THE USE OF LOCAL MATERIALS IN THE CONSTRUCTION OF HEALTH CARE FACILITIES

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CONTENTS

Foreword ................................................. 86

1. General considerations ................................ 86
   Brief review of the situation ......................... 86
   Local building materials in the building industry of the developing countries .......... 87
   Scope of study ...................................... 88

2. Sources of savings .................................. 89
   Factors in evaluation ................................ 89
   Conditions required ................................. 89

3. Knowledge of existing resources ..................... 90
   Natural resources .................................. 90
   Manpower resources ................................ 91
   Administrative, technical, and operational resources . 92

4. Possible approaches ................................ 92
   Local manufacture of building materials .......... 92
   Applications of local materials in building ...... 106

5. Contribution of small local building enterprises to the construction of health establishments . 116

6. Information and promotion .......................... 116

7. Conclusions ......................................... 117

8. Possible model of a development strategy .......... 117

9. Select bibliography ................................ 119

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FOREWORD

The rational use of local natural and manpower resources for economic development in the Third World is a fundamental political choice, since it is designed to satisfy the needs of the people by creating and putting to use the means through which each country may become economically, culturally, and technically independent of the industrialised countries.

To achieve this rapidly, one of the duties of a planner is to seek solutions that are capable of effectively reducing investment costs, particularly when buildings are being erected for social and community use.

This is particularly true when it is health care establishments that are being built, since the requirement that they should be up to date and satisfy certain specific and complex needs makes them among the most costly buildings of all. The application of modular methods to the definition of functional spaces and the drawing-up of standard plans suited to the climatic conditions and social structures of the countries concerned mark a beginning in efforts to meet this challenge.

A complementary factor is the promotion of local raw materials and of the appropriate technology for using them. Finally, local building labour, highly motivated and trained beforehand in these new techniques, will be an effective and highly suitable instrument for implementing the building programmes envisaged.

Many countries have understood this, including Togo, which has gone ahead in equipping itself with suitable research and development tools. The results obtained in Togo during the past decade prove that a way does exist of finding and applying economical and satisfactory approaches to the construction of buildings of every kind.

The purpose of this paper is to use examples taken from experience in Togo to try to demonstrate how the rational use of local building materials by previously trained local building labour can effectively reduce the cost of constructing health establishments.

1. GENERAL CONSIDERATIONS

Brief review of the situation

The rapid development and harmonious distribution of social and community amenities has always been a constant concern of governments in developing countries.

The construction of buildings for dispensing health care is among national priorities, but such buildings are expensive and take up a large part of the capital budget, since inter alia they require special forms of equipment and apparatus that mostly need to be imported.

Current programmes for constructing health establishments are very often based on models already existing in the industrialized countries and to a large extent use imported techniques, materials, and logistics.

Medical care, community hygiene, and the comfort of the sick also require various expensive forms of energy (electricity, air-conditioning, compressed air, gas, running water, etc.) that call for the permanent presence of qualified technical personnel to maintain installations and equipment. The total cost of all this creates financial and management problems that are a sore trial to the public authorities.

It must be added that the implementation of building programmes is generally entrusted to large companies, often foreign, established in the developing countries. This is done because they are thought to possess all the necessary technical and financial qualifications for carrying out the work properly.
Since small firms and local jobbing builders are considered to lack the necessary qualifications and financial stability and are often incapable of meeting the general conditions for tender laid down by the health authorities, they are not allowed to compete.

All these constraints lead to an increase in the cost of building and consequently reduce the number of projects that can be carried out, so that agonizing choices have to be made between several priority tasks.

Inland towns and rural areas are particularly affected, either because the available money has already been absorbed in building large hospital complexes concentrated in the capital cities, or because the remoteness, scattered nature, and large numbers of the primary and secondary health care centres it is planned to build would require the mobilization of equipment and labour costing far more than the available funds.

However, it is quite obvious that the strongest demand comes from the provinces and the rural areas.

Thus, in order to alleviate the situation it is essential to look for ways and means of reducing the actual building costs.

In the last analysis, it will be a question of making a decisive political choice, aiming essentially at self-sufficiency and with the long-term purpose of implementing health establishment building programmes for all, at the least possible cost, while taking into account the social and cultural features of the different populations to be served.

Some Third World countries have understood this and have willingly made considerable sacrifices in order to set up research and development bodies capable of finding original ways of making building materials and using them economically that can easily be learned by local populations.

Their findings can be successfully applied to the building of health establishments, for whatever purpose and of whatever size, provided that the problem to be attacked is properly posed at the outset, that the spheres in which the appropriate materials and technology can be used are properly delimited, and that local labour is prepared by suitable, occupational training to make an effective contribution to the implementation of the projects.

**Local building materials in the building industry of developing countries**

The building industry is of relatively recent establishment in Third World countries. For a long time local materials have served to build the dwellings of the local populations, to house their cattle, and to store their crops. Techniques of manufacture and utilization, worked out once and for all, were transmitted from father to son and enabled buildings to be constructed that possessed satisfactory qualities of comfort and durability. The architecture was an exact reflection of the social and cultural features of the group concerned and was adapted to its environment.

The gaining of independence by the Third World countries after periods of colonization of varying duration was destined to upset this balance and to lead in building to radical structural changes and new technical approaches.

The art of building, which was an often unremunerated activity for artisans and in which all the members of the community participated, was fated to enter the modern economic system, to obey market laws, and to create professional relationships of the same type as those found in the industrialized countries.

Thus, eager as they were to obtain without delay a socioeconomic infrastructure capable of raising them from underdeveloped to industrialized status, the countries concerned began to rely heavily on modern materials and on techniques provided by specialist labour.
Thus, very rapidly, cement blocks began to take the place of "bano" bricks or baked clay.

Reinforced concrete, followed by pre-stressed concrete and metallic frames, developed rapidly, since it permitted larger spans and the construction of multistory buildings.

Roofs of galvanized corrugated iron, or self-supporting aluminium or asbestos-cement corrugated roof decking, began very rapidly to gain public favour at the expense of thatched or vaulted roofs, since they were an outward sign of progress and a rise in social status, even though more expensive and less comfortable.

Once the flood gates had been opened, glazier products, plastics, etc. soon began to pour in.

In the heady days of independence and economic boom that followed, leading to a rapid influx of foreign capital and of capital and consumer goods of every kind into markets wide open to investment, the launching of ambitious modern building programmes was to modify very appreciably ways of looking at things (conditioned, moreover, by the increasingly pervasive mass media), so that the people were suddenly brought face to face with the delights of the western consumer society, of whose costs and long-term consequences they had as yet no inkling. These consequences are many and varied. It will therefore be necessary to limit the discussion to those that fall within the scope of this study, i.e., the effects of the expansion of towns on traditional housing, of prejudices against local traditional materials, and of the new social and community programmes. These three types of effect are complementary and inter-dependent. The confrontation of two systems of civilization, one of the agrarian type and the other industrial, was to bring about changes in the traditional types of dwellings and in building materials.

The exodus of rural populations to seek work in the towns, in addition to loosening the traditional ties between members of the same community, has also obliged them to adapt to an urban way of life under conditions that are often difficult or even downright insecure. However, the ultimate ambition is to acquire a masonry-built house like those of Europeans. To free oneself from the past in the form of the traditional thatch-roofed cob hut, which has to be repaired after each rainy season, is to choose progress, to choose the future.

The requisite building materials are of course more sophisticated and more durable, but they must be bought and they are expensive, since most of them are imported. The gradual disfavour into which traditional local materials have fallen is therefore bound to bring in its train an impoverishment of local building skills and a drift of the young towards trades of higher status or with better pay.

As for the implementation of social and community programmes, particularly those concerned with health, the choice of architectural and technical approaches depends on the attitude of the planner, who will be torn between his ambition to reproduce perfected models at the risk of remaining dependent to a certain extent on expensive imported technology (not always well understood and consequently difficult to apply) and his realization of what can reasonably be achieved having regard to local resources.

In striving to bring back into favour traditional local building materials through appropriate methods of manufacture and utilization, some governments, uneasily aware of the risks of an expansion that has been too rapid and often expensive, have succeeded in finding rational and economic solutions to this problem.

Scope of study

After this attempted sketch of the framework and the socioeconomic conditions in which the problem of utilizing local materials is set, it is essential now to demonstrate how it is possible to use such materials in the health field and to show that their use leads to a reduction in costs. For this purpose, sources of possible savings and the conditions required to achieve them will be examined. Approaches will be proposed and their operational implications explained. Examples will be used to illustrate the argument.
In view of the vast scope of the subject, this study must needs be restricted and makes no claim to exhaustive treatment of all the variations or approaches that could be considered or suggested.

The primary object of this study is to create awareness of the problem and to urge the development of a strategy for heightening that awareness and developing health establishment building programmes that make wider use of the materials and economical building procedures already developed by various countries and successfully applied in housing programmes.

The information supplied in this study is largely based on the records and example of the Cacavelli Building and Housing Centre in Togo, established in 1968 with UNDP assistance.

2. SOURCES OF SAVINGS

Factors in evaluation

The cost of building is generally estimated on the basis of the following main items:

- materials: 50 to 60% of the total cost of the work
- labour: (in towns) 25 to 35% of the total cost
  (in rural areas) 12% of the total cost
- overheads: 10 to 20% of the total cost.

It is generally estimated that the total cost of a building can be broken down as follows:

- vertical structures (frame, walls, and partitions): 20-30%
- horizontal structures (floors, false ceilings, timbering, and roofing): 15-20%
- joinery (doors and windows): 10%
- electrical installations (lighting): 10%
- plumbing and sanitary fitments: 10%.

The remainder is divided between wall and floor coverings, painting, and renderings.

Finally, the general architectural and technical design, no matter what the building is intended for, has a determinant effect on its cost, above all in the case of health establishments.

Conditions required

The conditions required for a local material to be considered as "economical" and "suitable for building purposes" are as follows:

- that it should be in abundant supply and of good quality
- that it should be found in the immediate neighbourhood of the place where it is to be used
- that it should have acceptable physical and chemical properties
- that it should be durable and resistant to mechanical damage and the effects of the weather.
- that the procedures for using or manufacturing it should be simple and should not need sophisticated technology or expensive equipment that is difficult to maintain

- that it should be aesthetically pleasing

- that it can be made available to urban or rural communities or used in the course of concerted operations of the "self-help" or similar type without having to pass through the ordinary trade channels.

This implies:

- a knowledge of the existing or potential resources of raw materials

- a knowledge of the environment and of traditional building techniques that can be used without modification or improved and adapted to the requirements of the new building programmes

- maximum use of local manpower

- appropriate occupational training.

3. KNOWLEDGE OF EXISTING RESOURCES

Knowledge of existing resources will determine the choice of building materials, the techniques for using or manufacturing them, the operational methods to be used for economical building, and the administrative and financial structures needed to back up operations.

Three main groups of resources can be distinguished:

- natural resources

- manpower

- administrative, technical, and operational resources.

Natural resources

Three kinds of natural resources are involved:

- geological resources

- botanical resources

- sources of energy.

Geological resources

These are abundant and have already been used for a very long time in traditional building. They consist of the following. Earths, produced by the natural disintegration of rock, such as sandy clay, estuarine soils, laterites, and china clays. They can be used as raw material for making burnt or unburnt bricks, roof tiles, and floor tiles. Aggregates: sands and gravels found in the beds of streams and at the edge of the sea. They are used in making mortar and concrete. Rocks, taken from quarries, of the granite or sandstone type. They supply building stone (rubblestone) or can be crushed to make concrete or for ballast, to metal roads, etc. Limestones: rocks based on calcium carbonate. These provide lime or cement, which are raw materials for making masonry cement, renderings, washes, and water-repellents.
Botanical resources

These consist mainly of the great many species of trees found in tropical countries that are variously used in building as structural timber or for joinery. Although preference is given to the rare timbers, which are exported on a large scale, thus making them expensive for local consumption, the promotion of secondary species on the local market would help to make them competitive. The wood of the Palmyra palm, known as "cocker" wood, is already used in Africa in traditional building and possesses remarkable mechanical strength and resistance to rot. The Graminaceae (reeds, bamboos, thatch grasses, etc.) and sawmill by-products, as well as agricultural waste, such as oil-palm husks, groundnut husks, maize leaves, and rice husks are among the botanical resources that could extend the range of local building materials. All these raw materials have already been subjected to research and experimentation and the ways in which they can be used are already known to specialists. Some examples will be given further on.

Climatic factors and sources of energy

A thorough knowledge of local climatic conditions can guide designers of health establishments in choosing the architectural layouts that best meet the climatic constraints, while reducing to the bare essentials installations and equipment designed to create artificially comfortable conditions inside the building (air-conditioning).

At a time when the oil crisis is impelling governments in all countries to use substitute sources of energy, knowledge and utilization of the available energy resources are also factors that may produce savings, particularly in Third World countries that are short of foreign currency but rich in renewable types of energy, such as solar energy, wind-power, hydro-electric power, geothermal energy, etc. These types of energy have long been the subject of research, and ways of using them have been found which can be successfully applied in the developing countries, but the special technologies and materials that they entail have to be evaluated case by case on the basis of the situation in the particular country concerned.

In a national economy of planned self-sufficiency, a certain level of autonomy in regard to energy resources can be achieved and substantial savings can be made in power consumption. Health establishments, which are big energy-consumers, can and must try to benefit from the achievements of these new technologies.

Manpower resources

Past experience has shown that the possession of national resources means nothing if they are not put to good use by a mobilized, educated population with technical skills enabling it to operate the whole range of systems that determine the industrial development and economic and social growth of the country.

The public's commitment to the operation of health care programmes in local communities, particularly in areas around cities and in the countryside, is yet another factor determining the success of the relevant building projects. It must be considered seriously, on the same level as the use of local building materials and appropriate techniques for using them.

This implies enlisting the support of three socio-occupational groups whose combined and coordinated activities should not only succeed in increasing the number of projects carried out but also help to reduce the flight from the countryside by speeding up the establishment of a low-budget social and community infrastructure (dispensaries, health centres, maternal and child health centres, schools, etc.).
The three groups are the following:

- local building handymen and artisans who, by reason of their numbers, their mobility, and above all their adaptation to the environment in which they were born, make up a category of medium-skilled operatives that is lacking in the present occupational structure of the building industry and could contribute to the national effort in conjunction with the larger firms

- voluntary workers taking part in self-help or community development activities

- national staff at every level, and particularly health workers under the authority of the Ministry of Health, such as health assistants, sanitary inspectors, social workers, group leaders, etc.; trained in the manufacture of local materials and the techniques of using them, they could make an effective contribution to the building of health establishments.

Administrative, technical, and operational resources

While a knowledge of natural and manpower resources is essential when looking for viable approaches in the field of health establishment construction, the utilization of those resources to achieve the purpose in mind will depend on the institutional or operational frameworks, already existing or to be created, that are responsible for formulating and implementing the plans.

The departments of the national health services should, in this connexion, strengthen their cooperation with organizations engaged in research and development work on building and building materials, whether they are national, regional, or international, since these organizations have at their disposal very extensive documentation and experience which can be validly applied to health establishments. From successful examples of such cooperation, it can be seen that the use of local materials helps to reduce costs dramatically. An inventory of buildings for health care and a systematic evaluation of their cost and cost-effectiveness and the recurrent charges should promote the wider use of appropriate local approaches and lead to the drafting of a code for the health infrastructure that would lay down inter alia the functional siting and layout of the buildings or premises, and their dimensions, and recommend the use of local materials and the relevant techniques, having regard to the resources locally available. Catalogues showing standard plans for dispensaries, primary health care centres, latrines, septic tanks, etc. could be issued as well as practical building manuals suitable for self-help activities.

Finally, agreements could be reached with loan agencies or development banks for financing programmes of health establishment construction to be carried out by do-it-yourself building groups or rural cooperatives.

4. POSSIBLE APPROACHES

Local manufacture of building materials

Stabilized earth

The use of earth in building is very widespread throughout the world and has been so for a very long time, since the raw material is available in abundance.

When it is used without treatment, its durability and resistance to mechanical factors and the weather are not long-lasting. For this reason, attempts have been made to improve it in these respects by adding stabilizers and by more or less elaborate techniques of manufacture and application.
Stabilization of earth. The effect of this is to bind together the particles and prevent the earth from absorbing water, thus precluding shrinkage or variations in volume. There are several ways of stabilizing earth, some of them empirical and others the result of laboratory research and experimentation. Four of them will be briefly described:

(a) Stabilization by reinforcement. This is achieved by adding seeds, fibres, or straw and increases the cohesion of the earth, although rotting constitutes a risk.

(b) Stabilization by waterproofing. This is achieved by adding water-repellent products of plant or mineral origin, such as vegetable oils, the sap of certain latex plants, rotted banana leaves, the residues from olive pressing, etc.

(c) Stabilization by cementing. Cement is added which binds the grains of sand and particles of earth solidly together, thus forming a skeleton structure resistant to variations in volume.

(d) Stabilization by treatment with chemicals. The effect of this is to improve the plasticity of the earth by adding lime, which reacts with the sodium silicates and aluminates present in the earth to form stable pozzolana compounds. The techniques of using stabilized earth vary from one region to another depending on cultural, climatic, material, and socioeconomic factors.

Traditional techniques of application

A brief summary is given below of the best-known traditional techniques of application. Some of them, by using modern stabilizers, such as cement or lime, and appropriate manufacturing and application technology, can be brought up to date and used effectively for building health establishments.

Some procedures, such as waling made of balls of earth mixed by hand and laid in 20 cm layers, or sodwork, which is better known in Great Britain and some parts of the USA, or half-timbered structures in which earthen bricks are used merely as nogging, are mentioned here simply for the record. Certain others, however, are of greater interest and are coming back into favour.

Cob ("pisé"). This is waling made from relatively gravelly earth with or without the addition of chopped straw, not very much wetted, and compacted inside formwork with a wooden rammer (punner). Its advantages are many: it is homogeneous, it harbours no parasites, great thicknesses can be made in a single operation, it does not shrink on drying, and it is fairly fire-resistant.

Its disadvantages (inadequate resistance to the mechanical effects of rain, risk of rotting) can be easily eliminated or diminished by adding cement or lime, applying a rendering, and waterproofing the foundations.

On the other hand, the wall must be dried out completely before the frame and roofing can be put in place. This procedure requires more labour, but in certain situations that is not a major drawback.

Adobe. This is a technique of making bricks with sandy and clayey earth placed in wooden moulds and hand-compacted. The size of the bricks varies greatly from one country to another and they may be very large as in Egypt.

Easier to use and quicker to make than cob, this material can be utilized for a great variety of building structures (vaults, domes, etc.). The buildings are immediately habitable and it is easy to make window and door lights and insert joinery. However, adobe bricks are more fragile when handled and adobe buildings are less homogeneous than those made of cob. It is also necessary to apply a stiff rendering to avoid erosion of the walls.
FIG. 1. SOME TRADITIONAL BUILDING TECHNIQUES USING LOCALLY PRODUCED MATERIALS

1. Sodwork (Great Britain; Kansas, USA)

2. Wattle and daub walling (single or double wattle frame)

3. Half-timbered architecture (wooden frame with brick nogging) The unbaked bricks are placed inside the ready-made wooden structure.

Formwork

Punnet used for compacting material in formwork

3. Cob walling
The walling is done bed by bed by moving the formwork horizontally

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1 Source: Bardou & Arzoumanian (see Bibliography).
FIG. 2. ADOBE WALLING

Adobe mould enabling 2 whole bricks and 2 half-bricks to be made simultaneously.

Moulding:
1. Hand tamping
2. Screeding
3. Stripping

The dimensions vary: 15 x 15 x 30 cm (Spain), 15 x 30 x 50 cm (New Mexico)

Different types of bond beam:
1. With double beam
2. With single beam and angle piece
3. Reinforced concrete

Source: Bardou & Arzoumanian (see Bibliography).
Appropriate technology for making stabilized-earth bricks

Basic materials. Sandy clays, estuarine soils, and laterites. Care must be taken to ensure, by analysing samples in the laboratory, that the earth it is intended to use is suitable for building. *Inter alia* it should be free from humus and contain enough sand to permit stabilization, an acceptable proportion being 55-70%, which may possibly have to be attained by the addition of extra sand.

The earth is stabilized by adding 5-10% of stabilizer or in practice 150 kg per m\(^2\) of earth. Cement is used as the stabilizer if the earth is sandy, and lime if it is clayey.

Manufacturing methods. There are two methods of manufacturing stabilized-earth bricks:

(a) Semi-wet method with compression

The mixture of earth and stabilizer is compressed by means of a Cinva-Ram hand press. This will produce solid or hollow blocks 14 x 10 x 29 cm, perforated bricks, or corner bricks for making beams.

The Cinva-Ram press consists essentially of a steel chamber enclosing a piston worked by a hand-operated lever. Its patented design makes it possible to obtain a pressure of 20 tonnes.

A team of three labourers per press is needed to make stabilized earth blocks. One fills the mould, another works the lever, and the third strips and stacks the blocks. A well-trained team can make 250 blocks per day.

One 50-kg sack of stabilizer mixed with 450 l of earth permits the manufacture of 80-85 blocks measuring 14 x 10 x 29 cm.

Six operations are needed to make the blocks:

- bulking of the freshly extracted earth
- sifting of the earth
- mixing the necessary amount of stabilizer with the earth
- wetting the mixture
- compacting the earth in a Cinva-Ram press
- stacking the bricks under cover and watering them daily to improve hardening.

After one month's drying the blocks achieve a crushing strength of 100 kg/cm\(^2\), which is amply sufficient for a two-storey building.

For building a single-storey structure, the wet method without compression is adequate.

(b) Wet method without compression

This technique makes it possible to dispense with the press and hence to reduce the cost of manufacture.

It can be used to make solid or hollow bricks of various shapes.

Operations follow the same schedule as when the press is used.
Stabilized-earth bricks have a very pleasant appearance, so that the use of plaster can easily be dispensed with when the walling is correctly made. Stabilized-earth brick walling has very appreciable thermal-insulation and soundproofing properties. Its durability is fully equal to that of other conventional materials such as cement blocks. Used with discretion, stabilized-earth brick is the material par excellence for economical building in towns and countryside alike.

Properties

(a) Compressive strength. The compressive strength of stabilized-earth brick depends on its sand content, its granulometric composition, the quality of the compacting technique, the stabilizer selected and the amount of it used, and the duration of the stabilizing process.

The compressive strength of stabilized-earth bricks increases with increasing amounts of stabilizer. For example, earth compacted at 40 kg/cm² shows a strength after seven days of over 100 kg/cm² when the percentage of cement is of the order of 10%.

When 5% lime is used as stabilizer, a compressive strength of 100 kg/cm² can be attained.

(b) Absorptive properties. When exposed to the air or enclosed in a humid environment, stabilized earth absorbs damp regularly until it becomes saturated. Like its compressive strength, the absorptivity of this material varies greatly in relation to various parameters such as the percentage of sand, the granulometric composition, the amount of stabilizer used, ambient humidity, and possible treatment with water-repellents.

The best earths, which are those that contain a good percentage of sand and are of correct granulometric composition, have an absorptive power of between 3 and 10%. With 10% stabilizer, the earth absorbs less damp than with only 5%. Earth stabilized with a small percentage of lime shows lower absorptivity. In any case it is important to determine carefully by preliminary tests the amount of water that should be added to a given weight of stabilized earth.

(c) Durability. By durability is meant the capacity of the material to stand up to bad weather, downpours followed by periods of intense sunlight, and wide or sudden variations in temperature. Here again, the durability of stabilized-earth bricks will depend on the parameters mentioned above. Laboratory tests have shown that suitable earths stabilized with 5% cement last for an average of 15 years. In practice, when the building work has been properly done they last for much longer than that.

Thermal insulation and soundproofing. Thermal conductivity (λ) is defined as the quantity of heat Q passing in one hour through a material 1 m thick and with a surface area of 1 m² when the difference of temperature between the opposite faces of the material is equal to 1°C.

\[
\lambda = \frac{QS}{Fh\Delta T} \quad \text{(in Kcal/m²h°C)}
\]

\(Q = \) the amount of heat that has passed through the material in Kcal

\(S = \) the thickness of the material in metres

\(F = \) the specific area measured in m²

\(\Delta T = T_1-T_2, \) the difference between the surface temperatures in °C

\(h = \) the time elapsed in hours

Consequently, the smaller the coefficient of thermal conductivity, the better will be the thermal-insulation properties of the material.
FIG. 3. DETAILS OF ADOBE BRICK CONSTRUCTION IN NEW MEXICO

Details of construction of individual house made of asphalt-stabilized adobe bricks

Fixation of preframes: details of construction

Individual house made of adobe brick

1 Source: Bardou & Arzoumanian (see Bibliography).
FIG. 4. THE CINVA-RAM\textsuperscript{1} PRESS FOR MAKING STABILIZED-EARTH BRICKS\textsuperscript{2}

\textsuperscript{1} Cinva is the Spanish abbreviation for the Inter-American Building and Housing Centre, and Ram stands for Ramirez, the name of the man who invented the press.

\textsuperscript{2} Sources: Cacavelli Building and Housing Centre, Togo; Bardou & Arzoumanian (see Bibliography).
Stabilized-earth blocks have an excellent thermal conductivity coefficient - better than that of cement blocks, whether solid or hollow:

<table>
<thead>
<tr>
<th>Block Type</th>
<th>λ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stabilized-earth</td>
<td>0.599</td>
</tr>
<tr>
<td>Solid cement</td>
<td>0.685</td>
</tr>
<tr>
<td>Hollow cement</td>
<td>0.678</td>
</tr>
</tbody>
</table>

It should also be noted that stabilized earth is a better soundproofing material than cement blocks, since it is a bad transmitter of vibrations. Moreover, because of the relative elasticity of the material it stands up better than concrete to earthquake shocks.

Finally, stabilized earth is an admirable material, attractive in appearance, and in its ochreous red colouring, fitting harmoniously into the landscape and making any painting superfluous. A linseed oil wash will give stabilized-earth block walls a pleasant varnished appearance and will constitute a protective weatherproof film.

Economic considerations. Stabilized-earth blocks are an economical material, above all in rural areas where all the required conditions are met. In urban areas the material is not very competitive with cement block, since its manufacture requires more care.

However, if certain optimum conditions are present, such as extraction of the earth on the spot (earth removed from cesspools, septic tanks, etc., manufacture of the bricks by the workmen themselves, etc.), savings of the order of 30% can be obtained compared with the cost of cement-block masonry. The savings are much greater in the case of self-help operations.

Baked-earth bricks

Before the appearance and general use of concrete in Third World countries, solid baked bricks were widely used by colonial administrations for public buildings and housing. Several small-scale brickworks were constructed and it is not uncommon even nowadays to find baked-brick structures which have stood up without difficulty to the onslaughts of time.

The appearance of concrete and the development of its use, coinciding with the economic "take-off" of these countries, accelerated the industrialization process and the use of new techniques, which have gradually slowed down the local production of bricks. In the absence of continuous quality control, brick manufacture has rapidly deteriorated and bricks have been cast aside in favour of cement blocks.

Recent research and experiments in certain countries such as Togo have demonstrated that, provided the inhabitants of rural communities with claypits are trained beforehand in the manufacturing techniques developed by the research centres, good-quality and cheap baked bricks can be produced by small-scale brickworks erected in the immediate vicinity of the claypits.

Basic materials. Earths such as sandy clay and estuarine soils, apart from china clays, are the basic materials for making baked bricks or derived products such as ceramic roof or floor tiles, with or without plasticizer, depending on their sand content. As for china clays, they are suitable for manufacturing sanitaryware or porcelain.

Manufacturing techniques. The procedure for making solid baked bricks in a beehive kiln comprises four operations: preparation, moulding, drying, and burning.

(a) Preparation. This consists in extracting, carrying, and crushing the raw material, then mixing the crushed soil with the plasticizer (e.g., phosphate residues), and finally leaving the mixture to stand so that it becomes homogenized.
<table>
<thead>
<tr>
<th>Place</th>
<th>Stabilized earth walls</th>
<th>Cost per m² (CFA fr.)</th>
<th>Cement blockwork</th>
<th>Cost per m² (CFA fr.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lomé</td>
<td>Supply of bricks 14 x 10 x 29 cm (32 at CFA fr. 12)</td>
<td>384</td>
<td>Supply of cement blocks 15 x 20 x 40 cm (13 at CFA fr. 38)</td>
<td>494</td>
</tr>
<tr>
<td></td>
<td>Mortar used in laying (23 l at CFA fr. 10)</td>
<td>230</td>
<td>Mortar used in laying (20 l at CFA fr. 18)</td>
<td>360</td>
</tr>
<tr>
<td></td>
<td>Microwash mortar (2 l at CFA fr. 10)</td>
<td>20</td>
<td>Microwash mortar (15 l at CFA fr. 18)</td>
<td>270</td>
</tr>
<tr>
<td></td>
<td>Labour:</td>
<td></td>
<td>Labour:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 mason (2.2 h at CFA fr. 68)</td>
<td>150</td>
<td>1 mason (1.36 h at CFA fr. 68)</td>
<td>92</td>
</tr>
<tr>
<td></td>
<td>1 labourer (2.2 h at CFA fr. 51)</td>
<td>112</td>
<td>1 labourer (1.36 h at CFA fr. 51)</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>896</td>
<td>Total</td>
<td>1285</td>
</tr>
<tr>
<td>Kouleoumi</td>
<td>32 stabilized earth bricks at CFA fr. 9 (400 km from Lomé)</td>
<td>288</td>
<td>13 cement blocks at CFA fr. 33</td>
<td>429</td>
</tr>
<tr>
<td></td>
<td>23 l mortar used in laying cement at CFA fr. 11</td>
<td>253</td>
<td>20 l mortar used in laying cement at CFA fr. 19</td>
<td>380</td>
</tr>
<tr>
<td></td>
<td>2 l microwash mortar at CFA fr. 11</td>
<td>22</td>
<td>15 l microwash mortar at CFA fr. 19</td>
<td>285</td>
</tr>
<tr>
<td></td>
<td>Do-it-yourself operation assisted by 1 mason (no labourers)</td>
<td>80</td>
<td>Do-it-yourself operation assisted by 1 mason (no labourers)</td>
<td>117</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>643</td>
<td>Total</td>
<td>1211</td>
</tr>
</tbody>
</table>
(b) **Moulding.** As in the case of stabilized-earth bricks the semi-wet method with compression by means of the Cinva-Ram press can be used. It has the following advantages: the shape and size of the bricks are more regular and they dry more rapidly, thus avoiding deformation during handling and drying. The procedure using wet moulding is more rapid and economical, since no press has to be bought. The productivity of the teams is doubled when this method is used.

(c) **Drying.** As in the case of stabilized-earth bricks, drying is done under cover and should last for a fortnight.

(d) **Burning.** There are several types of small-scale brick kilns of varying capacity. At the Cacavelli Research Centre in Togo, experiments have been carried out with natural-draught beehive kilns, with three hearths and grates enabling air to circulate and with a capacity of 15,000 bricks. In this case, the fuel used was coconut shells, of which there is an abundance on the coast of Togo. Six tonnes of coconut shells, representing a calorific value of 22 million Kcal, were used for burning the bricks.

**Properties of the bricks.** Burned bricks obtained by small-scale moulding and burning are of excellent quality, and a compressive strength of the order of 250 kg/cm² can be achieved.

If fuel of plant origin is used an ecological problem may arise, but if oil is used the problem will be an economic one.

It is therefore essential to undertake a viability study aimed at rationally siting the small-scale production units whose size and manufacturing techniques, choice of fuel, and transport facilities will have to be carefully evaluated.

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**Lime**

Apart from wood, dressed stone, and sun-dried brick, lime has been the best-known and most widely used material since ancient times. The principle of burning calcareous rocks has long been known.

Although immense progress has been made in its manufacture, lime, which in former times was the only binder used in building, has been gradually supplanted by cement. This disfavour is not always justified, since cement provides mechanical strength that is excessive for the multiple uses to which it is put or else is less appropriate than lime.

Lime is usually employed as a wash, whereas we have already seen that it constitutes an excellent stabilizer for earth and can also be used in making up water-repellent washes and mortars to protect roofs and walls, or for the manufacture of particle board or chipboard from agricultural waste.

**Small-scale manufacture of lime.** In the case of small-scale manufacture, all the possibilities of using local fuel must first be explored before fossil fuels are used, unless these are present in the district or are sold at favourable prices. The procedures used must be simple and cheap and easily understood and applied by workers with only moderate qualifications. Togo has studied and successfully introduced such procedures.

(a) **Basic materials.** Since lime is a product of heat decomposition of pure or mixed limestone, good deposits of the rock and an adequate source of energy are needed for its manufacture.

Limestones can be placed in two categories:

- Limestone proper (calcium carbonates), shelly rocks

- **Dolomites:** rocks containing calcite, dolomite, and double carbonate of calcium and magnesium. Lime obtained from these rocks is called "dolomitic lime".
(b) **Fuels.** The fuels used must supply sufficient heat but should not contain compounds capable of contaminating the lime obtained. The most common are wood and agricultural residues and waste, even if they have quite a low calorific value (3500-4500 Kcal/kg), and coconut shells, whose heat efficiency is around 100% with a considerable resultant reduction in heating time (to 24 h instead of 120) and which are very cheap.

(c) **Principle of manufacture.** This is quite simple. As already said, it is enough to use heat to decompose "limestone rocks" according to certain basic principles.

The reactions are endothermal, i.e., they occur by absorption of the calorific energy, which varies according to the geometrical shape of the rock, its size, and the kiln temperature (1000-1150°C). The temperature must be kept constant until the heat has reached the heart of the rock and thus brought about its decomposition.

It will therefore be essential to determine precisely, for each type of rock, the optimum size of the rock fragments (15 x 10 x 8 cm - 40 x 30 x 10 cm), the kiln temperature, and the duration of heating, so that mean values can be established that can be used in practice for small-scale production.

(d) **Burning.** Lime is burnt in two types of kiln: the vertical type, which is more common, and the rotary type, which is the same as a rotary cement kiln.

The kilns used are of various sizes. They are of cylindrical shape with a diameter 1/3 of their height; production can be continuous or in batches, and they can produce 8-10 tonnes of lime per 24 h per m² of cross-section.

A method of small-scale lime-burning, using coal as fuel, consists in introducing limestone fragments mixed with the fuel through the top of the kiln. The air needed to maintain combustion is introduced through judiciously spaced openings in the base of the kiln which can be opened or shut as needed. Natural draught is used for low-capacity kilns (5-20 tonnes per day).

The materials thus loaded travel towards the bottom of the kiln continuously but gradually, through three distinct zones: preheating, calcination, and cooling. The lime collected at the base of the kiln is in lumps, or in powder form together with ash. The Cacavelli Centre in Togo has designed a burnt-brick masonry kiln 30 cm thick, of the vertical cylindrical type, with a diameter of 1.5 m and a capacity of 2 tonnes of raw material. At the base of the kiln there is a metal grate that can be drawn out with the lime on it.

The lime rocks are piled up to form a stable dome, which should not collapse under its own weight during the lime-burning. To avoid important heat losses, this dome is covered with a layer of earth 1.5 m thick. The fuel used is coconut shells or a mixture of sump oil and oil-palm husks and the burning lasts for 8-10 h. The lime is withdrawn after cooling for 24 h.

This type of kiln is designed for batch production, and its yield is of the order of 100%.

(e) **Storage.** The storage of quicklime requires expensive waterproof containers. To store it economically, it should first be slaked in a pit in four phases: watering, mixing, homogenization, and transfer of the lime milk into a pit, the excess from which is stored in ordinary containers with a view to its use or sale.
FIG. 5. CONSTRUCTION OF A SMALL-SCALE LIME KILN

Utilization of the lime. Lime possesses technological properties that depend on a large number of factors, such as the nature of the raw material and of the fuel, the type of kiln, the size of the lime-rock fragments, the length of time for which the rock is burned, the duration of cooling, etc. Variations in these factors may have a considerable influence on the quality of the lime. Generally speaking, dolomitic lime has better qualities than limestone lime and in particular:

- it is more weatherproof;
- it adheres better to masonry;
- it has greater plasticity and can be used for obtaining stiffer and harder hydraulic mortars.

1 Source: Cacavelli Building and Housing Centre, Togo.
These properties make lime an excellent building material that can be manufactured locally and used for several purposes.

(a) Mortars and plasters. Lime is used to make ordinary mortars (mixed with sand), lime-sand mortars (lime, sand, and cement), or earth mortars (earth, lime, and sand) for stabilized-earth brickwork.

Lime-based plasters can also be made that are extremely weatherproof and consist of two parts sand, one part earth, and one part slaked lime.

(b) Washes. Ordinary lime paste is an excellent material for washes. When it is made from dolomitic lime, no fixatives such as glue or kitchen salt are needed.

It is also possible to obtain a water-repellent product to protect cob or adobe masonry by incorporating in the lime paste palmitic acid (about 30% by weight) obtained by precipitation in hydrochloric acid of a solution of the local soap normally used by African housewives (known as "akoto" in Togo). It should also be noted that in addition to being water-repellent, lime with an admixture of palmitic acid adheres better than ordinary lime, an important factor in humid tropical climates.

(c) Light-weight panels of the "Heraklith" type. Light-weight panels may be made by local craftsmen from chips or fibres of tropical timbers bound together with a special binder known as "Sorel cement" that is obtained by the partial burning of dolomitic limestones.

Agricultural waste can be salvaged for use in the manufacture of light-weight panels or pseudo-cellular hollow or solid chipboard panels. These panels are not attacked by termites, or affected by the ambient humidity and mortars and plasters based on dolomitic lime take very well on them. They can be used for making partitions and possess excellent heat-insulating and soundproofing properties. Made by local artisans, they are very competitive with similar imported products.

(d) Stabilization of road surfaces. Without going into detail, it may be stated that lime has been found to be effective for stabilizing road surfaces in tropical countries.

(e) Economic considerations. The manufacture of lime is a commonplace operation which can be carried out on a small scale. The techniques used do not require a highly qualified labour force and labour costs represent 15-20% of the total. This percentage can moreover be reduced by 3-6% if lime-burning is carried out continuously with several kilns.

The cost of fuel represents 67% of the total, and carriage of the raw material about 13%. In view of the multitude of applications of lime in building and housing hygiene and the possibilities of developing production by careful distribution throughout the country of small-scale or semi-industrial production units, lime can be considered as one of the local raw materials that can contribute to reducing building costs.

Plant saps and juices

In addition to palmitic acid, other protective agents based on local raw materials can be obtained, e.g., extracts of teak or néré leaves which protect joinery, thatch, mats, etc. against termite and other insect attacks while also preventing rot.

1 Néré is the West African locust-bean tree (Parkia africana R.Br.).
Applications of local materials in building

Design and the selection of materials are decisive in lowering building costs. However, the approach selected must also meet requirements of climatic comfort, particularly in the case of health establishments in tropical areas.

The building designs best adapted to the climatic zones under consideration must therefore be adopted, and they must be carried out in the materials with the best resistance to damp and heat.

Vertical structures, horizontal structures, and roofing will now be considered in turn from the standpoint of making the maximum use of local materials and the appropriate techniques for applying them.

**Vertical structures**

By vertical structures we mean cross or longitudinal bearing walls, frames, partitions, and infillings. In regions with small or moderate variation in outside temperature, light-weight or medium-weight structures are the most suitable and the most economical, particularly since most health establishments in developing countries are one-storey buildings, so that the structures do not have to withstand any great loads.

In regions with wide temperature variations, heavy-weight structures best meet the climatic conditions but are more expensive.

**Bearing cross-walls.** Bearing cross-walls support the roofing and ceilings, while at the same time providing good lateral windbracing. They must allow for good cross-ventilation and possibly act as partitions, thus guaranteeing good soundproofing. Their use is less flexible than that of frames and longitudinal bearing walls. This makes it essential to study the span between walls and to adopt a suitable modular system. Bearing cross-walls may be made of stabilized earth or burnt brickwork made locally, bonded with lime cement or ordinary earthen mortar. Their thickness will depend on the structure concerned.

**Longitudinal bearing walls.** These walls can be made of single or double thicknesses of stabilized earth or burnt brick or of local stone.

Outside walls must provide effective protection against solar radiation and weather. The establishment of shade areas and the application of reflecting coatings such as whitewash, simple renderings, or water-repellent renderings are easy and cheap methods of strengthening that protection.

**Frames.** Frames are more flexible and various modular systems allowing of extension can be applied. The frames can be made either from light-weight prefabricated reinforced-concrete elements (columns, footings, spandrels) or from masonry made of stabilized-earth or burnt bricks, or of uncompacted stabilized-earth moulded elements, or of panels of palmyra wood, bamboo, etc.

**Infillings.** These may be made up of a great variety of local materials selected on the basis of purpose, the choice locally available, the local climate, and cost.

**Partitions.** Indoor partitions may be made of brickwork or locally manufactured Heraklith panels or matting panels stabilized with dolomitic lime, with laterite infilling.

**Horizontal structures**

After the vertical structures, horizontal structures are the most expensive and the most difficult to erect, since, by their nature and purpose, and their weight, they determine the modular grids to be selected, the span widths, the types of foundation, and the types of vertical structure.
FIG. 6. TYPES OF VERTICAL STRUCTURE MADE FROM LOCAL RAW MATERIALS

LIGHTWEIGHT STRUCTURES
Partitions made of burnt brick covered with lime-stabilized earth mortar
specific weight: 1780 kg/m³; weight per m² = 139 kg

Thermal conductivity (λ) = 0.417

Heraklith panel partitions (made by local craftsmen, using wood wool, “Seral cement”, magnesium sulfate
specific weight: 280 kg/m³; weight per m² = 18.7 kg

λ = 0.089

MEDIUM-WEIGHT STRUCTURES
Partitions of burnt brick covered with cement-stabilized (10%) earth mortar
specific weight: 1780 kg/m³; weight per m² = 180 kg

λ = 0.584

Burnt brick partitions covered with cement-lime mortar
specific weight: 1780 kg/m³; weight per m² = 169 kg

λ = 0.417

HEAVY STRUCTURES
Double burnt-brick (5 x 10 x 20 cm) walls covered with cement mortar
specific weight: 1780 kg/m³
weight per m² = 285 kg (for thickness of 23 cm)
= 368.5 kg (for thickness of 26 cm)

Stabilized-earth brick walls, stabilized with cement (10%) or lime (5%) with or without rendering
specific weight: 1850 kg/m³; weight per m² = 260 kg

Burnt-brick walls rendered with lime-cement mortar
specific weight: 1800 kg/m³; weight per m² = 252 kg

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Based on work done at the Cacavelli Centre by Zbislav Fabovec, expert in building physics, Anton Skokanec, architect, and the subcontracting team of Polytechna-Keramoproject, Prague.
The introduction of "cocker" wood (palmyra palm wood) to make timber frames or of reinforced concrete lintels (to replace reinforcement rod) is an example of the use of local materials to make savings in building.

Various experiments with reinforced earth roofing over the palm-rib trelliswork ("secco") commonly sold in African markets have had encouraging results and suggest that in the end it will be possible to construct buildings with local materials alone. In that connexion a few other examples of horizontal structures will be referred to.

**Timber frames.** Iroko\(^1\)-plank collar-beams with an 8-m span laid on support columns of stabilized-earth brick masonry or precast reinforced concrete.

Trussed beams made of "cocker" wood with a 12-m span, resting on columns as mentioned in the last paragraph. Trussed arches of large span (18 m), made of mahogany or iroko-plank elements, where lateral thrusts are absorbed by reinforced-concrete beams and buttresses.

**Stabilized-earth arches.** It is also possible to build stabilized-earth brick surbased arches with an average span of 3.6 m, waterproofed with a water-repellent rendering based on lime with an admixture of palmitic acid.

Also worthy of mention are the so-called "delta" catenary arches which form both the wall and the roofing and with which spans of 5 m can easily be achieved.

**Roofing.** Several methods can be used for local manufacture of terracotta tiles of the flat or gutter type, glazed or unglazed. However, these items are relatively heavy and require solid timbering and a relatively large amount of wood, which by the same token cancels out the savings that had been aimed at. For that reason light-weight roofing, using factory-made products such as galvanized sheet aluminium or asbestos-cement roof decking, etc., have rapidly conquered Third World markets. However, their poor heat-insulating properties make it necessary to fit an insulating false ceiling, which is very costly if it has to be made of imported materials. A local solution to this problem is to use Heraklith panels made by local craftsmen or canework covered with a lime-sand mortar.

**Open modular structures**

The open modular system is a three-dimensional modular grid system, which by juxtaposing identical elements makes it possible to produce various architectural features and fulfill various functions.

It is based on a simple principle: the provision of a roof. It represents an industrial improvement over traditional building methods to the extent that it offers increased possibilities for architectural solutions both vertically (freedom of action under the roof) and horizontally (extension in all four directions), while enabling considerable savings to be made through the intensive use of local materials. The simple application of this system, in addition to enabling buildings to be put up rapidly, encourages self-help building schemes by eliminating constraints that have always made qualified technical assistance necessary or, if it has not been available, have led to incorrect building procedures.

The basic module is a multiplyable square measuring 3 x 3 m. This is a shelter consisting of four masonry columns supporting a roof of variable shape and composition and closed later by walls with or without lights. The intercolumnar distance can vary according to need, provided that the modular coordination requirements of 0.30 m are respected—corresponding to the usual size of a brick. The basic module in the open modular system is built in the following way:

\(^1\) "African oak" or iroko fustic tree (*Chlorophora excelsa*).

Frame: This is made of local "cocker" wood and whitewood and is attached to the columns with galvanized iron wire.

Roofing: Galvanized sheet.

Floor: Rammed earth with a protective rendering based on a néré seed decoction.

The shape suggested for the brick was determined by the need to use the columns for extensions in all four directions, to ensure that they are stable during building to heights of 2.4 and 2.8 m, and to supply an empty central core which could possibly be filled later with concrete and reinforced with 8-10-mm rod and could be used at the same time for anchoring the timbering to the column.

This brief list of building procedures making wide use of a large range of local materials and appropriate technology clearly shows their potential value in the construction of health centres and health establishments of every kind.

The building of the secondary health centre at Kouloumi in Togo is one example among many of a building constructed by low-technology methods using local materials.

Building of a secondary health centre of stabilized-earth brickwork

Architectural design. The secondary health centre at Kouloumi in Togo was designed and built by the Cacavelli Building Centre on the basis of standard plans and building techniques it had developed itself. It is a rectangular building of 175 m², based on a 0.90-m modular cell with a modular mesh of 9 modules by 24 modules.

This health centre comprises a maternity home, a small dispensary, and a waiting-room that serves at the same time as a health education centre. It also has a kitchen and a courtyard for visitors. The toilets and the kitchen are outside the main building.

Although the facilities and equipment are relatively modest, they are well adapted to the environment and to the level of development of the rural population in the sector.

Technical specifications. This health centre built exclusively by local craftsmen has front walls, side walls, and partitions that are made of locally manufactured stabilized-earth brickwork.

The aluminium roof decking is borne on local "wasa" roof-trees in the case of the main building and "cocker" wood roof-trees in the case of the kitchen. The roof-trees are anchored directly in the cross walls.

Thermal insulation of the main building is ensured by a false ceiling of fibreboard panelling.

The floors are of rammed earth covered with a finishing layer of smoothed concrete.

The joinery is locally made.

The inside walls, gables, and ceilings have been whitewashed with a wash manufactured by the Centre. The walls are simply pointed and protected with a linseed rendering.

Imported materials for this structure have been reduced to the bare essentials, viz., reinforcing rod for the spandrels, galvanized sheet and aluminium decking for the roofs, the plumbing fitments and sanitaryware, mosquito netting and builders' hardware, door paints, linseed, and xylophone.
Cost of the building. Built very recently, the Kouloumi Health Centre cost 2 769 760 CFA fr. at July 1979 prices, or about US$ 13 200, which means that the average cost per m² built was about US$ 67. Of this total,

- local materials represent 24.0%
- imported materials represent 34.0%
- labour (entirely local) represents 42.0%

Of the imported materials, which cost 948 504 CFA fr.,

- the galvanized sheet, aluminium decking, and fixtures represent 16.5%
- the fibreboard panels represent 2.0%
- the plumbing fitments and sanitaryware represent 5.0%
- the reinforcing rod represents 2.7%
- the flush doors and builders' hardware represent 4.7%
- the mosquito netting, paints, and xylophone represent 3.1%

Total 34.0%

Evaluation of the project from the standpoint of the materials. Although the scheme has made some progress in lowering costs by using local building materials and local labour, the percentage of imported materials used still seems too high for it to be claimed that the aim in view has been achieved. Thus, if radical measures were taken, the percentage could be considerably reduced by adopting a different roofing system and by a wider use, for certain types of work, of local materials that have been developed; for example, the aluminium roof decking could be replaced by a system of surfaced stabilized-earth brick vaulting, whose considerable thermal insulating properties would make it possible to dispense with the fibreboard false ceiling. Similarly, plant juices or calcium palmitate could be used to protect structural timber against termites and the flush doors could be replaced by louvred door panels which local joiners could easily make. Assuming for the sake of simplicity that the cost of the local materials would be the same as that of the imported materials, the following mean percentages could be achieved:

- imported materials (which would be restricted to reinforcing rod, plumbing fitments, and sanitaryware, builders' hardware, mosquito netting, and possibly the paint on joinery work) 12%
- local materials 46%
- labour 42%

It is easy to see what a beneficial effect an approach like this would have in "self-help" schemes for the building of health centres under the auspices of the Ministry of Health. If the State were to make a financial contribution, this would consist in the purchase of imported materials, while the cost of local materials and labour would be borne by the local communities.
FIG. 7. EXAMPLES OF ARCHITECTURAL STRUCTURES
THAT CAN BE MADE WITH LOCAL MATERIALS

Possible application by means of the open modular system

Stabilized-earth walls, thatched roof on "cocoder wood" frame

Lodgings for trainees and experts at the Cacavelli Centre, Togo

Stabilized-earth walls, Hexakith panel roofing, waterproof rendering

Metal tie-rods

Missionary buildings at Lame-Kara, Togo

Stabilized-earth walls, galvanized sheet roofing

Stabilized-earth brickwork catenary arch roof

Housing for experts at the Cacavelli Centre, Togo

Timber framework, wooden trellis work, aluminium roof decking, wooden-barrel false roof

Workshops and storerooms made in Togo

Framework made of timber or precast reinforced concrete columns, "Cockerwood" trussed frame galvanized sheet roofing

Reinforced concrete footing

Lecture hall/leisure centre, teachers' training college at Atakame, Togo; large-span arch made of teak or mahogany elements.

1 Source: Cacavelli Building and Housing Centre, Togo.
FIG. 8. OPEN MODULAR SYSTEM\textsuperscript{1,2}

\textsuperscript{1} Architect: Julia A. Silva.
\textsuperscript{2} Source: Cacavelli Building and Housing Centre, Togo.
1. Waiting room – health education centre
2. Rest room for parturients
3. Consulting-room
4. Examinations and internal care
5. External care and dressings
6. Auxiliary office
7. Antenatal clinic
8. Gynaecological examination
9. Labour ward
10. Delivery ward
11. Kitchen
12. Visitors’ courtyard

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Source: Cacavelli Building and Housing Centre, Togo.
FIG. 10. KOULOUMI SECONDARY HEALTH CENTRE, TOGO: (A) PART OF THE MAIN FACADE, (B) CROSS-SECTION

1 Source: Cacavelli Building and Housing Centre, Togo.
FIG. 11. KOULOUMI SECONDARY HEALTH CENTRE, TOGO: DETAILS OF WALLS

1 Source: Cacavelli Building and Housing Centre, Togo.
Applicability to an international standardization system

Without going into details on this subject, which would merit a long paper on its own, it can be stated that local building materials also lend themselves to any type of international standardization system.

Several countries have in fact undertaken research in this area with valuable results. Materials have already been listed and their characteristics clearly defined, as well as the ways in which they are made and applied.

In the same way as plans, structures, and building elements are already consonant with international modular coordination, the materials should be integrated in their turn.

It is easy to imagine the effects of such an undertaking on the development of the economical construction of health establishments in the Third World countries.

5. CONTRIBUTION OF SMALL LOCAL BUILDING ENTERPRISES TO THE CONSTRUCTION OF HEALTH ESTABLISHMENTS

The evils to which building labour has fallen heir in the developing countries have already been mentioned, but stress has also been laid on the positive part that local labour could play in enabling programmes for building social and community facilities and housing to be carried out throughout a country and lowering building costs by comparison with those charged by large undertakings.

Those responsible for the building programmes of the health services could assign to local craftsmen any work designed and suitable for local materials that would not present any particular difficulties (primary and secondary health centres, housing for staff, etc.).

Contracts could be made on the basis of general conditions specially adapted to the structure of small firms, which, for their part, would have to guarantee satisfactory levels of qualification and experience. These craftsmen and small contractors could be associated with the building of larger health establishments under the supervision of the firms mainly responsible, but as subcontractors.

6. INFORMATION AND PROMOTION

Once knowledge and mastery of the techniques of manufacturing and using local building materials have been gained, there should be concerted campaigns to make the methods and procedures widely known to the public authorities, building professionals, and the public at large.

From the point of view of the health services, these activities could be carried out at three levels:

(i) Among those responsible for planning programmes for health establishments and their construction. They should be informed of research achievements in this field, the cost of materials, and the availability of raw materials and labour in each region or zone considered, so that they can be taken into account when projects are being drawn up.

(ii) Among health service executive staff responsible for the implementation, supervision, or encouragement of health facility schemes, as part either of regular programmes or of "self-help" activities.

Training courses of varying length will have to be arranged for these people to give them theoretical and practical training on building technology, sanitation, and the execution of simple building work (latrines, septic tanks, draining wells, etc.) based on the use of local materials.
(iii) Among the population. Pilot activities would be launched throughout the country to make the rural population aware of the possibility of using stabilized earth and other local materials for building primary health care centres, dispensaries, or other health establishments with the help of local craftsmen and the active participation of rural or urban communities under the direct supervision of health service personnel working in association with community development workers.

Activities of this kind in Togo and other African countries have been crowned with success and have demonstrated that they can enlist the support of the population.

7. CONCLUSIONS

The subject dealt with here is a vast one and cannot, therefore, be exhaustively treated within the necessarily limited framework of this study.

The author has tried to demonstrate, with the help of a few examples selected from experience in Togo, the future of local materials in the building of health establishments as a factor in reducing their cost. An attempt has also been made to throw light on the diversity and flexibility of the traditional building materials which, by the use of appropriate technology, can be given an appreciable degree of durability and resistance to mechanical stresses and the weather, as well as excellent thermal insulation and sound-proofing properties, thus making them products of choice when comfort and hygiene are required in buildings in the tropics. The solutions suggested can be extrapolated to other countries: the approaches and applications may vary from one country to another, depending on economic, technological, and sociocultural factors.

If local materials are to be competitive, their manufacture must be on a small scale and require little investment, and their application must be simple and easily carried out by local craftsmen with fairly modest qualifications. Whether and how such materials can be employed depends on these conditions.

In the case of structures that require the exclusive use of manufactured products, sophisticated structural designs and high-level logistics, because of their special architectural, functional, or technical specifications, the use of local materials is reduced to essentials.

Thus, the joint use of "advanced" and "appropriate" technologies should enable building budgets to be allocated in a more balanced way, having regard to the available resources, the areas where the buildings are to be erected, the size of the buildings to be put up, and, of course, the various activities to be carried out in them.

8. POSSIBLE MODEL OF A DEVELOPMENT STRATEGY

The task outlined above necessarily entails the development of a strategy for greater awareness and development through a set of coordinated activities that might be summarized as follows:

1. Cooperation with research and development centres (national, regional, or international) which have acquired wide experience in the promotion of local materials and economical building procedures, so that the results can be applied to health care establishments. Such cooperation would make it easier to carry out the following tasks.

(a) The drafting of a health establishment code which would specify, according to the area concerned, the local resources available in relation to the size and functional characteristics of the buildings (their dimensions, orientation, nature of the materials, building techniques, etc.).
(b) The preparation of catalogues of standard plans for complete health buildings (working plan, specifications, cost estimates, general conditions of contract and procedures for tender, etc.), together with possible variations, depending on the geographical zones under consideration. These standard plans would be adapted to rural conditions and could easily be carried out by workers of a medium technical and professional level.

(c) The preparation of manuals and the planning of training programmes for health service workers responsible for supervising health building programmes.

Essentially of a practical nature, these would aim at providing an adequate level of qualification and familiarizing the workers with the reading and interpretation of technical documentation, the execution of simple work with local materials on the site, and supervisory assistance in the case of "self-help" activities.

2. Wider use of small undertakings and local building workers in carrying out building projects. Special facilities should be planned for this purpose in agreement with the Ministry of Public Health, the development banks, and funding agencies, so as to facilitate the active participation of such undertakings in the programmes. Some projects could be exclusively reserved for them, e.g., the construction of dispensaries, primary health care centres, maternal and child health centres, or other modest buildings, particularly those intended for the rural population.

In the towns the small contractors could be associated as subcontractors with the execution of more important projects.

3. Activities to heighten awareness and spread knowledge in the health services and among the public by organizing countrywide information campaigns with the help of the mass media and distributing well-illustrated explanatory booklets written in the vernacular.

4. Organization of training courses of varying duration for health service workers on techniques for manufacturing materials locally and employing them in the building of health establishments.

5. The launching of pilot operations for building health structures in local materials, with the help of the public, on sites previously identified as the most favourable for the development of subsequent activities.

6. Development strategy at the regional and international levels. The strategy should also be set in a wider context, on a regional and international scale. With this in view, contacts should be established in order to organize a system for the exchange of technical information and for technical cooperation between developing countries with the same geographical, climatic, and sociocultural characteristics and of comparable economic and technological levels. Such campaigns would be beneficial for the whole of the region. Against this background, some research centres could be asked to carry out specific studies on the design of health care establishments and on the preparation of standards better adapted to the special conditions in the region. In the same way, the transfer of appropriate technology in the fields of economical building and the use of local building materials, as applied to the design of health establishments in developing countries, could be ensured by sending consultants with particular qualifications in these disciplines, and preferably born in the country concerned, and by periodically holding working meetings with participants from different States.
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ISSUES AND APPROACHES IN HEALTH SERVICES MANAGEMENT IN DEVELOPING AREAS

Miles Hardie*

CONTENTS

Introduction .............................................. 122

1. Profile of existing services ....................... 123
   Country profiles and national programmes and plans 123
   Components and levels of care ..................... 124
   Organizational structures and levels of management 127
   Linkages ............................................. 128

2. Needs, problems, priorities, and options .......... 128
   Needs and problems .................................. 128
   Priorities and options ............................... 129

3. Functions, tasks, skills, and training ........... 130
   Functions and tasks .................................. 130
   Management skills .................................... 131
   Management training .................................. 132
   Career prospects ..................................... 135
   Monitoring and evaluation ........................... 136

Appendix ................................................. 138

Select bibliography .................................... 141

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INTRODUCTION

The aim of the present paper is not to draw up a list of policies and procedures applicable to all countries, but rather to try to identify some of the factors or questions that any country might usefully take into account in trying to develop the patterns of management and of management training appropriate to its own situation. No great originality is claimed for the suggestions or ideas mentioned in the paper—it simply represents an attempt to draw together some of the threads from the great wealth of spoken and written material about health services management that has accumulated in recent years. The author is also very conscious of the great debt he owes to the 450 senior hospital and health service administrators (medical and nonmedical) from over 80 countries, mainly in the developing world, with whom he has discussed the subject since 1961 during their attendance at one or another of the annual 10-week management courses sponsored by the International Hospital Federation: their experience and ideas have greatly influenced the author's thinking.

The paper represents a starting point for further study and action, rather than a final blueprint. It is hoped that it may be reviewed, revised, and extended through discussions amongst managers and trainers within individual countries, as well as at international workshops, and that eventually there might be produced some guidelines or checklists of continuing use to anyone responsible for hospital and health services management and training in developing areas.

For a start, one can try to list some of the questions that need to be asked in the process of developing policies for the organization and management of health services, and for management education and training in those services. At this stage, fourteen questions are just listed consecutively, amplification and comment being given in subsequent paragraphs.

A. Profile of existing services

1. To what extent are there already in existence country profiles and national programmes and plans for the health care system?

2. What are the main components and levels of care in the existing health care system, including the traditional or indigenous system?

3. What are the organizational structures and levels of management in the existing health care system?

4. What are the linkages within and between different levels, and with other health-related systems and agencies, and with the community itself?

B. Needs, problems, options, and priorities

5. What are the main needs for improving standards of health and the health care system?

6. What the main problems hindering the fulfilment of these needs?

7. What are the options and priorities for action to overcome these problems and meet these needs?

C. Functions, tasks and management

8. What functions need to be undertaken to translate these priorities into action?

9. What tasks need to be performed in relation to these functions?

10. What resources and organization are needed to enable these tasks to be performed, including mechanisms to help health services management to be responsive to community needs?
11. What management skills are required, and at what levels, to ensure the successful performance of these tasks?

12. What types and methods of management training are most appropriate for each level of management?

13. What career prospects are open to those holding management responsibilities at different levels?

14. What are the most appropriate methods for the monitoring and evaluation of the effectiveness of the health care system and its management?

These are questions that might in fact appropriately be asked at any level of a health care system. There can be definite advantages in having them asked not only at national and regional levels but also at the periphery of the system - in villages, small districts, or defined city neighbourhoods - which is where the individual actually needs services, care, or encouragement to self-help. Perception of needs and priorities may be very different (and perhaps more realistic) at the periphery compared with the centre, so that the two-way exchange or cycle of information and ideas between periphery and centre can and should become an important part of the whole process of planning and management.

1. PROFILE OF EXISTING SERVICES

Country profiles and national programmes and plans

The preparation of a profile or inventory for the existing health situation and health care system and services is now recognized as an important part of the process of developing country programmes and plans. At national level, the process of establishing country profiles has already been started by WHO, which has prepared a handbook providing guidelines for building up this type of profile. Some countries, such as Indonesia and Thailand, have already produced such profiles, whilst many others have prepared statements of national programmes and plans for health service development.

Another approach (M. I. Roemer, personal communication, 1979) is to analyse a nation’s health care system by classifying information on the total system (public and private sectors, preventive and curative services) under the following headings:

- administrative structure
- economic support
- health manpower
- health facilities
- research and knowledge
- preventive services
- ambulatory care delivery
- hospital organization and services
- health care of special populations
- regulation of health activities
- health planning and policy formulation
- evaluation and potentials for improvement.

A third approach has been to prepare profiles emphasizing the interaction of health and socioeconomic development, and this has been applied to a number of developing countries in the Synthesis series issued by the Division of Programme Analysis, US Department of Health Education and Welfare. Such country profiles or analytical descriptions can obviously be of considerable value, particularly to planners and managers at national level. Where such material is available it can provide an important basis for the formulation of options and priorities for programmes and plans and for subsequent monitoring and evaluation of progress towards implementing them.

Components and levels of care

Whether or not country profiles or descriptions are available, there is a great need for preparing profiles at village, district, and regional level. Different countries and different regions or areas within the same country will vary as regards the quantity and quality of the information they can assemble about their health systems and services. There may be great differences, for example, in the availability, accuracy, and comprehensiveness of information relating to government services on the one hand and nongovernment services on the other. There will also be differences in the type and quantity of information needed at different levels. It is therefore very important for planners and managers to define clearly how, and for what purposes, any information gathered is to be used at any level, and to establish priorities for the collection, analysis, and presentation of the information: it is far preferable to start on a small scale and then over a period of time to build up a more comprehensive profile. At each stage, it is important to demonstrate to those who provide the information how it is being applied and to what effect. From the viewpoint of practical management at the point of delivery of services, profiles for these subnational levels should be developed as swiftly as possible, however simple they may be initially. Guidelines or checklists for compiling these profiles should be such that the information can be effectively collected and collated by local staff rather than by "experts" from abroad. Information for such profiles may usefully be related in part to the guidelines for the preparation of a country profile as recommended by WHO in the information systems programme handbook mentioned above:

General information, under the same broad headings as for WHO country profiles:

Geography and climate

History

Demography (population size, geographical distribution, urban and rural, age and sex distribution, growth rate and trends)

Socioeconomic situation and projections.

Health situation

Vital statistics (birth rate, death rate, maternal and infant mortality rates, etc.).

Epidemiological information (morbidity patterns, communicable and noncommunicable diseases, initiation, etc.).

Utilization (catchment area, institutional, accessibility, and referral patterns, etc.).
Health care resources

Manpower: categories, distribution, training.

Finance: resource allocation and expenditure - government, nongovernment, insurance.

Physical facilities and equipment.

Range of health care provided at different levels:

(i) primary health care (including health education and self-care; indigenous and traditional care; sanitation and water supply; prevention of illness; maternal and child welfare and family planning; treatment of common diseases and injuries) as defined in the Declaration of Alma-Ata, 1978;

(ii) intermediate facilities, providing more complex medical care and hospital services, and acting as referral centres from the periphery;

(iii) central (regional and national) facilities providing highly specialized services, as well as primary health care and intermediate services for the local population.

Health service organization

Management structure of the health services and associated "vertical" programmes (malaria, leprosy, etc.).

Regionalization and linkages with health-related agencies and with the community.

Few practical examples exist as yet of local profiles of this nature, and there is much to learn about how best to construct and use them. The exchange of information within and between countries on this topic needs to be encouraged.

Organizational structures and levels of management

An important part of the profile at any level will be an outline of the existing organizational structure and levels of management, which need to be distinguished from levels of care. In 1973 the WHO Executive Board identified three levels of care and adopted for them the following definitions:¹

- "Primary care services are general health practice services which are offered to the population at the point of entry into the health service system."

- "Secondary care comprises the care provided through specialized services on referral from primary care services."

- "Tertiary care includes highly specialized services and eventually the super-specialties, such as plastic surgery, neurosurgery, and heart surgery."

These levels of care are related to the complexity of services and to the facilities and manpower which go with these services. Primary care at the periphery may serve only 500 persons, has simple facilities, and perhaps a village health aide. Tertiary care serves a million persons, has superspecialists, and medical centre hospital facilities. This level of care should not, however, be confused with the level of health system management for a million people, which must be concerned with all levels - not just the tertiary one. There are similar differences in respect of the secondary and primary levels. The following diagram² illustrates the position.

² Provided by Professor Alberta W. Parker, University of California, Berkeley, CA, USA.
FIG. 1. LEVELS OF CARE

<table>
<thead>
<tr>
<th>Levels of system management</th>
<th>Level</th>
<th>Population served</th>
<th>Facilities</th>
<th>Manpower</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning Evaluation</td>
<td>tertiary</td>
<td></td>
<td>medical centre</td>
<td>super specialist</td>
<td>medical</td>
</tr>
<tr>
<td>Linkages Support systems</td>
<td>secondary</td>
<td></td>
<td>referral hospital</td>
<td>specialist</td>
<td>medical</td>
</tr>
<tr>
<td>Financing whole system</td>
<td>primary – district level</td>
<td>etc</td>
<td>PHC centre</td>
<td>generalist</td>
<td>environmental community development, essential health care</td>
</tr>
<tr>
<td></td>
<td>– village</td>
<td>2000</td>
<td>health station</td>
<td>village health aide</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– smaller unit</td>
<td>500</td>
<td>in community</td>
<td>community worker</td>
<td></td>
</tr>
</tbody>
</table>

1 Management of facilities and programme takes place at each level, e.g., hospital, health centre.

In this context, a precise analysis of the specific size of population for each level of care or management is not so important as an outline of the management structure for the organization and supervision of the services at different levels. There is a need to answer such questions as:

- Where does the responsibility lie for planning the services at each level, and for financing and managing them?

- Is there an organizational chart for each level indicating:
  (i) line of responsibilities upwards and downwards for management of services/programmes/departments?
  (ii) linkages with:
  (a) advisory organizations (committees in the health field)?
  (b) health-related agencies (e.g., water supply, housing, education, etc.)?
  (c) local community representatives and groups?

- To whom do the professionals and other health workers report?

- Who is responsible for monitoring the services and evaluating them?

- What management training facilities are available?
- What basic and continuing management training is provided for those workers who have any element of management responsibility in their work? And the answer to this question should include information about any management orientation or appreciation courses or sessions for doctors and other professionals whose main duties are in clinical/technical work rather than in management.

- What are the main problems hindering the effective management of the services and institutions?

- What are the best features of the existing management system that you think others might usefully adopt, adapt, or study?

- What changes or innovations would the local staff like to see introduced in the management system?

The response to these and similar questions should certainly help to clarify some of the needs and priorities for future action.

Linkages

An essential part of the profile will be a summary of the linkages within and between the different levels, and with other health-related agencies and the community itself. In situations - and there are many of them - where there is a mixture of governmental and nongovernmental organizations involved in health care, it is important to identify these components, to establish what are the formal and informal links between them, especially in terms of managerial responsibilities, and to outline the patterns of collaboration both horizontally and vertically. Note needs to be taken of links in being or planned:

(i) to promote closer liaison with the local community and to ensure that facilities and resources are patient-oriented;

(ii) to achieve regionalization and rationalization of services in order to make better use of limited resources;

(iii) to relate training to services needed.

Reference also needs to be made to the relevant aspects of other sectors of society that have a bearing on health - land-ownership, housing, education, agriculture, nutrition, employment, indebtedness-levels, communications, etc. When it comes to deciding priorities for the allocation of scarce resources, it may, for example, prove to be the case that improved housing or water supply will be more effective than improved health care facilities in raising standards of health.

There is a real danger that the preparation of a comprehensive and accurate profile at any level can become a costly and time-consuming (and possibly self-defeating) process involving epidemiologists, sociologists, clinicians, planners, managers, and other professionals. But in this field it is perhaps particularly important not to let the best be the enemy of the good. There is much to be gained and learned from building up quite swiftly simple profiles at village or district level, as well as at regional or national level. The process itself is a valuable exercise in management, and the resulting profiles can be used as a basis for almost immediate action, as well as providing the framework for the more sophisticated profiles that can be developed more gradually over a longer period of time.

At present, few countries have the resources in staff and money to undertake high-powered studies for highly sophisticated and detailed profiles of their health services. Consequently there is much to be said for encouraging a self-help approach to such exercises at different levels within a country. Epidemiologists and managers in any given country might profitably cooperate in devising simple profile-questionnaires for the different levels of care and management in their health systems, from village/district onwards. The length and complexity of the questionnaires for each level would need to be realistically related to the reliability
of local records and other sources of information, and to the competence and capabilities of the managers and practitioners at each level who would be mainly responsible for assembling the necessary information and completing the questionnaires. The involvement of staff in local meetings to discuss problems and possibilities in the conduct of such an exercise can do much to help ensure good results. With the passage of time and the pooling of experience within and between different levels, and between different countries, the methods used for preparing and revising profiles can be progressively improved and refined, with a corresponding improvement in the quality and quantity of information available for planners, managers, and practitioners.

2. NEEDS, PROBLEMS, PRIORITIES, AND OPTIONS

Needs and problems

With a profile, however simple, completed for the health situation and health care system at any level, it becomes easier to identify health problems and the deficiencies of the existing health care system. A simple approach (H. L. Gwynne, personal communication, 1978) is to list the problems and deficiencies in one column and then to translate these into a list of service needs/options in another column, e.g.:

<table>
<thead>
<tr>
<th>Problems</th>
<th>Service needs/options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutritional deficiency (starvation)</td>
<td>Food, nutrition advisers, etc.</td>
</tr>
<tr>
<td>Malaria</td>
<td>Mosquito control programme</td>
</tr>
<tr>
<td>Road accidents</td>
<td>Road improvement, traffic laws, &quot;acute&quot;</td>
</tr>
<tr>
<td></td>
<td>beds, etc.</td>
</tr>
</tbody>
</table>

Without becoming involved in a discussion about the distinctions between planning and management, it can be said that in this type of exercise all managers have responsibilities for planning, whilst planners do not necessarily have managerial responsibilities. In making such analyses and assessments, the manager and planner can base the collection of data upon:

- personal experience
- expert opinion
- surveys of existing data and information
- sophisticated randomized population surveys and scientific research.

Going down the list, the data become more valid but also more time-consuming and expensive to collect and often more difficult to interpret. In practice, use will be made of a variety of sources in collecting, collating, and synthesizing information and opinions from people and from literature:

People

- authorities (e.g., hospital/health boards, councils, etc.) formally responsible for the health services at each level
- community: patients and the public
- professional practitioners, managers, and other health workers
- managers and workers in related agencies.
Literature

- international, national, and local written policies, standards, and guidelines
- general literature
- research findings.

Against the background of a published profile, information and opinions can be sought from people through public and private meetings, workshops, personal interviews, questionnaires, and other means. The processes of information-gathering and analysis can be very simple or very complex: the type and scale of the processes to be used in any given locality need to be decided in the light of local resources and capabilities. And again, it is important not to let the best be the enemy of the good. Although the information gained in these ways is often highly subjective, it is nevertheless of great importance, as it will reflect the views of those who have the day-to-day experience and responsibility for providing services, as well as the views of present or potential users. A very important criterion in deciding what methods of information-gathering to adopt is that of commitment to results. It is vital to get the providers (health workers) and the receivers (the public) committed to dealing with the findings and proposals. It may therefore often be advantageous to sacrifice some validity and to ensure that staff (expert opinion) and the local people (personal experience) are positively encouraged to give their views.

Although increasing month by month, the volume of authoritative literature on health service planning and management for developing countries is not yet very extensive. Some useful references are given in a document produced by WHO\(^1\) and a bibliography prepared by the International Hospital Federation.\(^2\) Neither of these could be claimed to be comprehensive, but they may serve to indicate some of the sources that can help the manager attempting to assess the deficiencies and needs of his own locality and services. Of great importance, of course, will be any literature produced locally or nationally in the country concerned on policies, standards, and guidelines for the different levels of the health system. These must be considered as valuable yardsticks against which to measure needs, but at the same time it must be remembered that such yardsticks, like the profiles, need to be regularly reviewed and revised in the light of changing circumstances. A short bibliography will be found at the end of this paper.

Priorities and options

Through the processes of gathering information and opinions, the manager should be able to set down on paper an assessment of the main problems and needs of his locality and its services. Through the same pattern of study and consultation, the manager then has to prepare a list of priorities for future change and development, and of the options available for translating these priorities into action. This ordering of priorities and options is an essential part of the manager's work. Once the problems and needs have been identified, amongst the main criteria (B. Correa, personal communication, 1978) on which the ordering of priorities should be based are:

(i) prevalence and incidence of the problems;

(ii) high-risk and low-risk population groups (risk being assessed socially as well as biologically);

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\(^2\) INTERNATIONAL HOSPITAL FEDERATION. Information on planning of health care facilities in developing countries. London, 1977.
(iii) feasibility of preventing, reducing, or eradicating the problems by means of the services which the health agency can reasonably expect to provide with the resources likely to be available;

(iv) results, or degrees of damage (e.g., handicap, social stigma, death) that the problems may entail for those affected.

For example, improvement of primary health care at village level may well prove to be a top priority, but it would be unrealistic (as well as very wasteful and inappropriate, short-term or long-term) to suggest as a feasible option that a fully trained doctor should be appointed to every village of over 500 people. It is obviously more realistic to think in terms of recruiting a network of local village health workers or volunteers, linked with appropriate referral centres. Options have to be prepared in the light of known realities and may often have to be expressed in terms of short-term and long-term objectives.

The preparation and presentation of realistic and soundly based statements on needs, problems, priorities, and options is one of the most important parts of the whole management process and it is as important at the periphery of the system as it is at the centre. Without such statements it is difficult - if not impossible - properly to formulate programmes and plans. Without such programmes and plans, objectives and targets, the manager’s role is virtually meaningless.

3. FUNCTIONS, TASKS, SKILLS, AND TRAINING

Functions and tasks

With priorities decided and options chosen, the detailed definition of the functions to be performed to implement the options becomes one of the manager’s major responsibilities. In preparing options in the first instance, functions will have been briefly outlined. For example, it may have been proposed that a simple laboratory service should be established at health centre level. To implement this option, it will be necessary to describe in greater detail the functions required to provide such a service and the specific tasks to be undertaken, and by whom, in performing these functions. Much of this information should in fact have been assembled in the course of formulating the original options, because it is needed to calculate the estimates of costs, manpower, and facilities that are an essential prerequisite for decision-making. This stage of the management process is another very important one, because without a clear definition of functions and tasks it is impossible to assess accurately the resources and organization that will be required to implement the selected options and to monitor and evaluate their performance.

At its simplest, the assessment of "resources and organization" will involve an estimate of costs and of the number, type, and location of staff and facilities needed for the performance of the required functions and tasks. In addition, it should ideally include a statement of the resources and organizational structure required to:

- motivate staff, patients, and the public
- introduce change and development
- clarify linkages and communications with other sectors of the health system and related agencies
- recruit appropriate staff
- provide orientation and training for staff, both initially and during their careers
- exercise day-to-day control and management
- provide appropriate support services
- record, monitor, and evaluate performance
- plan for future development.
It is the failure to provide adequate resources and organizational structures that is responsible for many of the difficulties or problems that have become so apparent in so many health care programmes.

**Management skills**

A further and particularly serious cause of difficulties and problems is the absence of, or deficiencies in, the management skills required by staff of different disciplines at different levels in the health care system. Management training will not solve overnight the manifold problems of health care throughout the world, but there is no doubt that considerable improvements in performance, efficiency, and effectiveness could be achieved by the swifter development of appropriate management skills in managers at every level, and in other health care professionals with management responsibilities. In approaching the quicksands of discussion about concepts of administration and management and management training, it needs to be emphasized again that management training or orientation should form an essential part of health worker training at all levels. The health care system brings together two bodies of technology - health care technology and management technology. Too often physicians, nurses and other health workers may be adequately trained in the former but not in the latter; whilst full-time administrators or managers (medical and nonmedical) in national, regional, or district health departments or hospitals may have had insufficient opportunity or incentive to get adequate and relevant training in management technology. And probably very few, if any, categories of staff will have received adequate training or orientation about management of the primary health care team or about the problems and possibilities emerging as political pressures increase for the democratization of health services through broader participation by the community in their planning and supervision.

As already implied in earlier paragraphs, management skills and training must be related to defined needs and tasks. This in turn means that there must be a properly designed management/organizational structure at all levels, with training geared to the needs and tasks defined at each level. Analysis of the skills required is a task that senior managers and their professional colleagues in the health and educational fields need to undertake at the appropriate levels within each country, in the light of their own needs and resources.

The Appendix gives examples of:

- tasks of management
- objectives for management development
- course content for different categories of professionals.

It is certainly not suggested that these examples are applicable to all countries but they could perhaps usefully serve as discussion points for any country seeking to analyse its own needs, and, as is the case with local profiles, there is much to be gained from the exchange of information within and between countries on these topics. For any given management structure, it will be necessary to identify training needs in relation to the management skills required for:

(a) management of primary health care and community health development;
(b) health service management in rural and urban areas;
(c) hospital management in large and small hospitals, including support for other health services;
(d) national health planning, programming, and management at the level of central government.
Management training

Definitions of management structures are of little use without a system of management training to equip people for their positions within these structures. In recent years there have been many statements at national and international level affirming the importance of commitment to the principle of providing management training in the health services. In some countries much has already been achieved, but in others there does seem to be a need for still more action to translate this principle into practice and to develop more rapidly facilities and services for such training. With so many competing demands on the limited resources available for providing health services, the cause of management training often still seems in some countries to come relatively low in the scale of priorities for the allocation of development funds. The following are among the problems resulting from this situation:

1. In most countries plans and programmes for professional training of doctors and nurses are relatively well developed, with very senior officials at national government level directly responsible for the promotion of such training. In very few countries are there any officials of comparable status and influence with corresponding responsibilities (and the appropriate qualifications and practical experience) for management training.

2. In most countries, the top management posts are occupied by medical staff, only a few of whom have received any formal management training. The status of the doctor is such that it is difficult to persuade others (particularly nurses and paramedical staff) to participate in management training or orientation unless doctors themselves participate as well.

3. In many developing countries (and in "developed" countries as well), there is a serious lack of facilities for management training and a serious shortage of trainers - and not enough is at present being done to remedy these deficiencies.

4. Equally, because of shortages of managers and supervisory staff, there is too often a lack of time and opportunity for managers either to take time off for courses themselves or to participate in training activities for staff within their own services or institutions, with consequent lack of attention to human development and in-service training.

5. Where training is provided, insufficient attention is paid to the problems of transference from classroom to working situation and to implementing principles and techniques learned during training ("steam does not get converted to energy").

6. Finally, within existing training institutions research on problems of management and management training appears to be inadequate.

It is encouraging that these problems are now becoming more widely recognized and that increasing efforts are being made to overcome them. As background to the initiatives and developments now taking place, it is useful to refer to a recent report from the WHO Regional Office for Europe, in which Professor J. E. Blanpain, University of Leuven, Belgium, distinguishes four types of training activity:

"Management education aims at providing relevant knowledge, attitudes and skills to permit managers to perform successfully a large variety of tasks in various organizational situations and settings."

"Management training is more organization-specific and is intended to prepare people for well-defined jobs by developing skills immediately useful for well-known tasks and assignments."
"Management development is intended to enhance the managerial performance of practising managers through a variety of job-related educational activities within a policy of continuing education.

"Organization development aims at improving relationships, communication, functioning of teams, etc., within organizations so that the transfer from what the individual managers have learned to improved organizational performance can be synchronized."

These definitions provide a useful overall framework within which any country can aim to formulate its own training needs, priorities, policies, and programmes. And in this context reference may also be made to a report on health service management training for developing countries published by the International Hospital Federation. Most of the following recommendations are taken from that report, and a number of others have been added in the light of further information and advice subsequently received.

1. It is desirable that training in management should be given in the country or region where a manager is going to work, rather than in a foreign country.

2. Wherever possible, it should be the aim to develop existing training institutions in developing countries, rather than build new ones. For example, it may be preferable to extend the work of an existing institute of public administration, rather than establish a completely new and separate institute of health service administration.

3. It may well be appropriate to aim at developing one or more regional centres in each continent for training and research in health services management and for the exchange of information and ideas within and between countries.

4. Of equal importance is the need to develop, nationally and/or regionally, institutions and methodologies for training the trainers of managers.

5. Courses overseas, outside the country in which a manager is going to make his career, should be limited mainly to post-qualification training in specific fields of management or to refresher-type courses for sharing experience and updating ideas.

6. In preparing training programmes, it needs to be recognized that in many respects health services management is a sociological discipline with a strong humanitarian component and with patterns of services influenced by political and ideological attitudes and policies.

7. More emphasis needs to be given to training for the positive dynamic management of health services and hospitals, with facilities and resources strongly patient-oriented, rather than just for the more passive administration of support services.

8. There need to be stronger epidemiological inputs into management training, to help ensure that managers are more sensitive to, and aware of, the kinds of shifting responsibilities that health services must deal with.

9. Management of the health care team, particularly in relation to primary health care, needs to be given greater attention, and training/orientation for community development needs to be included in management training programmes.

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10. In organization and training for management, recognition needs to be given to the distinction between "vertical" health programmes (e.g., malaria, tuberculosis, etc.) and institutionalized services.

11. As indicated earlier, an essential prerequisite for a successful training programme is the preparation of job descriptions for posts at different levels of the health services, together with analysis of the knowledge and management skills required for each post, so that appropriate training methodologies can be devised. These methodologies should include not only formal courses in special training centres but also (and often perhaps preferably) in-service, on-the-job training, action-learning, correspondence courses, manuals on specific topics, radio/TV programmes, travelling workshops, job rotation, and other innovative methods appropriate to each country.

12. Some management orientation should be included in the training programmes for doctors and other professional and para-professional staff. Conversely there should be some health orientation in the training programmes for nonmedical administrators. Encouragement could also usefully be given to joint training sessions and seminars.

13. Managers at every level, including clinicians with management responsibilities, should be encouraged to promote the self-development of staff who are responsible to them and who should be trained how to train and coach their subordinates (the "cascade" effect reaching many people for a small initial expenditure).

14. In training, and in daily work, there should be greater emphasis on the need to develop closer teamwork and collaboration between medical and nonmedical staff. This can also be encouraged through multidisciplinary problem-solving groups, joint refresher courses, and similar activities, which should form part of a regular programme of continuing education, and which should include courses and seminars that bring in representatives from departments having an influence on health matters (e.g., education, housing, social welfare, water supply, agriculture, economic planning, etc.).

15. It is important to encourage participation by the community in the planning and management of their health services, and training programmes for managers should include practical information, advice, and discussion on how best to promote such participation in the context of each country's history, culture and state of development.

16. Encouragement should be given to the development in each country of a professional association of health service administrators and managers, in order to improve professional standards and to represent the views of administrators to government and other organizations.

17. Last but not least, there should be continuing evaluation of training programmes, because it is inevitable that newly instituted programmes in particular will require modification in the light of experience.

Reference is made in these recommendations to extending the work of existing training institutions rather than establishing completely new ones. This point is worth emphasizing again, because in many countries there are already in existence institutions, inside and outside the health services, that have actual or potential capabilities for health service management training, for example:
- university departments/schools of health administration
- departments/schools of public health/community medicine
- departments/schools of public administration/business management
- schools of nursing
- institutes, technical colleges, and polytechnics serving industry, commerce, and public services
- organizations such as the Organization for Rehabilitation through Training (ORT)
- training departments of large industrial and commercial companies.

Much greater use could be made of these and other hitherto untapped sources of experience and expertise relevant to the management training needs of the health services - and particularly in relation to first-line/supervisory and middle levels of management, and to the support service aspects of institutional management, such as maintenance, supplies, transport, cleaning, catering, etc.

In the past, lack of definition of health service management structures, tasks, and job descriptions has made it difficult for any training institution to assess what contribution it might be able to make to the health services, but with clear definitions it becomes much more practicable to devise and implement appropriate methods of collaboration.

Career prospects

Any person in any occupation will normally expect to have some idea of the career opportunities and prospects open to him or her as experience is acquired and further training obtained. In most professional occupations, the rewards and satisfactions that are in prospect at the top of the career ladder will largely determine the quality of recruits coming in at its foot. Doctors and most other health professionals have traditional well-defined career opportunities and prospects, but in many developing countries this is not true of the full-time nonmedical administrator or manager - and the quality of recruits to the profession suffers as a result, as do the standards of management in the health services. Full-time administrators or managers are not required at every level of care in a country's health service, and at the level of primary health care in particular the necessary management functions can often be performed satisfactorily by doctors, nurses, or other health professionals, if they have had some management training or orientation. But in any health care system there will be important roles for full-time administrative and managerial staff, particularly in hospitals and national, regional, and district health departments. If standards of management are to be maintained and improved, then it is important to define not only management structures for the health services but also career structures for managers. But, in many countries, some or all of the following problems can be identified.

(i) There is lack of clarity about management needs and tasks at different levels of the health services (central government, regional and community health services, hospitals, etc.) and the varying skills required (e.g., in planning, programming, operation).

(ii) In consequence, in many countries there is no clearly defined career structure for medical and nonmedical administrators, and such management training as is provided is not related to any career structure.

(iii) Appointments to managerial posts are too often made on the basis of professional (medical) competence rather than on management ability or potential, and seldom are any management qualifications required for senior posts. This leads to tension and rivalry between medical and nonmedical administrators and considerable frustration on the part of the latter, who feel relegated to positions of nonprofessional status.

(iv) This situation in turn has an adverse effect on the recruitment of able youngsters, graduates and nongraduates alike, into the field of health service management and encourages those already working in this field to succumb to the temptations of industry and commerce where the financial rewards and other prospects are more attractive.
To overcome these problems it is worth re-emphasizing that it is essential to have a properly designed management structure at each level, with well-defined career structures for medical and nonmedical administrators. There also needs to be a clear definition of the management responsibilities of doctors and other health professionals whose main concern is with clinical/technical work. It also needs to be remembered that to attract able men and women into nonmedical management, it is vital to be in a position to offer them careers that will provide them with opportunities to shoulder real responsibility and that will give them the prospect of really satisfying and rewarding posts at the top of the ladder.

**Monitoring and evaluation**

Monitoring and evaluation are amongst the current catchwords in health services throughout the world - and it is easier to talk about them than to do anything about them. Nevertheless, it is generally recognized that, if progress and improvements in health care are to be made, it is essential for managers at any level (including clinicians and other professionals) to record details of their activities and periodically to review and assess them in relation to previously agreed criteria. In the past, such criteria have often been missing because of the lack of any clear definition of needs, priorities, policies, programmes, and objectives, so that it has been very difficult to carry out effectively any process of monitoring and evaluation. Conversely, where objectives etc. have been clearly defined, then it becomes practicable to develop appropriate measurements for these processes.

An essential basis for monitoring performance in any field is the maintenance of appropriate records - and this again is something that is easier said than done. The following points should be taken into account in determining what records should be kept (I. J. Jeffery, personal communication, 1979):

(i) It is important to keep records designed to provide information relevant to agreed priority needs and objectives. This implies that not just general data should be collected in the hope of sifting something useful: the data need to be especially geared to measuring progress.

(ii) There is a need for a simple longitudinal record-keeping (free of poorly considered changes in items collected, definitions, etc.) to allow a set of routine record time-series measurements to be available which will make it possible to interpret effects of changes in management more clearly.

(iii) Records should be regarded not only as fulfilling the function of comprising the information on individuals, but also as being the epidemiological basis for the organization of medical care. In both instances records provide a person-centred data source.

(iv) Whilst the importance of a basic set of longitudinal records as the basis for monitoring change is recognized, it is only by chance that this set of retrospective analyses will answer all questions adequately. Hence a records system in which the required information for evaluation is collected prospectively and built into the programme is often the most useful.

Taking these factors into account, decisions about the type and quantity of records to be kept must then be related to the resources and capabilities of those who are to be responsible for keeping the records, for it can be worse than useless to introduce a complex record-keeping system without having staff adequately trained to operate it. This may often mean having to accept different levels of comprehensiveness for records in different fields, such as:
- patients' records
- health statistics
- departmental records
- costs
- personnel
- equipment and supplies
- maintenance and other support services.

In every case it is far better to start with the simplest of records, and to extend them as experience and expertise are gained, than introduce a complex system that will be in danger of early collapse.

With the establishment of records systems, however simple, a basis is furnished for the development of evaluation. This is another of the essential tasks that managers and professionals at any level must be encouraged and enabled to perform, both as regards the organization (or part of the organization) for which each is responsible and as regards the individuals who are accountable to them. The skills required will include not only the ability to analyse the records, but also - to a greater or lesser extent, according to the level of management responsibility - the skills of method study, organizational analysis, staff appraisal, and others referred to in the Appendix. And the overall objective will of course be to improve existing standards of health care and to provide the basis for future change and development.

In conclusion, it may be appropriate to quote the words of one of the respondents in the survey report referred to on page 133: "In developed and developing countries alike, many of the technical solutions for health problems already exist: the difficulties lie in developing adequate organizational vehicles and the capacity for delivering these solutions, and the deficiencies here are largely those of management capacity. This is why the teaching of management is so critical. Without it, the horizon for successful health service interventions will be much more distant, and much more prone to the serious mistakes made by amateurs learning as they go along."
APPENDIX

This appendix gives some examples of management tasks and objectives and contents of training courses. As emphasized in the body of the paper, they are not offered as examples for general application, but as discussion points for any country seeking to analyse its own needs.

(A) Tasks of management

- assessment of needs
- formulation of goals
- mobilization of resources
- development of financial support
- organization of administrative structure
- delegation of responsibilities
- personnel relationships
- supervision and control
- coordination of subsystems
- accountability
- surveillance of quality
- identification of problems
- planning
- promotion of necessary innovation.

(B) Objectives for management development

(i) Objectives at first-line, supervisory level:

1. Leadership, including delegation, motivation, and coordination of the staff providing the service.

2. Supervisory skills including:

   (a) organization and control of work and allocation of duties,
   (b) deployment of staff,
   (c) interviewing of patients, relatives, and new staff,
   (d) appraisal and counselling of staff,
   (e) induction and instruction of staff,
   (f) techniques of securing and maintaining discipline.

   All strongly related to the environment within which the particular service is provided.

3. Effective communications with own and outside staff.

4. Systematic decision-making and problem-solving (immediate and local).

5. Simple method study and analysis of the local activity of the discipline concerned.

6. Recommending and implementing necessary changes.

7. Effective utilization of local resources - accommodation, equipment, staff, and finance - including an understanding of cost effectiveness.

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(ii) Objectives at middle level

(a) Skills involved in managing people, e.g.,
- job analysis, description, and specification
- interviewing and selection of personnel
- appraisal, counselling, and disciplinary action
- staff development and training
- leadership (including delegation), motivation, and coordination of the department’s staff
- initiating and handling change.

(b) Skills relating to communication, e.g.,
- report-writing and presentation of information
- public speaking and public relations
- leading group discussions, chairmanship, working in committees
- conveying information and instructions and securing feedback
- promoting effective staff relations, negotiation
- group decision-making and problem-solving (departmental and interdepartmental)
- ensuring effective liaison with other departments and external services.

(c) Skills involved in organizing work, e.g.,
- medium-term planning, forecasting, and programming of workload
- setting objectives and standards (medium-term)
- monitoring individual and departmental performance, including quality control
- method study and analysis of departmental activity
- collection and processing of quantitative data
- survey methods
- running an office.

(d) Skills involved in managing resources, e.g.,
- deployment and utilization of accommodation, equipment, and staff
- budgeting and cost control
- basic cost/benefit analysis and understanding of cost effectiveness
- selection and use of supplies.

(iii) Objectives at senior level

- policy formation and planning
- setting objectives and standards (major and long-term)
- consensus management and group interaction
- innovation and the management of change in the organization
- identification, analysis, and solving of problems (major and long-term)
- effective coordination and utilization of the organization’s total resources, human and material
- evaluation of information and decision choices
- leadership (including delegation), motivation, and coordination of the health team
- selection and development of subordinate staff
- collective bargaining, joint consultation, productivity, and effective industrial relations
- analysis of roles and relationships within the organization
- monitoring of individual and organizational performance
- understanding the organization’s environment.
(C) Course content for different categories of professionals

(a) For administrative assistants of small and medium-sized health institutions

<table>
<thead>
<tr>
<th>Subject</th>
<th>No. of hours</th>
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<tr>
<td>Human relations</td>
<td>60</td>
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<tr>
<td>Mathematics</td>
<td>60</td>
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<tr>
<td>National institutions</td>
<td>40</td>
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<tr>
<td>Written reports</td>
<td>40</td>
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<tr>
<td>Health care systems</td>
<td>90</td>
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<tr>
<td>Information and statistics</td>
<td>120</td>
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<td>General accounting</td>
<td>120</td>
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<td>General administration</td>
<td>120</td>
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<tr>
<td>Health services administration</td>
<td>90</td>
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<tr>
<td>Finance</td>
<td>90</td>
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<tr>
<td>Personnel management</td>
<td>60</td>
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<tr>
<td>Materials and equipment</td>
<td>90</td>
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<td>Supplies</td>
<td>90</td>
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<tr>
<td>Health planning</td>
<td>90</td>
</tr>
<tr>
<td>Labour law</td>
<td>40</td>
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<tr>
<td>Practical work</td>
<td>150</td>
</tr>
</tbody>
</table>

(b) For doctors taking public health as their specialty:

- introduction: general management concepts
- planning
- organization
- management: selection and assessment of staff, communication, leadership
- control: objectives, standards, types of control
- information: information systems, criteria for the selection of information, data handling and processing
- accounting: accounting procedures, books, "T" accounts, financial statements
- budgets: general concepts, characteristics, main health headings, budgetary control
- programme budgeting: concept, process of drawing up the budget, administrative changes needed to bring about its successful introduction, costing systems
- economic engineering: time value of money, interest tables, analysis of alternatives
- sequence and coordination of activities
- evaluation of health care systems: need, use, quality, efficacy, cover, effectiveness, activities, availability, accessibility, utilization, productivity, performance, efficiency
- the health market: analysis of customers and users, segmentation, presentation of services, rates, promotion.

(c) For students in their final year of business administration who are especially interested in aspects of health care administration, with emphasis on the problems of the particular country:

- conceptual framework
- demographic aspects
- health conditions
- health policies
- maternal and child care
- nutrition
- environmental hygiene
- organization of health services
- health care institutions
- financing
- staff
- social security.
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HUMANIZATION OF HEALTH CARE FACILITIES IN THE LIGHT OF THE GLOBAL STRATEGY FOR HEALTH FOR ALL

B. M. Kleczkowski

CONTENTS

1. A changing context .................................................. 144
2. Functional issues .................................................. 144
3. Structural issues .................................................. 145
4. Human issues ..................................................... 146
5. Concluding remarks ............................................... 147
6. References ....................................................... 147

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1. A CHANGING CONTEXT

During the Thirty-fourth World Health Assembly (held in May 1981), the "Global Strategy for Health for All by the Year 2000" was discussed and adopted (1). The main aim of this strategy is to develop national health systems, based on primary health care, for the delivery of countrywide health programmes reaching the whole population. These programmes include all essential measures for health promotion, disease prevention, diagnosis, therapy, and rehabilitation. They also specify the respective roles of individuals and families at home, of communities, of professional teams, and of facilities providing health services at the primary and supporting levels of health systems, as well as other sectors that can have an impact on health. They involve the selection of forms of health technology that are appropriate for the country concerned. It is crucial to the strategy to ensure social control of the development of the health infrastructure and health technology through a high degree of community involvement. It also sets down the international action to be taken to support relevant national efforts through information exchange, the promotion of research and training, or the provision of direct technical support to countries.

This new approach to the development of national health systems will certainly have its impact on the planning, construction, and operation of health care facilities. There can be no doubt that it brings out the need to reorient national health systems towards real human needs and local realities. This process of reorientation, complex and profound as it inevitably is, furnishes the changing context within which the problems involved in humanizing health care facilities must be reviewed if correct and useful conclusions are to be reached. Within this changing context, the salient issues are those relating to the functional, structural, and human factors involved.

2. FUNCTIONAL ISSUES

As pointed out in the introduction to this volume, it is essential to know what package of health services is likely to achieve the most relevant (in relation to human needs) and equitable distribution of health care and what is the appropriate role of facilities in such a package. To recapitulate, primary health tasks can often be performed in people's homes, in schools, and at places of work, and this approach is often most welcomed by the people. A "purpose-built" setting of a reasonable standard is, however, much more desirable for certain primary health tasks, even relatively simple ones (2).

The role of the hospital has recently been re-examined in this context. It was acknowledged that the hospitals, particularly the "frontline" ones, could and, in fact, would support and complement primary health care (3). It is widely appreciated that their role will inevitably change with the establishment of primary health care programmes, and they should eventually be integrated, with these programmes, into an appropriate local health system with clearly defined tasks and requirements.

The concept of "appropriate technology for health" has been developed in parallel by the World Health Organization and its Member States. Regarding technology in a comprehensive sense - i.e., as including, besides physical tools (often called techniques), such nonmaterial components as technical "know-how" (knowledge and skills) and organization and management of work (procedures) - the concept of appropriate technology stresses the fact that the choice and application of medical technology are not only a matter of conscious decision-making by medical staff but also, to a large extent, structurally determined by local patterns of production and distribution which will certainly vary between open-market and centrally planned systems or between developed and developing countries.  

Some attempts to demystify the mechanisms leading to the maldistribution and inappropriate use of various forms of medical technology were initiated in the mid-1970s. Attention was drawn to the increasing disparity between the tendency to expand health care coverage, often to the point of universal access, and the restrictive application of high technology to specialized curative services (4). The trend towards the widespread application of "restricted high technology" has obviously led to disequilibrium in the type of services provided and their distribution, with too much emphasis on institutional care for the acutely ill and too little on more essential care for large segments of the population. In more affluent countries such a disequilibrium has been compensated for, to some extent, by the rising cost of health care. However, in countries with more limited resources, it obstructs the development of priority health services, thus contributing to increasing public dissatisfaction and even to a deterioration in the population’s health (5). It is now becoming more widely recognized that health authorities should provide all parties involved, including the medical profession and the public at large, with reliable information on the value, cost, and limitations of - as well as substitutes for - various forms of medical technology, and on the rationale for various types of health services, so as to create an informed opinion that will encourage the realistic formulation of national health programmes (6). This could be seen as a further step towards the humanization of the health system as a whole.

3. STRUCTURAL ISSUES

As the author observed at the beginning of this volume, the development of inappropriate buildings for health facilities is felt to be often due to the lack of a task definition (or briefing) or failure to communicate it to the architects, and also to an unrealistic view of the kind of medical and construction technology that would best meet local requirements and constraints.

A plan for health facilities is, of course, only one of many components of the overall health strategy. The advantages of integrating the plans for building health care facilities into more comprehensive plans covering the entire infrastructure of community services for an area are quite clear from some case studies. In practice, however, planning authorities too often still have weak links with the agencies responsible for the physical design, construction, and maintenance of health care facilities. Accordingly, architects are frequently not consulted in the crucial early stages of planning. Moreover, the supervision of construction and the evaluation of completed projects are rarely assigned sufficiently high priority.

The situation is especially worrying in developing countries. The shortage of building designers is aggravated by their frequent lack of experience or of special education in the design and building of health care facilities. Specialist training is rarely available locally and training overseas, being generally not relevant to the needs of developing countries, leads too often to inappropriate designs and both professional and public dissatisfaction. The shortcomings of foreign consultants have already been discussed in the introductory paper. While they are usually welcomed because their fees are often covered by bilateral aid agencies, they are frequently inexperienced in, or lack motivation for development work. Since they are used to working on large-scale projects with sophisticated manpower, methods, material, and equipment at their disposal, they often produce inappropriate and out-of-scale solutions which are expensive to build and run and frequently imply an organization and staffing patterns ill-adapted to local resources and conditions. Also, the extensive use of imported skills, materials, and technology tends to result in an architecture that is out of sympathy with the cultural values of the local people and thus alien to them.

The use of local materials and skills obviates most of the above problems. In this context, it was noted time and again in the case studies that community involvement through self-help projects was extremely helpful. The involvement of the community in the development of their own health care facilities is generally valued very highly from the standpoint of humanization as well, but there is no doubt that some research will be needed before its full potential can be realized.

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4. HUMAN ISSUES

Human beings play either of two contrasting roles in health care facilities: staff or patient. All have their own motives and expectations in performing these roles. Caring for people is a fundamental motive of the staff, and should produce a "caring" environment in a facility. 'Caring' environments try to communicate hospitality, responsiveness, assurance, shelter, and comfort. They play host to welcome guests, i.e., the patients. Staff members who remain aloof fail to convey the sense of care; those who are overagreeable may foster a certain parentalism but ultimately may come to inspire distaste. Apparently technical and environmental decisions are not only value-based, they can, and frequently do, threaten the identity and status of certain groups while enlarging the powers of others (7).

This often creates tension between the various human groups involved (e.g., between patients and staff, or even between medical and nonmedical staff) which is detrimental to a "caring" environment, or, in other words, contributes to the dehumanization of health care facilities. To take an extreme example, increasing specialization in hospitals has led to a form of alienation from the broader aims of the health service: staff often regard themselves as workers on a mass production line. Automated organization has become the main driving force directing and controlling human beings instead of being controlled by them (8).

Endless reports of medical behaviour in health care facilities - behaviour so often contrary to the best interests of patients, particularly the least fortunate members of any society - are surely enough to suggest the existence of a problem not merely in personal morality but in the social ethics of medicine. It is not so much the behaviour of the doctor to the individual patient, or the relationship of one doctor to another staff member, that is involved. It is the attitude, the practices, and the policies of the medical profession towards the whole population that are involved or, more accurately, the medical profession's sense of social responsibility (9).

To turn to the influence of the physical environment, the location of partitions and walls between rooms or wards in any health care building will affect the amount and kind of interaction between people that takes place. Although this is not an important consideration in planning facilities for acutely ill patients, because these patients are not ordinarily expected to be wandering up and down the corridors, it does become important when patients are convalescing or attending rehabilitation, social welfare, or ambulatory facilities. More and more often, the medical staff in hospitals want the patient to be on his feet as soon as possible after treatment or operation, and socializing with other patients is distinctly encouraged so that invalidism will be minimized (10).

Until now, a characteristic of the patient's role was to accept the environment of the health care facility unquestioningly. This was because patients were traditionally expected to play a passive role. They were treated as objects of medical procedures rather than as thoughtful and sensible human subjects. The results of some recent studies and observations have once more drawn attention to the fact that a viable preventive and therapeutic partnership of patients with their families on the one hand, and with the health care workers on the other, is not only desirable but may be an essential factor in improving the quality of medical care. Self-care supported by problem-oriented health education (i.e., what the present author calls "guided self-care") may result in essential benefits to the individual and a better "caring" environment in health care facilities. An additional function of guided self-care is its potential contribution to the social accountability of the medical and allied professions. Patients' expectations and their performance of an "active patient role" reflect complex judgements concerning the appropriateness of the services and their satisfaction with them. Such judgements could be a desirable complement to medical auditing processes, thus making a further contribution to the humanization of health care facilities (11).
5. CONCLUDING REMARKS

The motives of those interested and involved in humanization processes at health care facilities vary a lot; they range from the purely scientific interest of research workers, through the professional interest of those with the practical responsibility for improving the quality of patient care, to, at its extreme, those who try to use a "humanization banner" as a sort of window-dressing likely to attract the potential buyers of their services. As a result, present knowledge about the humanization of health care facilities is still fragmentary and dispersed. Nevertheless, the time seems to be ripe for approaching the problem in a more systematic way. The changes that can be seen to be taking place as regards the overall humanization of health systems also create opportunities for consolidating the efforts of all those really concerned with developing a human "caring" environment at health care facilities. In this respect, the new strategy for health for all could inspire and stimulate fresh thinking and concerted effort on the part of all researchers concerned, whether architects, health planners, or medical workers.

The reader may wonder why the elimination of large wards, a favourite theme of the advocates of humanization, has not been mentioned. This is no oversight. Apart from the fact that living in a community may be as precious to some as privacy is to others, it is important to avoid reducing a broad concept, whose applications are numerous and far from simple, to a few easy, though costly, changes of a rather conspicuous kind. The humanization of health care facilities means looking at the "caring" environment and deriving, from what has been observed, guidance on what should be changed for the common good of the sick.

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ENGINEERING AND MAINTENANCE SERVICES IN DEVELOPING COUNTRIES

J. C. Mehta

CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Definitions</td>
<td>151</td>
</tr>
<tr>
<td>2. Principles of maintenance management</td>
<td>152</td>
</tr>
<tr>
<td>Objectives and standards</td>
<td>152</td>
</tr>
<tr>
<td>Economy and adequacy of resources</td>
<td>153</td>
</tr>
<tr>
<td>Master maintenance plan</td>
<td>153</td>
</tr>
<tr>
<td>Operating expenses</td>
<td>153</td>
</tr>
<tr>
<td>Design and construction</td>
<td>153</td>
</tr>
<tr>
<td>Maintenance staff</td>
<td>154</td>
</tr>
<tr>
<td>Planned preventive maintenance</td>
<td>154</td>
</tr>
<tr>
<td>Safety</td>
<td>155</td>
</tr>
<tr>
<td>Maintenance schedules</td>
<td>155</td>
</tr>
<tr>
<td>3. Activities of the hospital engineering and maintenance department</td>
<td>155</td>
</tr>
<tr>
<td>Primary activities</td>
<td>155</td>
</tr>
<tr>
<td>Secondary activities</td>
<td>155</td>
</tr>
<tr>
<td>Areas of activity</td>
<td>155</td>
</tr>
<tr>
<td>4. Planning and organizing the maintenance programme</td>
<td>156</td>
</tr>
<tr>
<td>Inventory</td>
<td>157</td>
</tr>
<tr>
<td>Task identification</td>
<td>157</td>
</tr>
<tr>
<td>Written job instructions/maintenance manual</td>
<td>157</td>
</tr>
<tr>
<td>The work-order system</td>
<td>158</td>
</tr>
<tr>
<td>Assigning responsibility</td>
<td>158</td>
</tr>
<tr>
<td>Cost analysis and controls</td>
<td>160</td>
</tr>
<tr>
<td>5. Personnel</td>
<td>160</td>
</tr>
<tr>
<td>Personnel manual</td>
<td>160</td>
</tr>
<tr>
<td>Job descriptions</td>
<td>160</td>
</tr>
<tr>
<td>Recruitment</td>
<td>160</td>
</tr>
<tr>
<td>Motivating staff</td>
<td>163</td>
</tr>
<tr>
<td>Supervisor-staff communication</td>
<td>163</td>
</tr>
<tr>
<td>Training</td>
<td>163</td>
</tr>
<tr>
<td>Evaluating performance</td>
<td>164</td>
</tr>
<tr>
<td>Staff discipline</td>
<td>164</td>
</tr>
<tr>
<td>Labour relations</td>
<td>164</td>
</tr>
<tr>
<td>National and international centres</td>
<td>165</td>
</tr>
</tbody>
</table>

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6. Components of hospital engineering services ........................................... 166
   Buildings .................................................................................. 166
   Public services and installations ......................................................... 169
   Air-conditioning and refrigeration ....................................................... 171
   Electrical services and installations .................................................... 174
   Lifts ......................................................................................... 175
   Laundry ....................................................................................... 175
   Communication systems .................................................................... 178
   Workshops .................................................................................... 179
   Choice of equipment ........................................................................ 179
   Stores .......................................................................................... 180
   Cost of maintenance .......................................................................... 184
   Conclusion ..................................................................................... 184

Annex. Strategy for setting up a maintenance organization in a developing country – Pierre Vogt . 188
1. DEFINITIONS

The tasks of hospital engineering are:

(1) To study and plan for a range of equipment adapted to the functions of the particular health care facility. This implies ensuring that the equipment is adapted to local conditions as concerns (both utilities and staff). The task of the hospital engineer begins at the outset of the design of the facility, as a direct relationship exists between the building and the equipment it will house.

(2) To ensure the adequate operation of the equipment so that the facility is constantly able to fulfil its function of ensuring patient welfare.

(3) To ensure that the equipment is properly maintained so as to guarantee its continuous operation and to keep wear to a minimum, thus prolonging the serviceability of the equipment to the utmost.

Definitions of some of the terms more commonly used in maintenance are given below. These should be used in conjunction with Fig. 1, which shows the relationships between the various forms of maintenance.

**Maintenance:** any action or combination of actions carried out to retain an item in, or restore it to, an acceptable condition.

**Emergency maintenance:** maintenance that has to be undertaken immediately to avoid serious consequences.

**Planned maintenance:** maintenance organized and carried out according to a predetermined plan.

**Corrective maintenance:** maintenance (including adjustment and repair) carried out to restore any item that has ceased to be in an acceptable condition.

**Preventive maintenance:** maintenance carried out at predetermined intervals, or in accordance with other prescribed criteria, in order to reduce the likelihood of an item ceasing to be in an acceptable condition.

**Running maintenance:** maintenance that can be carried out when the item is in service.

**Shut down maintenance:** maintenance that can only be carried out when the item is out of service.
2. PRINCIPLES OF MAINTENANCE MANAGEMENT

The scope of maintenance obviously varies with the size and complexity of the facility, but it is of paramount importance that there should be a maintenance programme for even the smallest facilities. While it would be impractical for the small health care facilities to operate their own maintenance programmes, the maintenance team of a facility at a higher level (e.g., an intermediate hospital) should have the task of carrying out a maintenance programme for the smaller health care facilities in its area. When more convenient, this may be one of the tasks of the public works department.

It must also be remembered that, since the tasks of the maintenance team will be much easier when operators of equipment know precisely how to operate it and take care of it, the inclusion of a teaching component in the team's programme will considerably reduce wear and breakdowns. The importance of this goes far beyond the economies made on repairs and replacements, as the work of a whole department may be jeopardized for a long time by the breakdown of essential equipment.

Objectives and standards

The first step in establishing a maintenance programme should be to establish general objectives. The general objectives of a hospital maintenance department may be stated as:

- to extend the useful life of assets;
- to assure the optimum availability of installed plant and equipment for production (or service) and to obtain the maximum possible returns on investment in these items;
- to ensure the operational readiness of all equipment for emergency use at all times;
- to ensure the safety of patients and of personnel using and operating the facility.
Economy and adequacy of resources

(a) Economy of time: all maintenance tasks should be performed according to a master maintenance plan. In cases of breakdown or malfunctioning, every effort should be made to carry out the necessary maintenance work as soon as possible. Experience shows that, while breakdowns are usually reported, malfunctioning too often is not. However, planned maintenance can greatly improve the detection of malfunctioning and thus help prevent the much more expensive breakdowns.

(b) Adequacy of staffing: the optimum number of workers should be assigned to the various tasks.

(c) Adequacy of equipment: it is important to have the proper equipment necessary to do the job.

(d) Adequacy of materials: along with adequate equipment to do a job, proper materials, spares, etc., are also necessary. Workmen must be provided with accessories, cleaning materials, testing equipment, etc. to accomplish their tasks. As concerns spares, a distinction should be made between spare parts that are often needed and cheap, and should therefore be stocked at site, and expensive spare parts, whose stocking would be too costly but to which access via supply lines should be ensured by earmarking funds for the purpose. Adequacy of materials is particularly important for all types of repair work.

Master maintenance plan

Every maintenance department should have a detailed, comprehensive maintenance plan:

- to provide a systematic approach to the work of the department;
- to provide a sound method of ascertaining the validity of budgetary requests;
- to serve as a communication link between staff at different levels in the organization.

The maintenance plan should be a cooperative, coordinated effort involving the entire maintenance staff. The plan must be dynamic, i.e., subject to constant revision as conditions change and/or better ways of accomplishing certain tasks are found. Above all, the maintenance plan should allow no substitute for quality.

Operating expenses

An essential policy of all who are building hospitals containing a variety of medical and engineering equipment should be: "If you can't maintain it, don't build it." Too often funds for capital improvements are secured and health care facilities constructed with no thought to the funds needed to operate and maintain them.

One of the most important and most often neglected aspects of the maintenance budget is the need to replace equipment, plant, and machinery. A separate, adequate fund, which can be drawn upon as needed, should be established for this purpose so that equipment can be replaced at the optimum time. For an agency to have the equipment needed to get the job done, some workable system of equipment replacement is essential.

Design and construction

Maintenance should be a primary consideration in the design and construction of hospital buildings, installations, and equipment. There is no truer maxim than: "Build it right from the start." In these days of high construction and equipment costs, it is easy to rationalize the cutting of corners to make a hospital project economically feasible. Compromising the principles of good design and construction is in the end more costly than "building it right".
One of the most important factors in good construction is the use of appropriate materials, i.e., materials that are:

- durable,
- easy to maintain,
- easy to repair,
- easy to replace.

The proper planning and choice of materials can ease the task of replacement when it becomes necessary. The factors just listed are critical from the standpoint of maintenance and should be carefully taken into account along with such considerations as aesthetics, safety, cost and function.

The best way to assure maintenance input is to have a maintenance engineer on the planning staff. In addition, there should be consultation with the operational maintenance staff when plans are being made for new facilities and equipment, particularly of a kind with which the maintenance staff has some familiarity.

There is no such thing as a maintenance-free facility, but there are facilities that are easier to maintain than others. Attention to minor details of the plan can ease the maintenance burden. The use of temporary structures should be discouraged and avoided whenever possible. Temporary structures have a way of becoming permanent and they usually prove extremely expensive to maintain.

**Maintenance staff**

A hospital must provide for adequate personnel - skilled and non-skilled - to carry out maintenance functions. The introduction of sophisticated mechanical, electronic, and biomedical equipment has increased the need for skilled maintenance staff.

A positive approach to maintenance manpower will involve:

(a) the hiring of high-quality technicians for X-ray, radiotherapy, and similar equipment (here the need to offer adequate wages is obvious);

(b) a good orientation programme;

(c) adequate initial and in-service training in the job for which the technician has been appointed;

(d) good supervision that is responsive to the needs of the employee; and

(e) good communication at the upper administrative levels to bring out the importance of the job the maintenance staff is doing.

**Planned preventive maintenance**

Preventive maintenance may be defined as continuous attention and care in order to prevent damaging wear and costly repairs. It is easy for a maintenance department to get into the rut of constantly trying to catch up with needed maintenance and repair, while paying little attention to preventive maintenance. Careful planning and scheduling are necessary to prevent such a situation.

Prevention is an important consideration in all aspects of maintenance work. Where equipment is concerned, it means daily, weekly, monthly, and seasonal attention to lubrication, oil-changing, and the replacement of worn parts before they fail rather than when the machine breaks down. Where buildings are concerned, it involves the care of mechanical, electrical, air-conditioning, ventilation, conveying, and elevator systems, whitewashing and painting, etc.
Preventive maintenance also involves keeping all recreational surfaces in first-class condition, for example, resurfacing bituminous roads and landscaping the hospital grounds. An advantage of preventive maintenance is that it can be scheduled at the convenience of the maintenance department, whereas the need to deal with breakdowns is liable to arise just when the maintenance department is understaffed or extremely busy.

Safety

The maintenance department has a primary responsibility for safety. A programme designed to reduce accidents must be based on accurate accident records and periodic reviews of these records. Accident records may be required by law or by the hospital authorities.

The maintenance staff should help to create areas and facilities that are as safe as possible. To this end, they should be trained to observe and report routinely any conditions that may endanger safety.

Safety should be carefully considered during the planning and construction stages. Errors made with regard to safety at this juncture are difficult, and often impossible, to correct.

Maintenance schedules

Maintenance work schedules must be based on sound policies and priorities. Every maintenance department should carefully consider the criteria to be fulfilled by such schedules. Once these criteria have been established, the relevant decisions can be evaluated against them and the schedules will be more consistent.

3. ACTIVITIES OF THE HOSPITAL ENGINEERING AND MAINTENANCE DEPARTMENT

Although in practice the scope of the activities of the engineering and maintenance department varies, being dependent on the hospital's size, type, administrative policy, etc., it is possible to classify such activities into two broad groups, primary and secondary.

Primary activities

1. Maintenance and operation of existing buildings, plant, and equipment.
2. Inspection, calibration, and lubrication of equipment.
4. Additions and alterations to existing buildings and equipment.
5. Installation of equipment in new buildings.

Secondary activities

1. Storekeeping.
2. Plant protection, including fire protection.

Areas of activity

The areas dealt with by the engineering department of the hospital may be grouped under the following headings:
Civil and architectural

1. Physical planning, designing, layouts, and construction in relation to operation and maintenance.
2. Ventilation.
3. Sewerage and plumbing.
4. Water supply.
5. Lighting.
6. Noise control.
7. Air pollution control.
8. Medical gases, including suction supplies.
10. Evaluation and improvement of hospital's technical programme.
11. Study of aspects of patient comfort, such as colour schemes, glare prevention, etc.

Mechanical, electrical, and electronic

1. Laundry.
2. Lifts and conveyors.
3. Central workshop with repair shops.
4. Air and water conditioning.
5. Radiological safety.
7. Thermal environmental engineering.
8. Electrical installations.

Administrative

1. Maintenance management and planning, including industrial engineering.
2. Management of the technical staff.
4. Relationship of medical and nursing activities to hospital engineering.
5. Engineering stores and supplies.

4. PLANNING AND ORGANIZING THE MAINTENANCE PROGRAMME

The deterioration of hospital buildings, plant, and equipment as a result of inadequate maintenance usually occurs gradually and is not noticed by patients, or even doctors, until it has become quite intolerable or dangerous. By this point, corrective maintenance will have assumed the proportions of an expensive, major repair project. This is why the hospital engineer and administrator must continually insist that maintenance be regarded and supported on an equal footing with all other aspects of the hospital's functioning.

A situation of which emergency and crisis maintenance is a regular and continuing feature cannot be tolerated. A maintenance programme must operate on a planned, systematic basis in accordance with maintenance standards, anticipating deterioration and breakdown rather than reacting to it. To be effective, the programme must not remain static. It must be evaluated continually and modified according to changing needs, not only by changes in the frequency of servicing, but also by the selection of better materials and tools, and the improved utilization of personnel.
The development of an acceptable and realistic maintenance plan involves the following activities:

- making an inventory of the buildings, plant, machinery, equipment, etc. to be maintained;
- identifying and listing specific routine maintenance jobs to be done, for each item of equipment;
- drawing up positive written maintenance instructions for each area or facility;
- providing a means of accomplishing nonroutine, nonrecurring jobs;
- assigning responsibility for each maintenance job, i.e., designating an individual, crew or contractor to do the job, and supervisory staff to see that the job is done properly;
- establishing a system for job planning and workload control, together with a well-defined time-schedule, for daily, weekly, and seasonal maintenance work. In the interests of economy, the most efficient way of doing a maintenance job must be determined. This involves estimates of the time, personnel, tools, equipment, and material required. It is also essential to keep records that will be helpful in comparing workload with available manpower.

Inventory

If the buildings and equipment are to be routinely maintained according to general objectives and established standards, a definite plan for accomplishing this must be developed and followed. This plan must include a detailed inventory of areas, facilities, and equipment, indicating the extent and time of their use by days, weekends, holidays, and seasons. The inventory must also mention types, sizes, special features, brief specifications, and condition prior to repair, which in turn will allow decisions to be made on work schedules, the need for specialized personnel, and the proper maintenance of equipment and supplies.

Task identification

A maintenance job list, based on a detailed inventory, must be prepared for each building. The list for each piece of work must include such items as cleaning, lubricating, painting, replacing spares, etc., and all other related jobs. Standards of maintenance must then be applied to each facility and piece of equipment; here it must be borne in mind that the amount or intensity of use that a given area is to sustain will determine the amount of maintenance necessary to minimize deterioration.

Written job instructions/maintenance manual

Following the identification of routine maintenance jobs, a maintenance plan should be drawn up. It is very important to recognize from the outset that the plan must be clear and easily interpreted both by field personnel supervising the prescribed maintenance work and those actually carrying it out. A most effective means of explaining routine maintenance responsibilities to field personnel is to present the maintenance plan in the form of an illustrated instruction manual.

Maintenance plans should also be established for specialized equipment and electrical systems such as heating, ventilating, air-conditioning, X-ray apparatus, etc. They are also necessary for utilities such as water and gas supplies, sewerage systems, fire-alarm systems, etc. Normally the major part of the data included about the maintenance of specialized equipment is quite general in nature, referring those responsible for such maintenance to more detailed information and instructions provided by the manufacturer or to other sources of specific information on the subject.
The work-order system

The effectiveness of a maintenance programme depends to a great extent on having a work-order system that will receive all requests for work to be carried out, initiates action, and follows the project through to completion.

Coordination of requests

A large hospital should establish one or more control centres to coordinate its work-order system. In a small facility, the task might be assigned to a complaints clerk or a middle-level maintenance manager, e.g., the hospital technologist.

Request forms or requisition slips

Requests for work to be carried out come from a variety of sources: wards, laboratories, hostels, the laundry, nursing staff, security staff, and preventive maintenance mechanics. In a well-managed maintenance department, requests should come from department employees trained to identify and report maintenance needs and problems during normal work rounds. Hospital administrations should see that those authorized to send such requests are trained in the classification of the tasks involved.

Special forms should, however, be distributed to all major operational and programme offices to facilitate requests for maintenance. A properly designed request form makes it possible for the service concerned to provide the complete and accurate information needed for the request to be analysed and a work order issued.

Assigning responsibility

The organization of the maintenance operations will depend on many local factors such as the size of hospital, the size of the wards, the quantity and quality of the equipment, and the use of the relevant facilities at different times (weekends, weekdays, holidays).

Only after each of these factors has been considered can responsibility for maintenance work be assigned and a workable maintenance organization developed.

Methods

(a) Unit maintenance

Under this method, each unit - electrical, mechanical, biomedical, or civil - performs its own component of the total maintenance work. The advantages are:

- It is relatively easy to determine responsibility when maintenance is not properly performed.
- The chief hospital engineer controls both the maintenance and programme staff, which should make for better coordination.
- Maintenance personnel tend to develop loyalty to their particular unit and often take more pride in their work.
- The system offers job satisfaction and opportunities for advancement in the relevant trade or training process.
The disadvantages of the unit method of maintenance organization include the following:

- Unit maintenance personnel have to learn to perform a variety of jobs and use a variety of equipment in a satisfactory manner.
- The supervisor has to be familiar with the various jobs and the equipment necessary to perform these jobs.
- Unit maintenance does not make the most efficient use of expensive tools and equipment.

(b) Maintenance by specialized crews

In the specialized-crew method of maintenance, each crew is trained to do a particular job such as repair of lifts, repair of boilers, repair of X-ray apparatus, etc. The crew moves from one unit to another to perform its specialized work. The advantages of the method are:

- The crew becomes extremely proficient in its specialized work.
- It provides the best use of expensive equipment, which should be used on a regular basis to justify its cost.

The major disadvantages of the method are:

- The repetition of the same job tends to make it monotonous for the crew.
- Time is lost in travelling from area to area.

The most appropriate applications of the specialized-crew method of maintenance occur when the requisite skill is difficult to learn, when specialized equipment is involved, or a number of small areas and facilities are involved.

(c) Contractual maintenance

The third basic method of maintenance is to use an outside contractor. It is not inconceivable that the entire maintenance function could be handled by having the various maintenance jobs carried out by contractors.

The advantages of maintenance by contract are:

- There is no capital investment in equipment, tools, etc.
- Well-trained specialists are hired for each job.
- There are no "in-house" personnel problems such as strikes, etc.

The disadvantages are:

- It is no longer possible to control when and how each job will be completed.
- Costs are higher because the contracting firms must make a profit — they charge "emergency" costs for repairs, and in large countries like India, they cannot have an economical servicing network.

The best application of contractual maintenance is in very remote areas where travel takes a great deal of time, in jobs requiring a high degree of specialization as regards both operator and equipment, where the job is not done routinely, and where there is a relatively low demand for the job to be done. Where outside contractors are used, the following precautions are necessary:

- Choose reputable firms.
- Draw up complete and detailed specifications.
- Keep a strict check on the contractor's work.
Experience of running the hospital of the Postgraduate Institute of Medical Education and Research (PGI), Chandigarh, India, suggests that a combination of the three systems of assigning maintenance is most common. With the passage of time, it has been able to bring 80% of equipment maintenance under the first two systems. Dependence on specialized operators is essential only for the remaining 20%, and this proportion might be reduced by the regionalization of the services of technicians and engineers.

Fig. 2 shows the organization of the Hospital Engineering Department at the PGI, Chandigarh, India, which is a 750-bed teaching hospital, with research laboratories, hostels, workshops, etc.

Cost analysis and controls

A soundly established and properly used operating budget will provide valuable information regarding changes in conditions and trends.

Separate cost figures for each function of the maintenance division should be recorded; if necessary, the cost of each function should be broken down in detail in the recording of expenditures. If the cost data are to be meaningful, expenditure must be directly related to work accomplished. If this is done, separate accounts must be kept for each function.

5. PERSONNEL

Personnel manual

That people are the most important consideration in any service operation certainly holds true for maintenance management. The finest equipment, supplies, and buildings will mean little if competent personnel are not available in sufficient numbers. Not only must staff be competent and positively motivated but, in addition, they must understand fully and thoroughly the scope of their duties and responsibilities and the general operation of the system as a whole.

A separate personnel manual or a section of the overall maintenance manual should be drawn up for maintenance personnel. It should include an outline of the duties pertaining to each post, the minimum requirements for appointments to these posts, rules of employee conduct, and other information that clearly defines what the management expects of each employee.

Job descriptions

Job descriptions should be drawn up for hospital technologists, foremen, lift-operators, boilermen, air-conditioning mechanics, storekeepers, manual workers, gardeners, and all other types of maintenance personnel required. Fig. 3 is an example of a job description.

Recruitment

Recruiting skilled workers who are competent and reliable is often difficult. The following suggestions may be helpful in recruiting capable engineering technicians for hospital work:

1. Provide good avenues for advancement. To promote job satisfaction, involve good technicians in innovation and development and compensate them suitably.

2. A policy of internal promotion ensures that the organization and the candidate each know the other's strengths and weaknesses in advance, thus minimizing the possibility of unhappy "surprises".

3. Take the advice of the senior staff under whom the candidate will work.

4. Secure qualified maintenance personnel, perhaps by operating your own apprenticeship programme. Postbasic training courses are essential for hospital technologists and hospital technicians. Depending on need, training centres could be opened to give in-service training.
FIG. 3. HOSPITAL ENGINEERING DEPARTMENT, PGz, CHANDIGARH: ORGANIZATIONAL AND FUNCTIONAL CHART

Director

Chief Hospital Engineer (Civil and Environmental)

Unit I

Deputy Hospital Engineer (mechanical and biomedical engineering)

Technologist (electronics)
Technologist (laundry)
Technologist (biomedical engineering)

Unit II

Assistant Hospital Engineer (electricity and air-conditioning)

Technologist (electricity)
Technologist (lifts)

Unit III

Technologist (stores)
Technologist (estate management)
Technologist (linen supply services)

Administrator (Accountancy, personnel, etc.)
Administrator (committee work, special assignments)

Technologist (civil engineering)
Technologist (preventive maintenance)
Technologist (engineering design and construction)
Technologist (booster station, horticulture)
Technologist (processing/purchase)

Technologist (civil engineering)
Technologist (preventive maintenance)
Technologist (engineering design and construction)
Technologist (booster station, horticulture)
Technologist (processing/purchase)
FIG. 3. JOB DESCRIPTION: PLANNED-MAINTENANCE CONTROLLER

<table>
<thead>
<tr>
<th>Department</th>
<th>Maintenance.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job title</td>
<td>Planned-Maintenance Controller.</td>
</tr>
<tr>
<td>Responsible to</td>
<td>Chief Hospital Engineer.</td>
</tr>
<tr>
<td>Responsible for</td>
<td>All maintenance planning staff.</td>
</tr>
<tr>
<td>Main Function</td>
<td>The efficient administration and development of the planned-maintenance staff.</td>
</tr>
</tbody>
</table>

**Duties**

1. The preparation, issue, and upkeep of a complete plant/equipment inventory.
2. Identification and physical numbering of all plant/equipment.
3. The preparation of maintenance schedules and their revision, as necessary, in the light of operational experience.
4. The compilation of job specifications from the maintenance schedule, and their revision.
5. Preparation of an annual maintenance programme.
6. Negotiating the release of plant for maintenance.
7. To obtain literature, data, drawings, spare-parts lists, manuals, catalogues etc. from manufacturers.
8. The preparation of plant spares and the setting of maximum/minimum stock-levels for stores.
9. The critical analysis of plant history, records, and maintenance requests.

**Qualifications (minimum):**

1. A 3-year diploma in Mechanical/Electrical/Industrial Engineering.
2. Minimum of 5 years' experience of maintenance in a plant/factory/hospital.
4. Ability to deal efficiently and tactfully with employees.
5. Versatility and initiative in dealing constantly with changing assignments.

---

1 Source: Postgraduate Institute of Medical Education and Research (PGI), Chandigarh, India.
A hospital technologist or foreman gets his work done with and through people and should therefore take a special interest in the selection, training, placement, motivation, and evaluation of employees. An effective maintenance supervisor succeeds in persuading employees to work towards the goals and objectives of the maintenance division. He recognizes that he must select the best employees from those available and carefully place them in the positions where they can function best.

Motivating staff

Worker performance is regulated by two factors: competence and commitment. Experience, skill, and knowledge applied to the job result in competence. Motivation produces commitment. Motivation is not something that a supervisor does to his employees. It is rather the individual's feeling about, or attitude towards, himself and his environment.

Motivation is a very individual thing. Attempts at group motivation will always fall short of the desired result. The hospital technologist must know his staff so well as individuals that he will never have to resort to threats, intimidation, or rank as instruments of motivation or control.

While no reputable behavioural scientist would deny the importance of money as a temporary motivator, research has shown that money is not so important a motivating factor in the long run as one might believe, and that several other approaches, for instance, participation of employees in decision-making, promise more permanent results.

Supervisor-staff communication

Adequate communication between supervisor and staff is essential for the development of effective cooperation. It enhances staff-members' sense of security and helps them to adapt to change. Bulletin boards and newsletters are valuable, but not so valuable as direct person-to-person communication. The supervisor must be a good listener.

Communication should not be undertaken without careful consideration of such factors as why it is necessary and how, when, and where it should take place. It is important also to ensure, through "feedback", that the message has been understood.

Training

The training of maintenance employees has two basic aspects:

(a) trainee orientation, which includes familiarizing the trainee with the work of the division, the new worker's job responsibilities, job performance standards, and the work schedule;

(b) the improvement of employees' knowledge, skills, and attitudes in relation to job performance.

Since many employees will have received less than adequate formal training, hospital engineers and technologists must place high priority on effective continuing education. The training section of the hospital engineering department must devote time to orientation, class-room instruction, on-the-job training and retraining, revision of manuals, careful record-keeping, etc. Also, since medical technology is changing so fast, contracts with firms supplying equipment should oblige them to train hospital technicians and technologists in its maintenance and repair.

To supplement training, hospital engineers should prepare manuals describing maintenance tasks. While a manual can never replace on-the-job and classroom instructions, it can serve other important needs. It is a readily available guide for the worker who cannot remember all the details of the more complicated or less frequently performed jobs. A good manual will present, for each task, a numbered sequence of operations explaining, in order, each step to be
followed. Regular employees should not have to carry such manuals on their routine rounds, but new workers may need them, and supervisors can use them to instruct new workers and advise experienced ones. Manuals prepared by the Hospital Engineering Department of PGI, Chandigarh, are popular with the maintenance units of hospitals in India.

Safety training

Besides the training specific to his trade, the technician should receive on-the-spot training aimed at making him safety-conscious, i.e. mindful both of his personal safety and of the safety of the sick and other users of the hospital. Selected technicians should be assigned responsibility for certain areas in case of fire. They should receive specific training in evacuation procedures and the use of fire-fighting apparatus.

Evaluating performance

The enlightened supervisor recognizes the benefits to be gained from working with all technicians, particularly the good workers. He realizes that it is important to build on the strengths of his work group, rather than on the weaknesses. He should spend as much time as possible on the job site, personally observing employees' performance and getting direct "feedback" on grievances affecting good performance. His appraisal will thus be continuous, informal, and routine to the point that it will, in fact, be supportive supervision.

A written record is essential if the supervisor is to be capable of making objective, defensible recommendations regarding training, transfer, dismissal, promotion, or permanent appointments for each technician. The supervisor should guard against personal bias and error in rating, regardless of the rating system employed.

Staff discipline

A worker's self-discipline is reflected in willingness to carry out supervisory instructions, abide by known work rules, and refrain from any personal behaviour that might undermine the achievement of corporate objectives. It usually results from fair and carefully established work rules and regulations, which are clearly understood and accepted.

Constructive discipline in a work group generally reposes on well-established policies executed through consistent supervisory practices. A systematic method for instructing employees on work rules and job performance standards must be established. There must also be a well-established fact-finding procedure permitting prompt decisions regarding possible disciplinary action. From the standpoint of positive motivation, supervisory warnings that prevent more serious breaches of discipline are preferable to more punitive measures. A reprimand should be given by the supervisor in private, and the worker should be offered ample opportunity for a positive response.

Labour relations

Although there are likely to be grievances wherever people are employed, competent managers can do much to prevent situations that precipitate them. Prevention is the proper approach.

Management must therefore:
- anticipate grievances,
- have a well-defined procedure for handling them,
- deal with them promptly.
The following three-step approach from the business world can be applied to a hospital with success:

- receive grievances properly,
- collect all facts,
- take corrective action immediately.

In the event of an appeal, the strength of the supervisor's case, in addition to his handling of the grievance, often rests upon his entire range of supervisory skills including communication, counselling training, and evaluation practices. Inconsistencies in employee evaluation, sarcastic communications, prejudicial treatment, and failure to inform workers of their appeal rights all work against the supervisor and invite the appeal board or labour commissioner to reverse the supervisor's decision or issue a reprimand.

National and international centres

The International Federation of Hospital Engineering strongly feels that every country should have one or more centres for training all categories of engineers and technicians working in health services. It is now considered desirable that there should also be international centres for this purpose in various regions of the world. Such centres have already been set up in Venezuela, New Zealand, and Cyprus to serve the countries of Latin America, the Western Pacific, and the Eastern Mediterranean respectively.

An example of a national centre is to be found at the Postgraduate Institute of Medical Education and Research (PGI) Chandigarh, India, where a department of hospital engineering and planning was established in 1969. By now it has a strong team, consisting of 3 hospital engineers, 30 hospital technologists, and about 500 hospital technicians. None of them has had specialized training in hospital maintenance. However, the following formal training courses are being contemplated:

- postbasic courses of 3-16 months' on-the-floor training for the technicians who are actually responsible for repairs and maintenance;

- postdiploma courses of one year's duration for middle-level managers, designated as hospital technologists, who already have a 3-year post-matriculation diploma from a polytechnic;

- postgraduate courses for hospital engineers/architects who hold a university degree in engineering or the equivalent; these will be of 2 years' duration with specialization in the second year:
  (a) in health facility planning and designing (architects and engineers);
  (b) in biomedical engineering (electrical, mechanical, electronics engineers, etc.).

In addition, the postdiploma and postgraduate students will undergo training in "core" subjects, along with doctors, at a postgraduate course in health and hospital administration. Their training will also cover aspects of institutional environmental health such as microbiology, environmental toxicology, environmental radioactivity, biometry, air and noise pollution, epidemiology, etc. India has established a professional body known as the Indian Society of Hospital Engineers, which has its headquarters at PGI, Chandigarh, and is federated to the International Federation of Hospital Engineering.
6. COMPONENTS OF HOSPITAL ENGINEERING SERVICES

Unless drastic changes are made in the design of buildings and other services from the standpoint of maintainability, an opportunity to decrease the enormous cost of hospital upkeep will have been lost.

Many new facilities have been constructed in such a way as to eliminate the production or service inefficiencies that were unavoidable in the old buildings and plants. But, unfortunately, maintenance problems are perpetuated from the old facilities to the new because the economic importance of maintenance has not been sufficiently stressed, or perhaps because too many people are unaware that an opportunity to change the situation does exist. The greatest possible return on the investment in maintenance will undoubtedly be realized when the maintenance programme is developed during the planning stage of a building. Maintenance personnel should work with the architect and the engineer in selecting materials, plant equipment, and surfaces. Working together, they can avoid decisions that ignore the maintenance aspect - which is equivalent to leaving out one of the variables in an equation.

It is likely that the benefits of maintenance planning will never be fully realized without due interest on the part of owners and managers of buildings. The architect, engineer, maintenance manager, and maintenance consultant all have an obligation to awaken and sustain such an interest.

**Buildings**

Urban and metropolitan hospitals in India are generally multistoreyed concrete-frame structures with bricks as filling material. In the case of hospitals of up to four storeys, walls are generally of brick and load-bearing. Brickwork is mostly plastered to protect it from the effects of the weather, though in certain areas where the quality of bricks is good, or where they are machine moulded, brickwork is exposed. Flooring consists of terrazzo tiles. Red stone flooring is provided for ramps, and some public areas in hospitals are provided with Kota stone flooring. Joinery is generally in deodar or teak, though steel and aluminium are increasingly coming into use. Roofs are of terraced tiles with bituminous tarfelting. Multistoreyed blocks are generally designed to resist earthquakes, or high winds. The construction cost for hospitals of this type is between Rs 750 and Rs 950 per m² in urban areas.

Rural hospitals are also brick-built. Flooring is of concrete, and local wood is used for joinery.

Nothing much has been done yet to develop or apply new or cheaper building materials for hospitals in India. The Central Building Research Institute at Roorkee and National Building Organizations have developed some new materials and there are certain new techniques used in housing that could conveniently be applied with due professional courage and conviction.

There is no research unit in the country on health facility planning, and there are no courses on hospital planning/architecture. The urban-based architects continue to remain under the influence of western styles for hospitals. All building work, including hospital construction, is labour-intensive and thus too slow.

The above conditions are probably much the same as those in other developing countries, reflecting a great need for research on design, materials, and techniques as applied to the construction of health care facilities. Training centres for hospital architects and engineers are urgently needed in developing countries.

Some of the factors conducive to the good maintenance of hospital buildings are listed below:
- Advantage should be taken of standardization, but the standards should be reviewed regularly.
- Measures to limit soil settlement should be taken from the beginning.
- Before applying covering, remove any pencil marks or other foreign matter from walls.
- Replace marked or soiled ceiling tiles.
- Give adequate attention to the details of backfill material.
- Be sure that soil is compacted properly.
- Protect walkways or paving from damage.
- Remove soil from streets or walks to prevent its being tracked into buildings.
- Consider soil sterilization wherever termite infestation could become a serious problem.
- Apply concrete or asphalt paving over a well-constructed base, coated with sealers.
- Do not use asphalt on a gradient steeper than 10%.
- Provide diagonal as well as rectangular walkways between buildings.
- Give walkways a 2% transverse slope, or a crown for drainage.
- Barricade any paved areas that cannot support vehicles.
- Use guards to protect the corners of walls adjacent to driveways.
- In asphalt truck-parking areas, provide concrete strips to support steel wheels.
- Install storm drainage in loading and parking areas.
- Use granite curbing where snow-ploughs operate; it is most successful.
- Provide ramps at curbs for wheelchairs and similar vehicles.
- Use a gravelled splash area to prevent mud splatter on lower outside walls.
- Where two or three steps are planned, replace them with ramps.
- Provide a well-designed loading dock.
- Install concrete strips under fencing to avoid mowing and litter problems.
- If possible, use maintainable materials, such as polished stone, stainless steel, and glass, for exterior surfaces.
- Use brick, cast stone, natural stone, and other permanent materials for exterior walls. Avoid wood.
- Avoid using porous stone, or at least use rust-proof fasteners.
- Install compression layers on masonry walls to avoid damage due to shrinkage.
- Avoid designs that create natural ladders.
- Do not use signs made of individual letters affixed directly to a wall.
- Use roof walkways or tread-boards for inspection and maintenance purposes.
- See that canopies have drains.
- Avoid asphalt tiling, which is a poor investment, even though the initial cost is low.
- Be cautious with impregnated wood, which has some of the same drawbacks as natural wood, although it is more durable.
- Avoid linoleum as, after a time, it develops a poor, irregular appearance.
- Be cautious with marble, as its porous structure is easily stained and it is easily damaged by chemicals.
- Consider plastic tiling, which is expensive, but generally maintenance-free.
- Use vinyl asbestos, generally the best investment for most floors, alternatives being concrete, carpet and terrazzo.
- Use good surfaces: precast terrazzo, stone, and formed synthetic materials.
- Use doormats, which are useful soil traps.
- Be sure that handrails are simply designed, continuous, and firmly attached.
- Use epoxyresin coating for a smooth, durable surface.
- Avoid flat paints, which mark easily and are difficult, if not impossible, to wash.
- Avoid specially mixed paint colours.
- Use glazed tiles for problem areas such as those used for food processing, dressing-rooms, etc.
- Reinforce plaster corners with metal.
- Use a minimum width of 2.5-3 m for corridors, in order to avoid wall damage.
- Use rounded corners in busy intersections.
- Consider stainless steel corner-guards for walls and columns in areas where equipment or furniture will be moved regularly.
- Enclose fire extinguishers in recessed cabinets.
- Do not use soft, sprayed-on mineral materials; they simply cannot be cleaned.
- Where plastic ceilings are used, be sure they are removable.

Services are best carried out at the following intervals:

A - Whitewashing:

Quarterly
- kitchen

Half-yearly
- bathrooms (hospital)
- outpatient departments
- canteens and cafeterias

Yearly
- All other buildings, whether residential or non-residential

B - Painting and distempering:

Yearly
- laboratories
- operating theatres
- corridors
- ramps
- private and general wards
- bathrooms (hospital)
- outpatient departments
- canteens and cafeterias
- restaurants
- hostels
Biennially
- doctors' offices
- other non-residential buildings

Triennially
- residential buildings

C - Treatment of woodwork:

Biennially
- non-residential buildings

Triennially
- residential buildings
- hostels

D - Resurfacing of roads: every four years

E - Waterproofing (renewal): every eight years.

The general technical specifications will be the same as those prescribed by central public works departments.

Public services and installations

The water supply to hospitals is generally linked with the city supply in urban areas whereas rural areas have their own supply through tube-wells, etc. Some of the larger hospitals have their own underground storage tanks and, after collecting filtered water from the city's mains, they have their own diesel-operated-boosting-pumps and internal distribution system through small gravity-operated storage tanks placed on the top roof of various blocks/ buildings in the hospital grounds. The water is generally subjected to microbiological tests for quality; quantity, however, is a major problem, particularly in summer. The Indian Standards Institute recommends a supply of 135-230 l/day/head (30-50 gal/day/head).

The hot water supply is mostly provided through geysers with a capacity of 45-135 l/h.

The central steam supply for autoclaving and sterilization comes from the central boiler house. The same steam, by reducing the pressure, is fed to water tanks for the supply of hot water to wards, operating theatres, outpatient departments, and other areas. Oil-fired boilers of 300-600 kg of steam per hour have been found quite suitable for hospitals. Steam is generally produced at 10.5 kgf/cm² and suitably reduced through pressure valves for supply to the various areas according to need and equipment. There is now an increasing tendency to use steam for cooking in central kitchens and for heating wards, though increasing fuel costs are a limiting factor. More should be done to harness solar energy for use in hospitals.

The medical gas system has a central manifold room for the provision of oxygen, nitrous oxide and vacuum suction. A battery of large oxygen and nitrous oxide gas cylinders is installed in this room. The piped supply is, however, restricted to the main operating theatres, emergency wards, and private wards, other areas being supplied by small portable cylinders that are refilled from the central manifold room. The medical gas manufacturing units are very limited and should be expanded because of the constant growth of health facilities. These units are generally maintained by the proprietary firms.

The laboratory fuel gas supply in hospital is generally provided by oil-type central gas plants.
Incineration. Solid waste disposal, particularly from operating theatres, labour rooms, etc., is a major source of infection. Only during the last 2-3 years have incinerators started to be installed in the major hospitals in India. Similarly, pathological and other contaminated wastes are being increasingly disposed of by incineration.

Drainage. There is an increasing tendency to provide surface drainage through underground corrosion-proof pipes. For economy, such hospital equipment as X-ray and radiotherapy apparatus, generating sets, etc., should therefore be on the ground floor. Every hospital should have an emergency system for pumping out flooded areas.

Check-list

The following guidelines may serve as a useful check-list.

1. The following preventive maintenance schedule has been found satisfactory in hospitals:

   Overhauling of plant                   - Yearly

   Painting of appliances and fittings   - (a) Biennially in the case of overhead tanks
                                                  and fittings.
                                                  (b) Half-yearly in the case of hospital and
                                                      hostels.
                                                  (c) Yearly in all other cases.

   Checking for leakage possibilities     - Yearly

2. Sloping loading and parking areas should be located away from buildings in case of drains becoming clogged.

3. Provide adequate roof drains.

4. Be sure guttering is of ample size.

5. Use a deflector hood or skirt for ventilator pipes or similar items piercing the roof, especially if the roof slopes steeply.

6. In gas plants, a compressor should maintain supplies of air in the specified percentage.

7. In gas plants, electrical motors, retorts, bonnets, oil syphons, etc. should be thoroughly cleaned.

8. Proper gas pressure should always be ensured. A constant watch should be kept on regulators, diaphragm rings, scales, nylon seats, etc., and those that are worn out should be replaced. Self-cleaning valves, oxygen line flowmeters, keyed plugs for hosebeams, etc. should be regularly checked against leakages.

9. In incinerators, the ash should be removed every day. In electrically operated incinerators, the contact-breaker point connexions should be regularly checked. In oil-fired incinerators, the oil cleaner in the furnace oil line should be cleaned two or three times before starting. Remove the burner rod, open and clean the nozzle with turpentine, kerosene, or compressed air, but never with a metal wire or cotton waste. Clean the photoresister and glass of the housing from both sides so that flame under full intensity is correctly observed. The draught stabilizer should always move freely. The silver contacts of relays should be cleaned with tetrachloride. The top refractory, nozzle spray, filter channel, etc., must be checked at least once a year.
10. In booster pumping stations, the cooling system should always be in order. The air cleaner, exhaust system, and fuel pump strainer should be cleaned after 250 working hours, and the return filter in the fuel delivery pipe every 1000 hours. After every 2000 working hours, rebore cylinders, examine crankshaft bearing and renew if needed, and wash out lubricating tank thoroughly.

11. Where corrosive vapours are present, use gutters and down-spouts of resistant materials.

**Air-conditioning and refrigeration**

City hospitals with 500-750 beds, or more, generally have central air-conditioning plants, but for limited use in such areas as operating theatres, labour rooms, emergency wards, intensive care wards, kidney units, neonatal units, private wards, etc. The general practice is to use reciprocating-type compressors. The plants work on a chilled water system and have automatic unloading arrangements, remote control of air-handling units, and remote temperature-sensing of various air-conditioned areas. They also have automatic humidity controls. Fresh water is used for humidification, in order to avoid waterborne infection, growth of fungi, etc., though these can still present a problem. The hospital areas mentioned above are air-conditioned on a 100% fresh-air basis and the air is not recirculated. Heating is by reverse cycling or directly by electricity, although the latter is preferred. However, owing to high capital and operating costs, including expenditure on electricity, central air-conditioning has low priority.

Smaller plants (7.5-15 tonnes) are provided for research laboratories, autopsy units, blood banks, etc. Refrigerators of various capacities from 140 l to 286 l are provided in wards. Deep freezers, at between -20°C and -70°C, are used for freezing chemicals, samples, and food. Walk-in cold storage areas are also provided in large hospital kitchens.

**Check-list**

The following preventive maintenance schedule for air-conditioning plants, cold rooms, deep freezes, etc. (Table 1) can be used as a check-list.1

The following schedule is suggested for the servicing and maintenance of cold-rooms.

A. **Daily**

- Check gas pressure
- Check temperature inside room
- Check voltage and amperage
- Check water level

B. **Monthly**

- Oil fan motors
- Check wiring
- Test for leaks

C. **Half-yearly**

- Grease compressor motors
- Replace compressor oil

1 It is, of course, left to each country to determine what periodicity they would recommend for this schedule (Editors' note).
<table>
<thead>
<tr>
<th></th>
<th>Compressor</th>
<th>Pump set, condenser, chiller</th>
<th>Spray pond</th>
<th>Fan/Blower</th>
<th>Condenser</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Check voltage, current, and three phases of the electricity supply</td>
<td>D</td>
<td>D</td>
<td>-</td>
<td>D</td>
<td>D</td>
<td>-</td>
</tr>
<tr>
<td>2. Check discharge and suction pressure</td>
<td>D</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3. Check temperature and humidity in conditioned space</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>D</td>
</tr>
<tr>
<td>4. Check oil level and pressure</td>
<td>D</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5. Check temperature and pressure of brine or chilled water</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>D</td>
</tr>
<tr>
<td>6. Check motor for overheating</td>
<td>D</td>
<td>D</td>
<td>-</td>
<td>D</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7. Check over-heating</td>
<td>D</td>
<td>D</td>
<td>-</td>
<td>D</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8. Check operation</td>
<td>-</td>
<td>D</td>
<td>-</td>
<td>-</td>
<td>D</td>
<td>-</td>
</tr>
<tr>
<td>9. Check water level</td>
<td>-</td>
<td>-</td>
<td>D</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10. Test pipe joints</td>
<td>W</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
</tr>
<tr>
<td>11. Check water distribution</td>
<td>-</td>
<td>-</td>
<td>W</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>12. Check belt tension and alignment for belt drive</td>
<td>W</td>
<td>-</td>
<td>W</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>13. Check pump glands</td>
<td>-</td>
<td>W</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>14. Check refrigerant liquid, line valve</td>
<td>W</td>
<td>-</td>
<td>W</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>15. Inspect and clean pump strainer</td>
<td>-</td>
<td>W</td>
<td>W</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>16. Check bearing lubrication, motor, and fan</td>
<td>W</td>
<td>W</td>
<td>-</td>
<td>W</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>17. Blow out motor dust</td>
<td>M</td>
<td>M</td>
<td>-</td>
<td>M</td>
<td>-</td>
<td>-</td>
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<tr>
<td>18. Check air-filter</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>W</td>
</tr>
<tr>
<td>19. Check and clean contact points in starter and controls</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>W</td>
</tr>
<tr>
<td>20. Check setting and operation of protective and emergency operating devices</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>M</td>
</tr>
<tr>
<td>21. Check and clean tubes and coil</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Y</td>
<td>-</td>
</tr>
<tr>
<td>22. Check heavy-duty starting equipment</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Y</td>
<td>-</td>
</tr>
<tr>
<td>23. Carry out winter pumpdown</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Y</td>
</tr>
</tbody>
</table>

\(^1\) D = daily. W = weekly. M = monthly. Y = yearly.
<table>
<thead>
<tr>
<th></th>
<th>Compressor</th>
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<th>Condenser</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>24. After winter shutdown, check freezing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>25. Replace or reactivate drier protection as required</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td>26. Clean and replace motor lubricants</td>
<td>Y</td>
<td>M</td>
<td>-</td>
<td>M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>27. Check alignment and tighten bolts</td>
<td>Y</td>
<td>Y</td>
<td>-</td>
<td>Y</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td>28. Check operation of control devices</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td>29. Check and clean air intake where necessary</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Y</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td>30. Check and replace valve stems as required</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>-</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td>31. Clean and overhaul motor starters</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>-</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td>32. Check motor rotation</td>
<td>-</td>
<td>Y</td>
<td>-</td>
<td>Y</td>
<td>-</td>
<td>Y</td>
</tr>
<tr>
<td>33. Check for leaks, test coil returns and bends, check for weak spots</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Y</td>
<td>-</td>
</tr>
<tr>
<td>34. Clean and paint</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>35. Clean standpipe and spray header</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>36. Check noise of motor/compressor</td>
<td>D</td>
<td>D</td>
<td>-</td>
<td>D</td>
<td>D</td>
<td>-</td>
</tr>
</tbody>
</table>

1 D = daily, M = monthly, Y = yearly, X = as needed.
D. Yearly
- Test efficiency of compressor
- Descale condenser
- Test temperature and gas-pressure controls
- Overhaul fan motors

E. When required
- Overhaul compressor
- Varnish compressor motor
- Repaint

The following schedule is suggested for the servicing and maintenance of deep-freezes, refrigerators, water-coolers, and air-conditioners.

A. Daily
- Check automatic working
- Check water level

B. Weekly
- Check voltage and amperage

C. Monthly
- Clean condenser
- Check wiring
- Check gas pressure in open units
- Test for leaks

D. When required
- Repaint
- Replace gas driers
- Rewire
- Replace electrical controls

**Electrical services and installations**

**Electricity supply and distribution**

Generally all urban and rural hospitals are supplied with electrical power by the urban power supply system at three or more alternative points through transformers. The internal distribution is through 4-wire, 400-V, 3-phase AC feeders. The ring-main system is a "must" for hospitals so that continuity of supply is doubly ensured.

**Standby generating sets**

All large hospitals should be provided with standby diesel-operated generating sets with capacities ranging from 250 kVA to 500 kVA. These sets feed operating theatres, labour rooms, autopsy rooms, blood banks, and vital points in research laboratories, automatically coming into operation within a few seconds of the stoppage of the electricity supply.
Lifts

Vertical transportation is generally via lifts when the number of floors is four or more. Functional lifts for patients, i.e., bed lifts, and for the public are provided separately.

Lifts are generally maintained and repaired by a specialist or the manufacturer on a contractual basis, though the experiment at PGI, Chandigarh, of training the hospital’s own maintenance crew for this task has proved quite economical. However, it has given rise to difficulties over spares, since manufacturers rarely offer any. Even when they do, the rates are exorbitant and the delays considerable.

When choosing lifts, due attention should be paid to their size, speed, and maintainability. A stoppage of lifts disturbs the entire transport system. For the maintenance of lifts, the local regulations and the instructions of the manufacturers should be strictly followed.

Laundry

Laundry equipment consists of washing machines, hydro-extractors, tumble-driers, drying chambers, steam presses, disinfectors, sluicing machines, boilers, dry-cleaning machines, etc. The mechanical/electrical design of such equipment does not fall within the scope of this paper. Similarly the architectural lay-out and planning of laundry buildings cannot be covered here. However, readers are strongly advised to make a thorough study of designs, layouts, and the materials used in various machines, before taking a final decision. The economic aspects cannot be ignored, and a thorough cost-benefit analysis is therefore essential. Mechanical laundries are already becoming a heavy liability for hospitals. The answer might be to set up regional laundries in the larger cities for groups of hospitals. Soap, bleaching-powder, detergents, etc. should be carefully selected to ensure quality of wash.

Checklist

Washing machines

A. Daily
   - Dust exterior
   - Oil gears
   - Check gear-oil in cam assembly system with dipstick
   - Check tightness of belts
   - Check motors by disengaging gears from the prime-mover shaft and then re-engaging them

B. Monthly
   - Change oil in cam assembly system
   - Grease bearings
   - Descale inner chambers

C. Yearly
   - Carry out complete overhaul and replace worn-out parts.
Hydro-extractors

A. Daily
   - Dust exteriors
   - Oil pulleys
   - Check tightness of belts
   - Check tumbler balance
   - Check cover lock
   - Check motors by disengagement and re-engagement of load
   - Check brakes

B. Monthly
   - Clean outlet pipe

C. Yearly
   - Carry out complete overhaul and replace worn-out parts.

Tumble driers

A. Daily
   - Dust exterior
   - Dust heating coils with electric blowers
   - Grease driving-chain and check tightness
   - Check oil in wormwheel box with dipstick
   - Start and check motor

B. Monthly
   - Change gear oil
   - Grease bearings and chain wheels
   - Check coupling rubbers and replace if necessary

C. Yearly
   - Carry out complete overhaul and replace worn-out parts.

Drying chambers

A. Daily
   - Dust exterior
   - Dust heating coils with electric blowers
   - Grease driving chain and check tightness
   - Check oil in wormwheel box with dipstick
   - Start and check blower fan and chain after closing chamber
     and checking air joints
   - Check clamps and rollers

B. Monthly
   - Change gear oil
   - Grease bearing and chain wheels
   - Check and replace packings

C. Yearly
   - Carry out complete overhaul and replace worn-out parts.
Steam presses

A. Daily
   - Dust exterior
   - Check rotation in twin presses
   - Check compression spring in single-bed type presses
   - Oil rotary parts and hinges
   - Check for steam leakage when steam supply starts

B. Monthly
   - Change piston oil in twin presses
   - Grease bearings

C. Yearly
   - Carry out complete overhaul and replace worn-out parts.

Disinfectors

A. Daily
   - Dust and clean both exterior and interior

B. Monthly
   - Check packings

C. Yearly
   - Carry out complete overhaul and replace worn-out parts.

Boilers

A. Daily
   - Dust and clean exterior
   - Oil pumps, etc.

B. Weekly
   - Check oil pump
   - Check water pump
   - Clean burner
   - Clean glass tubes of gauge
   - Check safety valves
   - Check pressure gauge
   - Check furnace lining

C. Quarterly
   - Descale shell

D. Yearly
   - Overhaul mountings and accessories and replace worn-out parts and lagging
   - Carry out hydraulic test and other formalities required for renewal of fitness certificates.
Electric motors

A. Daily
   - Dust
   - Check against overheating by manual touch

B. Monthly
   - Check and clean contact-breaker points of starters

C. Quarterly
   - Grease
   - Check the current taken by the motor against its rated capacity under full-load conditions.

D. Yearly
   - Check connexion at terminals, carry out complete overhaul and replace worn-out parts, e.g., bearings, etc.

Communication systems

Good communication in hospitals is essential not only for doctors, nurses, and allied staff, but also for maintenance staff. Hospital engineers, hospital technologists, and key technicians should be linked with one another and other service heads through an effective communication network.

A radiocommunication system must be established between members of the mobile maintenance crew, but should not be allowed to serve as a crutch for poor organization and ill-planned work assignments. However, changes in maintenance work assignments are often needed in an emergency. In this case, a good radiocommunication system can prevent many wasted man hours. It is not normally necessary to provide all maintenance personnel with radiocommunication facilities.

The two types of radiocommunication systems most frequently used in hospitals are:

(a) Two-way radios. These are mobile units that can be used with or without a base station or stations at a fixed location.

(b) Paging system. The basic unit is a compact radio receiver that buzzes when activated; it is generally worn on the employee's belt. When it buzzes, the employee goes to the nearest telephone or two-way radio and contacts the communications centre for a message or instructions. These units are suitable for persons who move about frequently in their work and may not be within hearing distance of a loudspeaker. A licence may be required to operate radio transmitters apart from low-powered walkie-talkies.

When deciding on radiocommunication equipment, it is important to seek the advice of an expert. Even a small system is relatively complex, and such items as number of units needed, wattage, range, and type and height of antenna for the base station should be considered carefully.

In intensive care units and similar areas, intercom systems are quite useful. It is possible to have one master station and 10-15 substations. This system can be refined to permit one master station to call up to six substations simultaneously.

Indian hospitals still use internal telephone exchange systems largely because there have been import restrictions on paging systems. Now, some international firms have introduced indigenously manufactured paging equipments, which are being increasingly installed.
**Workshops**

A committee under the chairmanship of Mr P. L. Varma (the father of hospital engineering in India) strongly favoured the view that every hospital with 500 or more beds should have its own workshop for the maintenance and repair of electromedical equipment. In fact, the workshops of teaching hospitals and district hospitals could have mobile units attached to them to cover suburban and rural hospitals.

The Varma Committee advised that hospital equipment should be classified as follows:

**Type 1:** Those whose failure affects the entire hospital, e.g., transformers and generators at substations.

**Type 2:** Items of daily use such as suction machines, catheterization apparatus etc.

**Type 3:** Sophisticated and ultrasophisticated equipment such as computers and X-ray and cobalt therapy plants.

To begin with, the workshop should cater for the maintenance of type 1 and type 2 equipment. For type 3, the work should continue to be done through specialist firms until a strong biomedical/electronics unit has been built up (perhaps even at regional level for the sake of economy).¹

**Choice of equipment**

1. Equipment should be functional, capable of doing the job, and versatile. It is a good idea to test equipment in the field, if its efficiency is in question.

   When possible, it is desirable to select equipment that can be used for more than one purpose.

2. Purchase equipment of proven quality - generally, industrial- or commercial-type equipment that has a long life when properly cared for is the best buy. When making this choice, experience with the equipment can be extremely helpful; maintenance records are invaluable in this respect. Those who will use the equipment being purchased can also be helpful. Unfortunately, the hospital engineers are generally not consulted by the doctors either at the time of purchase or on receipt of the equipment - a situation that creates obvious problems. Also the hospital engineers are not usually informed in advance about the infrastructure - electrical connections, flooring, air-conditioning, etc. - to be provided; as a result, equipment may await installation for months and years. Hence, total involvement of the hospital engineers from the time an order is placed until its commissioning is a sound policy.

3. The most functional and durable piece of maintenance equipment can be useless if parts and services are not available. It is important to ascertain whether the local distributor carries a complete range of parts for the equipment it is intended to purchase. Time spent waiting for parts to be shipped by the manufacturers can be extremely costly.

4. There are at least two important safety aspects to be considered: the safety of the operator using the equipment, and that of the persons who handle it.

5. The advantages of using standardized equipment generally outweigh the disadvantages. One advantage is being able to switch operators and technicians without additional training.

¹ The type of maintenance workers employed depends on the size of the hospital: for health centres and very small hospitals (fewer than 50 beds), a handyman; for hospitals up to 500 beds, qualified but polyvalent technicians; for hospitals with more than 500 beds, polyvalent technicians plus specialized technicians (Editors' note).
Repair jobs are simplified, and the department can stock frequently used parts without the need for an enormous range of spares. A final advantage is that, when a piece of equipment is worn out or damaged beyond repair, usable parts can still be salvaged for other equipment.

If it is decided to standardize most of the equipment, it is desirable to invite estimates for a large quantity of equipment at one time.

Another important consideration when selecting equipment is ease of maintenance and operation. Finally, the cost must be considered. It is important to think in terms of long-term rather than immediate cost.

Stores

A wealth of literature has been published on storekeeping and stock control methods, and it is not intended to cover the subject in any depth here. The following conditions should be met for good storekeeping:

1. Fast-moving spares and materials should be available, either from stock or from local suppliers at a comparable cost, 24 hours a day, 7 days a week.

2. Spares and materials within stores should be easy to locate and clearly identifiable, and there should be no ambiguity in their nomenclature.

3. Unavailability of fast- and moderately fast-moving items and the need for panic buying should occur only rarely.

4. There should be a "stores expense account" in which the costs of all materials are entered against the jobs for which they are intended at the time when they are finally needed, and not at the time of purchase.

5. Up-to-date and relevant spare-parts catalogues or lists, preferably illustrated or with specifications, should always be made available for all plant, machinery, and equipment that has to be maintained.

6. All worthless and obsolete items (including spares for machines no longer in service, even though they may not be obsolete) should be removed from stock, as should all used parts that have not been reconditioned and accepted back as serviceable replacements. Such items could be stored separately in a "plant store" until disposal instructions are available.

7. If the maintenance manager is not directly responsible for the administration of the maintenance stores, then he must at least have an overriding say in:
   - deciding what is stocked, including price and quality of items;
   - setting stock levels;
   - disposing of obsolete items and items rendered unserviceable through deterioration in storage.

However, since the maintenance manager is responsible for maintenance expenditure, and since materials frequently account for at least half this expenditure, steps should be taken to ensure that he has overall control of the maintenance stores system even if it is operated and administered by a stores division manager (a situation that is rare outside large hospitals).

8. The maintenance manager must decide as a matter of policy whether to keep supplementary stores with each section. In large hospitals, it is generally desirable to keep 15 days' supplementary stores.
9. Supervision of the maintenance stores should be considered a full-time occupation, even in small undertakings. The practice, so often encountered, whereby hospital technologists are virtually responsible for their own stock-ordering and stores administration, should be strongly opposed.

10. A reconditioning service should be set up for spare parts, where it can be shown that this is more economical than purchasing new items, or where it is difficult, impossible, or undesirable for security reasons to procure spares from outside suppliers.

Location and layout

A store of a suitable size to allow for future expansion, with proper heating, lighting, and ventilation, and a simple but reliable storage system, is essential if planned maintenance techniques are to be operated with the maximum efficiency. A system for the procurement of the correct parts, materials, and tools for carrying out maintenance work with the minimum of unnecessary delay is of paramount importance.

A substantial amount of hospital investment is likely to be tied up in providing suitable stores and, for this reason, maximum efficiency and security are called for in this area. Only storekeeping personnel and the engineering supervisor should be permitted to enter the stores at any time, and access outside normal working hours should only be possible by arrangement with the storekeeper on duty or the security personnel.

Where accommodation permits, all stores should be located in one building for the following reasons:

- to improve security,
- to simplify administration,
- to economize on manpower, yet ensure the essential requirement of having a storekeeper readily available at all times, especially at night and at weekends.

For efficient storekeeping, it is essential to be able to locate any item required, day or night, without wasting time in searching.

Plant spares are best located in groups according to the type of plant. This reduces duplication and simplifies location, especially if it is decided not to adopt a classification and coding system.

The use of storage racks, not more than 2.13 m high, subdivided into bins, pigeonholes, trays, or shelves for "tote-pans" has been found to be the most suitable way of storing most engineering materials. A numbering system for location of bins is essential and very simple to apply; it has the advantage over other methods that it can accommodate almost unlimited extensions to the stores.

As the stores expand, it may become necessary to employ a strip wall-chart, or similar index, indicating the location of all materials in the stores.

At least one item in every bin should be suitably labelled, so that no doubt should arise as to its correct identification. The labels should carry a description similar to that provided on the bin card.
Classification and coding

Most people have at some time encountered the jungle of letters and numbers used by manufacturers and suppliers to identify different items. A positive means of identification is necessary, but it is only in recent times that a logical approach to this problem has been applied by some industrial organizations. The problem becomes more acute as the size of the inventory grows.

One method adopted for identification is known as "classification and coding". This is similar in principle to the method employed for making a plant inventory, machines, equipment, etc. being segregated according to group and type and allocated suitable code numbers following a wholly digital system.

A similar method can be used for allotting a code number to every item purchased for maintenance use. The initial work involved may be somewhat tedious, but when it has been done there will be no problem in maintaining the system.

Documentation

Documentation should be kept as simple as possible commensurate with efficiency. Four basic documents are required:

1. Bin Card: As the name implies, this is a card kept in or near the bin to which it refers. It is used to record receipts, issues, and stock levels, and also bears a technical description of the item stocked.

2. Store requisition: This is the storekeeper's receipt for materials issued over the counter. It may be submitted without copies, or in duplicate or triplicate, depending on the system of storage adopted. No items whatsoever should be issued from the stores without this document.

3. Stores-receipt voucher. This will apply to:

   (a) goods received from suppliers in response to a purchase order;

   (b) goods returned from the maintenance department, usually as a result of over-requisitioning or some other change in requirement.

   All materials in the stores should be accounted for. On the receipt of goods, the storekeeper prepares a stores-receipt voucher, normally in duplicate, detailing the quantity and description of the goods received or returned. No items should be accepted in the stores without this document.

4. Stock control card. This is a card printed on both sides, with the stock record on the front and the order record on the reverse. It is kept in the stock control office. Materials of a fast-moving nature have to be restocked on a maximum/minimum stock-level basis. This is best done by the stock control office as the staff should be familiar with the materials being handled, whereas this is seldom true of staff in the accounts department. All too often, however, technical items are purchased by nontechnical staff, but it is the maintenance manager who will ultimately have to deal with any queries, so that he might as well do the buying in the first place. Every medium-sized and large hospital should employ a technically qualified buyer, who, it is often said, should be able to save the hospital more than ten times his salary by reducing expenditure on materials.
Purchase orders

Maximum and reorder levels for stock should be established by the stock controller, in close collaboration with the planned-maintenance controller, who will be following the repair policy laid down by the hospital engineer. The stock control office issues purchase orders in the following circumstances:

(a) Need to replenish stock items when reorder levels are reached.

(b) Need to replenish stores when no reorder level has been set. This can occur because experience with the item is not yet sufficient for a maximum/minimum level to be set. This situation also arises in the case of store requisitions that cannot be met. It should be noted that it is quite normal to have a maximum/minimum stock of one. As an item is taken out, another one is ordered; this is particularly appropriate if the turnover is small and unpredictable or the item is expensive. If stock is to be run down for any reason, all the relevant stock control documents should be clearly marked "do not reorder".

(c) Inability to meet store requisitions from stock items. This could arise as a result of short delivery (part order), delayed delivery, abnormally large demands on stock, or simply failure to reorder when the reorder level was reached. Such instances should be reported without delay to the planned-maintenance controller who will reconsider the advisability of altering maximum/minimum levels, depending on the circumstances.

(d) Receipt of request for spares or materials not previously stocked.

(e) Performance of service repairs to equipment by outside contractors.

Stores/materials for capital works at hospitals

Material requirements for capital works, non-capitalized projects, machine modifications, changes in production layouts, and other non-maintenance operations, should normally be planned for. The requirements should be estimated and the relevant orders made well in advance of the commencement of the work.

These activities are unlike pure maintenance work in that the requirements respecting materials tend to fluctuate, and if the materials are drawn from the stores at short notice without any kind of control being applied, two problems arise:

- It becomes virtually impossible to set sound maximum/minimum stock levels to meet the requirements of pure maintenance work alone.

- Items may frequently run out of stock, and this adversely affects the efficiency of planned maintenance.

To obviate this state of affairs, material ordered for project work, etc. should be kept quite separate from that required for maintenance, and, on receipt, it should be stored until required in an area specially set aside for the purpose. Only in isolated instances, i.e., major emergencies, should materials be drawn from the storage stock for this type of work.

To sum up, all goods received into and issued from the stores must be accounted for by the appropriate documents, if satisfactory, well-organized storekeeping procedures are to be achieved and maintained, and if these assets of the hospital are to be stored and used in a safe and economical way.
Cost of maintenance

In India, the cost of maintenance work is estimated in relation to the capital costs of buildings, plant, and equipment - though exceptions may be made for ancillary services and utilities. The Varma Committee realized that the standard rates are inadequate in the case of hospitals, since maintenance in hospitals differs considerably in type and level from maintenance in other buildings, and it accordingly recommended higher rates, wherever necessary, for various services. The existing and proposed rates are shown in Table 2.

Hospital/biomedical equipment

For the maintenance of biomedical equipment, no standard rates have so far been established at national level. The funds provided are always inadequate and, as a result, 25-40% of the equipment lies idle waiting for repairs for years on end. On the basis of eight years' experience at PGI, Chandigarh, the following rates have been worked out for various items of equipment and may serve as guidelines (Table 3). They were presented in a scientific paper by the author at the Fifth All-India Symposium on Biomedical Engineering, held at Kanpur, India, in July 1975, and were generally agreed to by the scientists/engineers present.

Conclusion

The experiment of reorganizing engineering services under the unified control of hospital engineers being conducted at PGI, Chandigarh, is possibly the first of its kind in a government hospital. Hitherto, the maintenance system in hospitals was hierarchical, coming partly under the Ministry of Works and partly under the medical superintendent. This practice is still practised in many hospitals in India and by other government hospitals in developing countries.

The new approach is paying dividends in economy, quality, and speed of maintenance. Efficient scientific maintenance management also saves on capital investment and overheads. It is to be hoped that it will gain ground, because of the particular need in developing countries to conserve, and make the most of, resources for the welfare of the ailing members of the community.
<table>
<thead>
<tr>
<th>Services provided</th>
<th>Standard rates (percentage of capital cost)</th>
<th>Proposed rates, where applicable (percentage of capital cost)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering works, for:</td>
<td></td>
<td></td>
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<tr>
<td>- hospital buildings, and research laboratories, including public health installations</td>
<td>1.95 (component for public health installations is 0.45%)</td>
<td>4</td>
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<tr>
<td>- other buildings such as hostels, residences, etc.</td>
<td>1.95</td>
<td>1.95</td>
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<tr>
<td>Electrical services, (including internal wiring, etc., for:)</td>
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<tr>
<td>- hospitals</td>
<td>5</td>
<td>7.5</td>
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<tr>
<td>- other buildings</td>
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<tr>
<td>Air-conditioning and refrigeration services:</td>
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<tr>
<td>- window-type AC units</td>
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<td>- packet-type units</td>
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<td></td>
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<tr>
<td>- central plants (reciprocating)</td>
<td>6</td>
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<tr>
<td>- desert coolers</td>
<td>22</td>
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<tr>
<td>- central plants (centrifugal)</td>
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<td>No increase</td>
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<tr>
<td>- refrigerators (sealed type)</td>
<td>13</td>
<td></td>
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<tr>
<td>- cold storage</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>- water coolers</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Maintenance and operation of lifts, laundry plant, gas supply, pumping station, generating sets, workshops, and other ancillary services and utilities</td>
<td>-</td>
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</tr>
<tr>
<td>Type of equipment</td>
<td>Annual repairs including labour and material (percentage of capital cost)</td>
<td>Special repairs including labour and material (percentage of capital cost)</td>
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<tr>
<td>Hot oven</td>
<td>8</td>
<td>5</td>
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<tr>
<td>Incubators</td>
<td>8</td>
<td>5</td>
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<tr>
<td>Water bath</td>
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<td>3</td>
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<tr>
<td>Centrifuge (small)</td>
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<td>3</td>
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<tr>
<td>Centrifuge (big)</td>
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<tr>
<td>Water-still (small)</td>
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<tr>
<td>Water-still (big)</td>
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<td>5</td>
</tr>
<tr>
<td>Shakers</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Vacuum pump and compressor</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Grinding machine</td>
<td>5</td>
<td>3</td>
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<tr>
<td>Compressor</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Respirator</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Cold centrifuge</td>
<td>5</td>
<td>25</td>
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<tr>
<td>Dental units</td>
<td>5</td>
<td>6</td>
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<td>Furnace</td>
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<td>5-HP motor with starter</td>
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<td>6</td>
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<td>Plastic cutter (electric)</td>
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</tr>
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<td>1-1/2-HP motor with starter</td>
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<td>Double stills (big)</td>
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<tr>
<td>Double stills (small)</td>
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<td>5</td>
</tr>
<tr>
<td>Single stills</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Storage tank</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Autoclave</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Suction machines (big and small)</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Sealed compressor motors for window air-conditioners</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>Sealed compressors for deep freezers</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>Sealed compressors for water coolers</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>Fan motors for air-conditioners</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>Freeze driers</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Diathermy apparatus</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Spectrophotometer</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Contamination monitor</td>
<td>10</td>
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<tr>
<td>Dialysis machine</td>
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<td>20</td>
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<td>Autoclave</td>
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<td>Vaporax boiler</td>
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<tr>
<td>Sterilizer, big</td>
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<tr>
<td>Ceiling lights</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Hot and cold sterilizer</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Baby incubator</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Microscope transformer</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Air-drier</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Electrophotostat</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Hair-drier</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>KMT spotlights</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Recording drum</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Defibrillators</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Type of equipment</td>
<td>Annual repairs including labour and material (percentage of capital cost)</td>
<td>Special repairs including labour and material (percentage of capital cost)</td>
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<tr>
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<tr>
<td>Emergency lights</td>
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<td>Emergency master unit</td>
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<td>Drop counter, electronic</td>
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</tr>
<tr>
<td>Ultracentrifuge</td>
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<td>3</td>
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<tr>
<td>Hot plate/stove heater</td>
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<tr>
<td>Hot-food cases</td>
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<td>Intercom sets</td>
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<td>Voltage stabilizer</td>
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<td>3</td>
</tr>
<tr>
<td>Radios</td>
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</tr>
<tr>
<td>Animal-cages</td>
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<td>Bottle-washing machine</td>
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<td>Trolleys (patient)</td>
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<td>5</td>
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<td>Trolleys (goods)</td>
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<tr>
<td>Beds</td>
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<td>15</td>
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<tr>
<td>Operation lights</td>
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</tr>
<tr>
<td>Operation tables</td>
<td>5</td>
<td>15</td>
</tr>
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<td>Laboratory tables</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Office tables</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Dining tables</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>X-ray units</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Radiotherapy unit</td>
<td>5</td>
<td>10</td>
</tr>
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<td>Portable X-ray unit</td>
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<td>Fundus camera and allied equipment</td>
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<td>Gamma chamber</td>
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<td>Physiotherapy apparatus</td>
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<td>Cardiacare monitoring</td>
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<td>High-speed centrifuge</td>
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<tr>
<td>Laboratory equipment</td>
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<td>Refrigerators</td>
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<td>Cold and hot rooms</td>
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<td>Cryostat (manual)</td>
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<td>Cryostat (automatic)</td>
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<td>Electroencephalograph</td>
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<td>Heart pumps</td>
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<td>Copying machine</td>
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<tr>
<td>Electrocardiograph machine</td>
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<tr>
<td>Calorimeters</td>
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<td>Tissue-processing equipment</td>
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<td>Microscopes</td>
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<td>Isotope counter</td>
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<td>Blood gas analysers</td>
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<td>Endogastroscopy apparatus</td>
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Annex

STRATEGY FOR SETTING UP A MAINTENANCE ORGANIZATION IN A DEVELOPING COUNTRY

Pierre Vogt

Anyone in charge of an industrial plant, knowing the amount of capital invested in it and the losses that would be incurred in the event of a breakdown, will take great care to ensure the efficient functioning and long life of the plant through proper maintenance.

With its various buildings, installations, and equipment, today's hospital may be compared to an industrial plant. In a hospital, however, a breakdown of equipment could cause not only financial loss but serious disruption of services and even the death of patients.

To judge by the alarming situation that prevails in many countries, public health authorities are not yet sufficiently conscious of their responsibilities in this field. More attention and more energy are necessary to avoid the point of no return being reached in the near future.

Drawing up a strategy

According to reports from developing countries, 20–30% of the entire equipment in their health care facilities is defective. The only way to improve this situation is to draw up a national strategy.

A rehabilitation programme will have to be prepared, whose time-table will depend on the country's administrative structure and financial possibilities, the existing network of facilities, the possible collaboration of international or bilateral institutions, local manpower resources, and the degree of public or private support.

This rehabilitation programme will proceed by stages as follows:

(a) establishment of a maintenance directorate within the central public health administration;

(b) performance of a survey;

(c) preparation of a plan of action;

(d) setting up of a pilot maintenance service;

(e) extension of the plan of action.

Development of the rehabilitation programme

Establishment of a directorate of hospital engineering

For the organization and execution of a rehabilitation programme, the first requirement is the establishment of a body competent in matters of hospital technology and maintenance. This body should form part of the central public health administration so that it can work in close collaboration with the various services concerned.

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1 Former WHO Adviser on Medical Equipment Maintenance.
The director of the department should have a degree in electrical or electromechanical engineering and should be assisted by technicians as the need arises. It will be his task to work out the rehabilitation programme, carry out the survey, and prepare a plan of action; he must also play an active part in setting up the pilot maintenance service. Later on he will supervise the extension of the plan of action.

Besides these activities, he will advise the public health authorities on subjects within his competence and will be in charge of maintenance matters.

The survey

The plan of action should be based on a thorough knowledge of the situation in the country as a whole. To this end, a survey involving all the authorities concerned will have to be conducted, in order to obtain as much information as possible on the prevailing situation as well as on any factors that may be helpful in the execution of the plan of action.

This survey will cover the following institutions:

- all public health facilities, in order to:
  (a) make an inventory of their equipment, stating its condition;
  (b) obtain information on the staff operating this equipment and on existing maintenance facilities;

- vocational training institutes, in order to obtain information on the subjects taught, the academic standard, employment prospects of students, and possibilities of collaboration in matters of training;

- international organizations (WHO, UNICEF, UNIDO, ILO), in order to obtain information on such of their programmes as may be of interest to the project and on the possibility of their assistance in the rehabilitation programme;

- commercial undertakings in the private sector, in order to find out whether they would be prepared to collaborate with the project and to obtain information on the facilities they offer for services and supplies;

- the central health administration, in order to obtain information on terms and conditions for the purchase of equipment and on the possibilities of obtaining its assistance within a framework of bilateral cooperation.

Preparing a plan of action

The above survey will permit an evaluation of the situation and the preparation of a plan of action. To be successful, this plan must take the country's administrative structure and financial capabilities into account and make use of all possible means of assistance and of existing facilities.

It will also be necessary to concentrate as much as possible on the maintenance of standard equipment and facilities. The maintenance of specialized equipment requires highly qualified technicians, whose recruitment presents a problem for all public administrations. Experience has shown that it is preferable to entrust this task to the private sector, in so far as it can provide a high quality of service. If the survey shows that this is not the case, the organization of this type of maintenance will be undertaken in parallel with that of the pilot service. During the first stage, a reference centre will be created and, with the experience gained there, other centres will later be developed, if this is warranted for geographical reasons.
Setting up a pilot maintenance service

Numerous experiences have shown that a dispersion of forces dooms any plan of action to failure. It is therefore preferable to concentrate on one facility, so as to ensure success in the short run, rather than try to give a little assistance to all facilities and lose impetus midway.

Experience gained in the pilot service will be useful for the future extension of the plan of action.

The pilot service will be developed in the following stages:

(a) selection of a medium-sized hospital (300-400 beds) having at its disposal the facilities needed for setting up the pilot service;

(b) recruitment and further training of qualified staff:
   - 1 engineer or high-level technician as head of the service
   - 2 electricians
   - 2 electro-mechanics
   - 2 mechanics
   - 2 plumbers
   - 2 joiners
   - 1 painter;

(c) fitting out of the following workshops and premises:
   - 1 workshop for electricians and electro-mechanics
   - 1 workshop for mechanics and plumbers
   - 1 workshop for joiners
   - 1 workshop for painting
   - 1 office
   - 1 store for spare parts
   - 1 store for working material
   - 1 room for technical archives;

(d) ordering of equipment for workshops and tools;

(e) ordering of working material and indispensable spare parts;

(f) streamlining of the service’s organization and administrative structure;

(g) establishment of a programme of periodical maintenance;

(h) creation of technical archives;

(i) progressive development of the service, starting with the reconditioning of faulty installations and the repair of broken-down equipment;

(j) implementation of the programme of periodical maintenance.
Gradual extension of the plan of action to the other health care facilities

The extension of the plan of action to other facilities should not take place until the pilot service is established on a firm basis. It should be carried out according to a list of priorities and should take local conditions into account.

The different stages will be the same as for the pilot service.

Staff for the new maintenance services can be trained in the pilot centre.