogenic bacteria from the air, from operating personnel or from the patient himself. Air cleaning with high efficiency filters, careful air flow patterns to avoid bacterial and dust accumulation in undesirable areas, and air flow curtains around the patient are all used, but much experimentation combined with design is necessary to achieve the optimum conditions.

In situations where it is necessary to nurse patients who are put at risk by the hazards of a normal environment, it is desirable to build sterile nursing units. These may be complete wards with associated sterilising air conditioning plant and with medical diagnostic and treatment apparatus operated from outside the unit, or as air curtained beds[12]. A situation, similar in principle, arises where infectious patients are being nursed and air flows should be directed over the patient and then filtered with high efficiency filters before discharge, and where technicians are manipulating pathogenic or radioactive materials. With adequate research and design procedures, the production of clean air and correct flow patterns might do a lot to reduce cross infection in hospitals.

These are all aspects of the problem of separating solids and gases in difficult environments and well suited to the chemical engineering approach of associating research and design in novel plant situations. The work at AERE Harwell on sterile nursing units[12] and at the Papworth Hospital on pollution of operating theatres by anaesthetic gases and vapours[13] are relevant examples.

Manipulation of radioactive substances

Hospitals are using radioactive materials to an ever-increasing extent. The handling of such materials, the correct design, installation and operation of fume cupboards, safety cabinets and glove boxes, and the questions of safe discharge and continuous monitoring all give rise to important problems which require careful attention, especially where accident conditions are taken into account. This is a very apt subject for a chemical engineering approach.

There are many other aspects of hospital engineering, for example laundry operation and the planning of large dispensing facilities, which could usefully command the attention of chemical engineers, for a hospital is in many ways like a factory which handles chemical and biochemical materials, processes them and discharges them. It gives rise to problems of flow and balance, safety and efficiency in a world which would be fully understandable to the chemical engineer and an area in which one would like to see many more chemical engineers serving.

Conclusion

Perhaps enough has been said to substantiate the view that there is a definite place for the chemical engineer in biomedical engineering. As we have seen, this has not gone unrecognised, particularly in the United States, and many contributions are already being made by chemical engineers in the United Kingdom and elsewhere.

Biomedical engineering is essentially a team business, with the fusion of life sciences, physics and engineering. Chemical engineering is one further discipline which can make a valuable contribution to the team, without being the dominant member of it. The time has come for a more thorough examination of the chemical engineering function and for a greater sympathy to the biomedical option among the chemical engineering professional institutions. Is there sufficient university training in the field, do university chemical engineering departments encourage biomedical research projects, and is the medical profession sufficiently aware of the help it might receive from the chemical engineer? These questions are worth exploring.

Appendix

The Working Group on Chemical Engineering in Biomedical Technology of the Institution would welcome further information about medical or hospital projects involving chemical engineers, about university teaching and research in this field, about contributions being made by chemical engineering industry and particularly from chemical engineers serving in hospital engineering.

The Institution of Chemical Engineers would like to encourage a fruitful alliance between the professions of Medicine and Chemical Engineering. A copy of the Institution's Report of its Working Group is available, free of charge, from Technical Officer, Institution of Chemical Engineers, 165-171 Railway Terrace, Rugby.

Any queries about possible involvement of chemical engineers in particular medical fields may be referred to the author.

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Product News

BSI Standard Patient Trolleys

The British Standards Institution has published BS 5402 Patient trolleys at the request of the DHSS. It forms one of a series relating to tubular framed equipment for hospitals, and supersedes BS 2505 and BS 2563.

The new standard specifies materials, dimensions and constructional and electrical safety requirements for patient trolleys, which may be supplied in four basic forms. These are with fixed top, with tilting top, without top for stretcher carrying, and with sliding top for patient transfer.

Recommendations for buffering patient trolleys to prevent damage to the building fabric, anti-static requirements and limits of electrical resistance are included.

BS 5402 may be obtained from: *BSI Sales Department, 101 Pentonville Road, London N1 9ND. Price £2.40.*

Larger Instant Offices

Wyseplan have introduced a new 60ft (18.2 m) monospace accommodation unit. The new unit is 10ft (3.2 m) longer than the previous maximum size, and is entirely self-contained. The units are relocatable, and may be used singly or linked to each other and to existing buildings, to provide good standard one- or two-storey accommodation at a fraction of conventional building costs.

The illustration shows the first unit being delivered to Middlesbrough Hospital in Cleveland. It will provide six 10ft × 12ft (3 m × 3.6 m) instant offices for the Pathology Department.

For further information contact: *Wyseplan Limited, Chawston, Bedford MK44 3BH. Tel. 0480 75377. Telex 32176.*

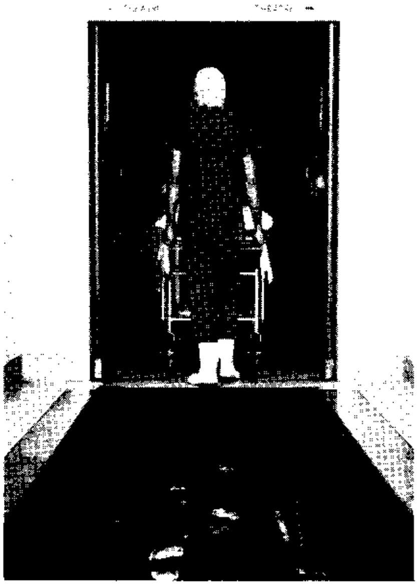
Contamination Control Floor Screen

Dycem Plastics have developed a full-length continuous contamination control screen which they believe will revolutionise the control of footborne bacteria in hospitals. The new screens have become available as the result of a new manufacturing process, and are available in either 3 or 4 metre by 1.2 metre lengths. The screen is produced from a unique material that is inherently tacky and non-slip. This ensures that any particulate contamination that comes in contact with their

surface is caught and retained.

The new continuous lengths are easy to clean, since the screen retains its position while it is washed over with a simple soap and water solution. It can then be dried ready for immediate use. The screen's guaranteed life is one year, and there is no bacteria-harbouring frame, no sticky carry over and no refills to purchase.

Dycem are offering free two-week trials. For details of these, and of the new screens, contact: *Dycem Plastics Limited, Parkway Trading Estate, Minto Road, Bristol BS2 9YB. Tel. 559921. Telex 449576.*



Foil Prevents Heat Loss

Savings of up to five per cent on central heating bills are claimed with the use of Radfoil, a new material to prevent heat loss through walls behind radiators. British Gas researchers say that infra-red measurements show that hot spots on outside walls disappear, and confirm that more than half the waste heat is saved.

Radfoil is a reflective surface on a laminate backing, easily fixed by means of tape and pads, which also create an air gap that serves as further insulation. Radiators do not have to be removed, and the only tools required are scissors and a pencil. The material remains permanently effective and hidden from sight.

Further information from: *Carrs Paper Limited, Shirley, Solihull, West Midlands B90 4LJ. Tel. 021-744 2215. Telex 337836.*

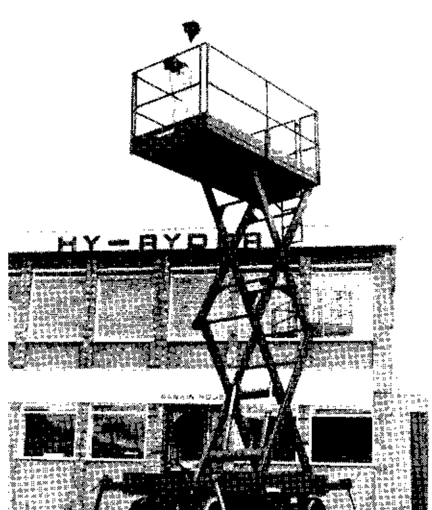
Mobile Work Platform

Hy-Rider have developed a lightweight easily manoeuvrable mobile work platform, which replaces traditional scaffolding on many construction, installation and maintenance projects. The platform is easily manoeuvrable by hand, and can readily be towed by a variety of vehicles.

The platform is of the scissor type, and has a maximum working height of 21ft 6ins (6.5 m). The non-slip 8ft × 4ins (2.4 m × 1.2 m) plywood lined work platform can carry a working load of 1,000 lb (450 kg), and controls are duplicated both at ground chassis and work platform level. Control is through solenoid operated valves which activate the 3,000 psi hydraulic pump to raise and lower the platform.

The new machine should have many applications, from initial installations, to maintenance in high and awkward overhead areas which are otherwise difficult to work in using static equipment. The new machine will be exhibited at the Public Works Exhibition from November 15-20.

Further details from: *Hy-Rider, Andrew House, 616 Mitcham Road, Croydon, Surrey. Tel. 01-684 6221.*



Cape (Warwick) joins Intermed

The Cape (Warwick) Holdings Group, suppliers of medical equipment, clean air filtration engineers, and materials handling systems, was acquired by Thomas Tilling Limited on October 14. The Group now becomes a member of Intermed, the £25 million group of companies formed less than three years ago to co-ordinate Tilling's own interests in the medical field.

Companies in the Cape Group include Cape Engineering, which has recently been granted sole manufacturing and world-wide marketing rights for the unique controlled environment treatment system developed by the Biomechanical Research and Development Unit at Queen Mary's Hospital, Rochampton. Other companies in the Group include Capecraft, Microflow and Pathfinder, Warwick Production and Warco Products. Group turnover in the year to June 30, 1976 was £5.3 million.

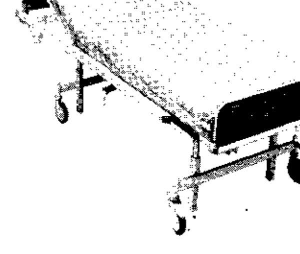
New Extracare Bed

Ellison have introduced a new extracare divan bed as their contribution to answering the demand for a new pattern of bed. With the styling of a domestic bed, this model has been developed to include a wide choice of nursing features.

The bed can be supplied fitted with skids for ward conditions calling for stability, or with conventional castors for mobility. These are interchangeable as required.

Ellison regard the new bed as a new concept, offering a general purpose divan bed, combining patient comfort with nursing amenity. It is designed to allow the speedy fitting of basic nursing accessories such as side-rails, drip pole and a simple but effective form of traction. The beds measure 80ins × 37¼ins (2,032 mm × 940 mm). They will accept mattresses 75ins × 34ins × 5ins deep (1,905 mm × 864 mm × 127 mm). The fixed platform height with skids is 17ins (432 mm or 21ins (583 mm) with castors.

Further information from: *Ellison Hospital Equipment Limited, Dept. Ex., Wellhead Lane, Perry Bar, Birmingham B42 2TD. Tel. 021-356 7306.*



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To place an advertisement in this section, please write or telephone:
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OFFICIAL APPOINTMENTS
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APPOINTMENTS AND SITUATIONS VACANT

SCOTTISH HEALTH SERVICE
COMMON SERVICES AGENCY
Building Division

Three vacancies for Technical Assistants have arisen. The work will be on the design of heating, ventilating and air conditioning systems for health buildings under the direction of senior staff.

Technical Assistant I — Mechanical — Aberdeen

£4,032-£4,788 p.a. Two posts

Minimum requirements are an ONC or alternative qualification in an appropriate subject plus not less than ten years' relevant experience (the first three years of practical or theoretical training are not included). It is preferred that officers in this grade have an HNC. He/she may be expected to provide technical assistance of the highest order.

Technical Assistant II — Mechanical — Edinburgh

£3,594-£4,029 p.a.

Minimum requirements are an ONC or alternative qualification in an appropriate subject plus seven years' relevant experience (the first three-year practical and theoretical training are not included).

Application forms and further details are available from Common Services Agency, Building Division, Room 06, Clifton House, Clifton Place, Glasgow G3 7YY (or phone 041-332 7030 and ask for Mr. Meikleham) and should be returned there by November 20, 1976.

Re-Advertisement

SOUTH GLAMORGAN HEALTH AUTHORITY
ASSISTANT AREA ENGINEER

Salary: £4,371 - £5,262 per annum
Plus £291 Supplement to Earnings

Applications are invited for the third-in-line post within the Area Works Department.

The duties and responsibilities of the post will be to assist the Area Engineer in the liaising with Hospital Engineers on planned maintenance throughout the Area. He will advise on the economic usage of energy and provide technological information for delegated capital and revenue schemes.

Applicants should have a sound knowledge of engineering work to Health Service buildings and possess HNC in Mechanical or Electrical Engineering together with an appropriate administrative qualification or a similar approved qualification.

Application forms and job description from: Mr. J. E. Taylor, Area Personnel Officer, 14th Floor, Pearl Assurance House, Greyfriars Road, Cardiff.

Further information from: Mr. P. Jackson, Area Engineer, University Hospital of Wales.

Closing date: November 19, 1976.

EAST SUSSEX AREA HEALTH AUTHORITY

THIRD-IN-LINE ENGINEER AND BUILDING OFFICER POSTS

Applications for the following posts are invited from suitably qualified and experienced Officers currently employed in the National Health Service (England and Wales).

BRIGHTON Health District
Sector Engineer
Sector Building Officer

EASTBOURNE Health District
Sector Engineer
Sector Building Officer

Salary Scale (all four posts): £4,371-£5,262, + £291 (non-enhanceable).

Application form and job description may be obtained from: The Area Personnel Officer, East Sussex Area Health Authority, PO Box 10, County Hall, St. Anne's Crescent, Lewes, Sussex. Tel. Lewes 5400, Ext. 205.

Closing date: November 22, 1976.

CENTRAL PUBLIC HEALTH LABORATORY

ENGINEER

required for the operation and maintenance of the engineering services and related building maintenance.

Applicants must be experienced maintenance engineers and have a sound practical knowledge of boilers and mechanical and associated electrical equipment. A knowledge of plumbing installations associated with large institutions an advantage. HNC or City and Guilds in engineering, or equivalent qualifications, desirable.

A new laboratory is at present being planned and the Engineer will be consulted on engineering and associated aspects.

Whitley Council salary scale for Hospital Engineers, at present £3,954 rising by five annual increments to £4,545 per annum inclusive of pay supplement and London Weighting. In the event of an unqualified, but well experienced person applying, the salary would be abated by £150 per annum at all points.

Application form and job description from Personnel Officer, Central Public Health Laboratory, Colindale Avenue, London NW9 5HT.

EALING, HAMMERSMITH AND HOUNSLOW AREA HEALTH AUTHORITY (TEACHING)

SOUTH HAMMERSMITH HEALTH DISTRICT (T)

Charing Cross Hospital

ASSISTANT BUILDING SUPERVISOR
£3,009-£3,414

Applicants must have relevant experience in the building industry, the supervision of staff, and should hold an Ordinary National Certificate in Building or equivalent qualification.

The person appointed will assist in the supervision of a wide range of maintenance tasks in the District. The duties will include general maintenance responsibilities and preparation of drawings and specifications.

Informal visits to the Department may be arranged through the District Building Officer, Mr. John Bullen (tel. 01-741 0517) and closing date for return of completed application forms is the 19th November, 1976.

Job descriptions and application forms are available from Heather Dann, District Personnel Department, Charing Cross Hospital, Fulham Palace Road, London W6 8RF (tel. 01-748 2040 ext. 2997).

CLASSIFIED ADVERTISEMENTS — *continued from previous page*

APPOINTMENTS AND SITUATIONS VACANT

Greenwich Health District

Assistant Engineer

Based at Greenwich District Hospital Vanbrugh Hill, London SE10 9HE

Applicants must be well experienced in the operation and maintenance of large air conditioning units, and their associated plant and controls, refrigeration machines, etc., and will be responsible to the Hospital Engineer for carrying out this function at Greenwich District Hospital, although he or she will be expected to assist over the whole range of an Assistant Engineer's duties if required.
This is a new Hospital, fully air conditioned. The work is interesting but very demanding, requiring the services of a skilled and energetic Engineer. It is stressed that this is not a training post.

Applicants must have served an engineering apprenticeship and possess an ONC in mechanical or electrical engineering, or recognised equivalent. Hospital experience is not important.

Salary scale £3,666 to £4,110 inclusive of London Weighting and earnings supplement (starting salary may be above minimum for a suitably qualified and experienced person).

Temporary single accommodation may be made available.

Mr. N. Kenney, Sector Engineer, or Mr. G. Hughes, Hospital Engineer, would be pleased to discuss technical details with interested persons, telephone 01-858 8141.

Further details and application forms from the Personnel Officer, Greenwich District Hospital, Vanbrugh Hill, London, SE10 9HE.

Closing date for receipt of applications: November 22, 1976.

HOSPITAL ENGINEERING CENTRE EASTWOOD PARK, FALFIELD, AVON

Two Lecturers

Two Lecturers are required at this Centre situated between Bristol and Gloucester. The Centre provides through it three Departments of Electronics, Environmental and Mechanical, training for all grades of engineering staff employed in the National Health Service in England, Wales and Scotland. Courses which are of one or two weeks' duration are provided for Design Engineers, Maintenance Engineers and Craftsmen and cover all the major aspects of Hospital Engineering with emphasis being placed on practical demonstration and student involvement through the medium of a wide range of installed hospital plant equipment.

Post A requires a thorough knowledge of building services with particular application to Health Service Engineering or equivalent experience.

The successful candidate for Post B will have experience in lift design, maintenance and operation and will participate in the development of a new course on lift maintenance. Additionally knowledge or experience in building services will be an advantage.

Candidates for both posts should be qualified to at least HNC standard and have practical Health Service Engineering or similar experience.

Salary scale: £3,906-£4,692 per annum plus flat rate supplement. Commencing salary may be above the minimum. Whitley Council conditions of service for the National Health Service will apply. Temporary residential accommodation may be available at an economic rental.

Application forms are obtainable from the Regional Personel Officer, South Western Regional Health Authority, UTF House, 26 King Square, Bristol BS2 8HY to whom they should be returned by January 3, 1977.

CHESHIRE AREA HEALTH AUTHORITY — CREWE DISTRICT
LEIGHTON HOSPITAL

ASSISTANT ENGINEER

Salary: £3,063 to £3,507 plus service supplement of £291 p.a. plus bonus allowance.

The person appointed will be responsible to the Hospital Engineer over the whole range of his duties. Applicants should have a sound knowledge of the principles and practice of steam boiler plant, engineering and electrical service and possess ONC or OND or approved equivalent in engineering. A recognised apprenticeship should have been served.

Application forms obtainable from the Personnel Department, Leighton Hospital, near Crewe.

Closing date for returned application forms, November 22, 1976.

AMERICAN MEDICAL INTERNATIONAL

MAINTENANCE ENGINEER

is required for the new Private Hospital to be opened in the New Year at Nottingham Place, London, W.1.
The person appointed will be responsible for both building and engineering maintenance arising within the hospital (140 beds) and its annexes, and for the small maintenance department to be established.
Applications are invited from suitably qualified Engineers. Experience of hospital plant and equipment will be an advantage.
Salary negotiable within the £4,750/£5,000 range according to experience.
Applications should be made in writing without delay to the Commissioning Officer, 46 Wimpole Street, London, W.1.

CLASSIFIED ADVERTISEMENTS for the next issue of Hospital Engineering (published December 3) should reach Earlsport Ltd., 33 Ludgate Hill, London EC4, by November 24.

CLASSIFIED ADVERTISEMENTS

SITUATIONS VACANT

WEST MIDDLESEX HOSPITAL, ISLEWORTH, MIDDLESEX

DISTRICT ENGINEER

Applications are invited from suitably qualified and experienced officers for the post of District Engineer to the Hounslow Health District.

This district comprises six hospitals, several clinics and health centres, and offers an excellent opportunity to gain valuable experience in the Health Service engineering field.

Salary scale £5,763 p.a. rising to £6,945 p.a. + £312 p.a. London Weighting + £291 p.a. supplement.

Application form and job description from and returnable to Mr. P. J. Harris, Assistant Senior Personnel Officer.

For further details please contact Mr. D. Alexander, Acting District Works Officer. Tel. 01-560 2121, Ext. 695.

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