to see how much more can be done with our existing resources without a falling off in our standards of care. The rise of hospital infection, with its morbidity and mortality, is a grim warning of what may be in store unless the public conscience is roused to demand more new hospitals sooner. It is also suggested that the more efficient use of our personnel in modern hospitals—the replacement, for example, of two outworn hospitals for one fully equipped one—may make a significant contribution to the problems of medical, nursing, and ancillary staffing.

In addition, some observations are made on what seem to be important points to consider when designing new hospitals. They are not intended to be exhaustive but to serve as items for discussion. The need to marshal such knowledge as we have of hospital needs and hospital building is stressed, and through a central intelligence service this information should be immediately available to anyone called to help in hospital development.

Finally, we would stress again that in the space available we have concerned ourselves solely with general hospitals. The problems of mental hospitals, for example, and other special hospitals are no less insistent; nor have we explored the role of the local authority or the part which it is hoped the general practitioners will play within the hospital service. Discussion on hospital

building reflects vividly the overlap of the three arms of the National Health Service and the need for the fullest co-operation and integration. Indeed, at peripheral level the hospital provides the only possible meeting-ground for all the professional elements of the service. Is it too much to hope that in the construction of new hospitals this will be recognized and definite meeting-rooms made available in which the medical and other workers in the National Health Service can come together to deal with the problems which affect them all?

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ARCHITECTURAL PROBLEMS OF NEW HOSPITALS

BY

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It has been said that it was lucky that our economic difficulties prevented us from building any hospitals in the decade immediately following the war, because our ideas of what a hospital should be like have changed so radically in this period. They have indeed changed, but of course they are still changing, and it is by no means certain that the rate of change has slowed down very much. However, we have now to build a substantial number of new hospitals to replace many which are hopelessly out of date and uneconomic, and we therefore have to take decisions now which will establish the pattern of hospital building in the next few years. The ability to meet changing need must be a first consideration in design.

Buildings have a considerable life. Even lightly constructed modern buildings will last, so far as structural soundness is concerned, for 50 to 100 years. Over such a period we must expect many changes in use. It has sometimes been argued that we ought to try to put up hospitals in a very temporary form, designed to last only a short period. However desirable this may be, it is not possible; building structures have to be designed to stand up against certain maximum stresses imposed by the British climate, including rare events such as gales of 100 miles an hour. If they are strong enough to stand up with certainty for one year they will be strong enough to last for 50 years. Buildings are expensive and we cannot afford to plan on the basis of a very short life for our hospitals. We must therefore try to design hospitals which, although structurally long-lived, are flexible enough to remain efficient under changing use.

There is more than one way of approaching the problem. One approach, which was strongly urged a few years ago, is to use buildings which are, in large measure, demountable. These buildings, it was hoped, would be composed of unit parts which could be taken apart and reassembled easily whenever necessary. Amongst other attractions this idea appeared to absolve hospital planners from the need to think very carefully about function; it presupposed that the building could always be rearranged to fit any type of use. Unfortunately, demountable building is not really practical. Complex modern buildings, like hospitals and laboratories, are an assembly of services—heating, lighting, ventilation, and drainage—they do not consist merely of walls and floors. To change the use of a building therefore involves not merely unscrewing and reassembling wall panels, but also changing the position of sinks, wash-basins, lights, power points, etc.

Attempts have been made to provide for freedom for rearrangement of services, but this means installing a tremendous network of service lines with take-off points in all possible positions. In any given arrangement of the building, only a very small proportion of the service lines are in actual use, and therefore buildings with this degree of flexibility are prohibitive in cost. Again, it has been found that demountable walls, with numerous channels and ducts for services, make effective soundproofing impossible and present difficult problems in hygiene and control of infection. There is little likelihood that we shall solve the problem of soundproofing demountable walls, as the soundproofing properties of

the wall are directly related to its weight, and a wall heavy enough, for example, to give privacy between two adjoining consulting-rooms is far too heavy to be demountable. Hence the idea of demountable building, which appears at first to be so attractive, is now generally recognized not to offer any general solution to the problem of flexibility in use.

How then, can we plan our hospitals to accommodate change? We have recently developed certain design techniques which go a long way towards solving this problem. Two principal approaches are involved—one concerned with the general planning of the hospital site as a whole, the other with the detailed design of individual departments.

Planning for Growth and Change

Traditionally, buildings have been designed as a single static entity. The Parthenon and the Royal Palace at Versailles are finished buildings in which every part has been designed in relation to the whole; nothing can be added or taken away from such a building without disrupting it, both functionally and aesthetically. Most hospitals in the past have been designed like this, and unfortunately some still are. But another approach is possible—organic design which allows for growth. A Cotswold village exists as a functional and architectural entity, but it has grown over time; its layout has permitted change and expansion without disruption. We now recognize that the design of a hospital should be looked at almost as a problem in town-planning rather than architecture. Hence, in working out a site plan for a hospital we think in terms of town-planning concepts, such as traffic routes and the zoning of areas for development. It is possible to develop plans which permit ordered growth and change, and which enable various departments to be added to from time to time, without cutting traffic routes or invading space already used for other purposes. In such planning the placing of supply departments such as kitchens, laundry, and stores in relation to the service routes is of great importance. It is also necessary to identify those departments which are most likely to expand substantially, in order to ensure they are placed so that they can do so.

Some general principles are already clear; one is that it is a disadvantage to embed one department within another if this can be avoided. For example, if the operating-rooms are embedded in the ward building, it will be very difficult to allow for the expansion or alteration of both wards and operating-rooms. A certain looseness of planning is necessary to allow for growth of individual parts, and this may well be worth it even at

the cost of some little separation of one department from another. In other words, the ideal plan for the hospital *now* may not be ideal if we envisage the hospital as something living and growing over a number of years. It is very difficult to extend any buildings vertically, and in a hospital it is particularly difficult to add an additional floor while keeping the existing building in use. Hence provision for growth is best made horizontally. From this follows the general principle that low buildings are better than high ones wherever much growth or change is envisaged. Here again the principle of flexibility is in conflict with compactness and militates against highly compact solutions. To achieve a wise balance we may try to distinguish between those parts of the hospital most susceptible to growth and change, and those which are relatively static. The former are best planned loosely in low buildings, while the latter may be grouped more compactly in tall blocks.

Without much question, the wards form the most static portion of the hospital, both quantitatively and qualitatively. We now know pretty well how to relate the number of beds in a hospital to the population it serves, and we have no strong grounds for believing that the demand for beds will increase very much in the foreseeable future. Hence if we build a hospital of, say, 600 beds to serve a given population, and these beds are so planned as to be usable by any specialty, we do not expect to have to add to them very much—unless, of course, there is an increase in the population served. Again, the requirements for the nursing care of a sick human being, while they change slowly with changing culture, are not susceptible to the dramatic variations which we have seen and expect to continue to see in the departments such as x-ray, operating-rooms, etc. A well-designed ward built to-day may still provide acceptable conditions for nursing patients in 30 years' time; it is unlikely that an x-ray suite built now will be functioning unchanged after 10 years. Thus, if we consider flexibility and freedom for growth as an important objective, the conclusion is in favour of low, rather loosely planned buildings, with the ward block as the only portion rising to any considerable height.

Convenience and Efficiency

But flexibility is not the only consideration; convenience and efficiency in use can also be regarded as a major objective in good hospital design. Many of our older hospitals, planned in a horizontal form with low buildings, are very inconvenient and costly to run. Where food, linen, etc., have to be transported long distances by trolley, many porters have to be employed,

FIG. 1.—Princess Margaret Hospital, Swindon, from the west. The superimposed physical medicine and pathology departments are on the left and the operating department on the right, showing their stone-faced podium. (Consultant Architects: Richard Llewellyn Davies and John Weeks. Architects: Powell and Moya.) (Reproduced by permission of *Architectural Review*.)

and staff and patients' time is wasted by long journeys from one department to another. In America, much attention has been devoted to developing labour-saving methods of transport and communication within hospitals, and certain American hospitals are remarkably efficient in this respect. A number of new hospitals recently built in Kentucky and West Virginia by the Miners' Memorial Association have achieved striking economies in running. It is claimed that in these hospitals the ratio of staff to patients has been dramatically cut. This economy is achieved by placing all wards in a tower block which rises above the kitchen, laundry, and central stores. All supplies to the wards are delivered vertically by lifts, conveyors, or pneumatic tubes.

These hospitals are revolutionary in organization as well as design, and indeed the design depends on the organization. The possibility of direct delivery of supplies from kitchen, laundry, and stores to the centre of the ward floor has been exploited to the extent of doing away with most of the normal ancillary rooms and practically eliminating local storage. In place of store cupboards, each ward unit has a stock of supply trolleys which are sent down daily for replenishment in the central stores. Nothing is stocked or prepared in the

ward kitchens: even a glass of milk is sent up from the central kitchen. In fact, the ward kitchens are little more than service points connecting with the main kitchen. The effect of these changes on the organization of the ward is, of course, very great, and these hospitals contain no identifiable ward unit comparable with what we are used to in this country. As a logical development of the supply system, the "race-track" ward plan has been evolved. The ward block is a thick, rectangular, or even square building, with patients' rooms on the outside; the centre core, which must be artificially lit and ventilated, contains the lifts, conveyors, and service rooms. (The "race-track" plan has been recently advocated for use in this country, but it should be noted that there is little justification for it except when the revolutionary methods of supply and storage are also adopted.)

Most of the hospitals in which this vertical service system has so far been installed are rather small—between 150 and 300 beds; but larger hospitals are now being designed on this principle both in Great Britain and in the United States. There is, however, an upper limit to the size of hospital in which the system in its simplest and most efficient form can be used. This limit is set by the ward block. A single block containing 200 to 300 beds is already a large building, comparable in size to a large office block; a building of 800 beds in a single block is a very big thing indeed, perhaps 300 feet (91 metres) long and 10 stories high. It is likely to be far bigger than any other building in most towns. Probably from the point of view of both its outside appearance and its interior character a building of this size is near the limit of tolerance in many situations. Hence, if we need to plan hospitals much more than 800 beds in size, we may be driven on the grounds of general amenity to divide the wards into two or more separate buildings. When this is done many of the advantages of vertical planning disappear at once, as most journeys will involve horizontal travel as well as vertical movement. Fortunately it does not appear probable that many new hospitals in this country will exceed 800 beds in size, but even this figure presents difficulties when we try to plan the wards in a single building.

Design of Individual Departments

Imaginative, organic design of the whole hospital can provide for long-term growth and change. A hospital planned with good circulation routes, and with space for growth where it is needed, can accept slow changes, spaced over 10, 20, or even 50 years. But there is another problem—the need for flexibility in use day by day, or year by year. This need can be met by wise planning of the individual departments. The first point here is that flexibility in use is greatly increased if individual departments are grouped by function. This means that wards are grouped together, operating-rooms are in one operating department, x-ray facilities are in one x-ray department, and so on.

The alternative arrangement, common in the past, of grouping together all the facilities used by one medical specialty militates against freedom and flexibility in use. For example, in the Westminster

FIG. 2.—Princess Margaret Hospital, Swindon. The pool in the garden court enclosed by the out-patient department. (Reproduced by permission of *Architectural Review*.)

FIG. 3.—Princess Margaret Hospital, Swindon. Looking along the entrance front, past the out-patient and casualty departments. The main ward block to be built as part of the second stage is shown diagrammatically. (Reproduced by permission of *Architectural Review*.)

Hospital, completed in 1939, the out-patient clinics are housed on each floor, adjoining the corresponding wards. Thus, on one floor there will be wards and out-patient clinics for general surgery; on another, wards and out-patient clinics for orthopaedic cases, and so on. But the balance between in-patient and out-patient work varies as between specialties, and even within one specialty the balance can change rapidly with changes in medical care. With the Westminster plan there is a fixed ratio of space for in-patient and out-patient work in each specialty, and there is no easy way of adjusting the accommodation to meet changes in the pattern of work.*

With the other arrangement, now general, where all wards are grouped in one block and all out-patient clinics are grouped in one area, it is much easier to meet the needs of a medical specialty which finds a change in its work. More or less ward space and out-patient clinic space can be allotted to each specialty to meet current needs. Similar reasoning applies to the grouping of operating-rooms, x-ray facilities, and laboratories.

Thus a substantial measure of flexibility is obtained at once by the simple decision to group departments according to function. A hospital with a ward block containing wards designed to accommodate any specialty, with an out-patient department with general-purpose clinical suites, and with central operating and x-ray departments can meet a wide range of different patterns of use without any physical alterations simply by allotting elements of space according to the need of each specialty or service. But this freedom to allocate elements of space calls for a special approach to the design of the individual departments; each department must be composed of elements or units which can be used equally well by any specialty within a certain range. An appropriate design method has lately been advocated by John Weeks.† This method, known as "duffel-coat" planning in contradistinction to "tailored" design, consists in seeking unit plans which fit a certain range of methods of work, rather as the Naval duffel-coat, manufactured in only a few sizes, provided effective covering for a wide range of sizes of sailors. But it is fatal to guess at a general-purpose design; the only safe way to proceed is the hard way, by very careful detailed study of the needs of all the different kinds of work within the range it is hoped to cover. When we can design a tailor-made plan for each different way of working, then, and only then, will we be in a position to see what might be a possible duffel-coat solution for all. Fortunately, a fair amount of this preliminary study has been done, and tried techniques are available for prosecuting it.‡

Function and Design

These close studies in the function and design of wards, operating-rooms, and out-patient clinics represent a character-

*The Westminster design had a very real purpose in its time—to break down an artificial division which then existed between in-patient and out-patient work.

†Planning for Growth and Change, J. Weeks, *Archit. J.*, 1960, 132, 20.

‡Studies in the Functions and Design of Hospitals, Nuffield Provincial Hospitals Trust. Oxford University Press, 1955.

§The Welfare of Children in Hospital, Central Health Services Council, 1959.

istic British contribution to the topic of hospital design. They start in all cases with the consideration of a human group or team engaged in the care of the patient—a group of doctors and nurses. The designs which result are always based on the working of a team, whether in a ward, an operating-room, or an out-patient clinic. Thus the experimental ward block at Musgrave Park Hospital, Belfast, is based on units of 20 beds, each cared for by a nursing team. Similarly the out-patient suites at the Princess Margaret Hospital, Swindon, are based on the teams of doctors conducting the clinics. In both cases each unit is made self-contained so far as is possible, and is planned to take in a wide range of ways of working.

What are the limits to which this idea can go? What are the exceptional functions which cannot comfortably use general-purpose accommodation? We already know enough to answer some of these questions.

So far as wards are concerned the obvious exceptions are children and expectant mothers. The recommendations of the Platt Committee§ confirm the need for a special form of accommodation for children. There should be a separate entrance to the children's unit, and ready access to a garden or terrace from all children's wards. These considerations will generally result in a children's block, built at low level and close to, perhaps abutting, the main hospital. The needs of the maternity unit also differ greatly from that of most other departments in the hospital, and here again it is desirable to have a separate entrance if possible. In addition to children's and maternity units, there is some case for providing special accommodation for the psychiatric unit. Here it is not a question of wishing to separate psychiatric patients from others, but there is a practical difficulty in providing sufficient free space for recreation and therapy within the ordinary ward unit, and free access to a garden is desirable.

So far as operating-rooms are concerned the two principal services which should have their own operating-rooms, separate from the main operating department, are the casualty and the out-patient departments. There is also some case for planning a small special operating-room for the eye department adjoining its own wards.

Future Character

What are our new hospitals going to look like? What will be the results of the approach discussed above on architectural design? A few new hospitals have now been completed and there are already some indications of the architectural character we are going to see.

Planning to allow for growth and change will mean that our future hospitals will have a good deal of low

FIG. 4.—Nuffield House, Musgrave Park Hospital, Belfast. Exterior view of the south-east façade. (Architects: R. Llewelyn Davies, John Weeks, and the team of the Nuffield Foundation Division for Architectural Studies.) (Reproduced by permission of de Burgh Galwey.)

building of an informal character. Fig. 1 shows a portion of the new Swindon hospital with one- and two-story buildings for the departments of pathology and physical medicine. Fig. 2 shows a small garden planned in a courtyard within the single-story out-patient department at the same hospital. Fig. 3, also taken from the new Swindon hospital, shows the low buildings for the out-patient and casualty departments, with the future, higher, ward building sketched in the background. Fig. 4 shows the ward block at the Nuffield experimental hospital building at Belfast. Here the treatment of the

façade reflects the interior organization of the ward into small nursing units, two on each floor.

These examples suggest that the hospital of the future may perhaps draw architectural inspiration from the size and shape of the functional units within it, whether they be nursing units, out-patient clinics, or other units of care. By expressing these working units in the architecture we can break up the very large masses of building which go to make a modern hospital, and create a more human scale, and an environment more comprehensible and reassuring for the patient.

HOSPITAL CENTRAL STERILE SUPPLY DEPARTMENTS*

BY

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The purpose of a central sterile supply department (C.S.S.D.) is to supply all departments of a hospital—theatres, wards, out-patient and casualty departments—with complete, sterile (and the accent is on "sterile") equipment ready and available for immediate use in the treatment of patients. The only exception to this may be the theatre instruments, which are generally kept, cleaned, sterilized, and used in the theatre suites.

The essentials of the department are correct design, modern plant, skilful operators, and a proper work-flow. Regular skilled maintenance to avoid breakdowns of plant, especially steam-pressure sterilizers, is also essential. The basic equipment consists of steam-pressure sterilizers and hot-air ovens, which provide a uniform standard of sterility of supplies throughout the hospital—a much higher standard than prevails where decentralized boiling-water sterilizers, used for instruments, bowls, syringes, etc., are scattered in wards, theatres, and out-patient and casualty departments, and are manipulated by many persons engaged in multifarious duties. Other advantages include decreased maintenance and replacement costs of expensive equipment, more time for the nursing staff to devote to nursing care, better care and maintenance of instruments and utensils resulting in longer life, and fewer losses of items due to control from the centre at all stages. But perhaps the greatest value of a C.S.S.D. is the supply of sterile equipment designed to suit every procedure in ward or theatre, and the sterility of which can be guaranteed—a further step towards the prevention of hospital infection.

All new and projected hospitals in the United Kingdom include the provision of a C.S.S.D., and many existing hospitals are actively engaged in planning or constructing such a department. The C.S.S.D. in Nuffield House, Musgrave Park Hospital, Belfast, is unique in that it was the first department of its kind to be established within the framework of the National Health Service of the United Kingdom, although the system has been used by British military hospitals during and since the second world war. Nuffield House, an 80-bed surgical unit, was built by the Northern Ireland Hospitals Authority, to the design of the Division of Architectural Studies of the Nuffield Foundation, as a research project on the function and design of hospitals; this building incorporates a C.S.S.D.—a special project designed as a joint investigation, by the Northern Island

Hospitals Authority and the Foundation alike, into the value and economics of such a department.

As part of their original investigation the Division had reviewed current practice in centralized departments of this kind in countries abroad, and it was convinced of the need, in the interests of hygiene, safety, and efficiency, to centralize those less personal services such as sterilization, linen, etc.

The Division considered that there was valuable experience to be gained in experimentally grafting a centralized service of this sort on to an existing hospital organization. It therefore welcomed the Northern Ireland Hospitals Authority's invitation to do so at Musgrave Park Hospital. The planning of the department is based on preliminary study, from North American experience, of the flow pattern and general space allocation thought to be desirable.

Whereas syringe supply had previously been the subject of an investigation in this country (Nuffield Provincial Hospitals Trust, 1958) the lack, in a British civilian hospital, of a central service of sterile equipment prevented the Division from carrying out functional studies as a prelude to design. The likely load, the equipment provision and placing, storage, working methods, and production flow had therefore to be envisaged in the absence of precise information from time-and-method studies or previous records. Information collected *ad hoc* on the daily numbers of procedures carried out throughout the hospital and in an acute surgical ward in the teaching hospital formed a basis of calculation in deciding the size of certain equipment. The department is a prototype capable of certain modification as work in it progresses.

The planning of the C.S.S.D. has been steered by a technical subcommittee, which includes representatives of the Northern Ireland Hospitals Authority, the hospital itself, and the Nuffield Division of Architectural Studies, drawing upon the knowledge and experience of the bacteriological, medical, nursing, and administrative staffs. The subcommittee now includes the sister-in-charge of the C.S.S.D., and has met monthly during the last five years to consider problems and to discuss new procedures or alterations to existing procedures in the light of experience, and has given a most valuable contribution to the organization and smooth running of the department.

Nuffield House is attached to Musgrave Park Hospital, which is a general hospital with 701 beds, 302 of which are medical and 399 surgical (239 orthopaedic, 80

*Opening address at a symposium on "Sterilization and Central Supply," organized by the Wessex Regional Hospital Board in Portsmouth for senior administrative medical officers.