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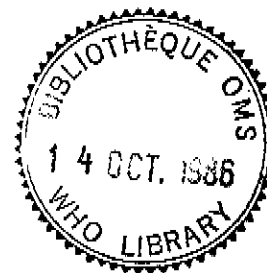
BACKGROUND DOCUMENT

for reference and use by
personnel dealing with

WHO Programme for Support to Countries in the Field
of Maintenance and Repair of Hospital and
Medical Equipment

by

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This document outlines:

- a. the present situation and problems concerning repair and maintenance facilities, strategies and available manpower;
 - b. requirements for the technical, administrative and managerial components necessary in establishing effective Health Care Technical Services in order to meet the demands of technology required by health systems based on primary health care.
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CONTENTS

1. Introduction
2. The Problem at Present
 - 2.1 General background: repair and maintenance in health care systems based on primary health care
 - 2.2 Current situation
 - 2.3 Identification of main system failures
 - 2.3.1 The place of repair and maintenance in the health technology cycle
3. Proposed Plan of Action and Objectives
 - 3.1 Short term strategy
 - 3.2 Medium term strategy
 - 3.3 Long term strategy
 - 3.4 Repair and maintenance for peripheral facilities
4. Conclusion
5. Acknowledgements

Annexes

- Annex I : Information Seminars on Repair and Maintenance Projects and Technical Manager Posts
- Annex II : Survey of the Actual Situation concerning Repair and Maintenance Activities
- Annex III : Training Centre Activities
- Annex IV : Generic Specification of Common Hospital and Medical Equipment: Need for a handbook
- Annex V : Establishing Collaborative Centres for Calibration, Testing, Research and Development Work
- Annex VI : Typical Organogramme of a Repair and Maintenance Workshop serving a District

Figures

- Figure 1 : National Infrastructure required for the Support of a Health Care System
- Figure 1a : Health Care Technical Services and Associated Services Responsibilities
- Figure 2 : Main System Inputs and Outputs of a Health Care Technical Service
- Figure 3 : Chart of Potential of Equipment Versus Time
- Figure 4 : The Place of Maintenance and Repair of Equipment in the Health Technology Cycle

Definition of Terms used

Life Time of Equipment: The expected operating life time of medical equipment

Down Time of Equipment: Time equipment remain inoperative

Health Care Technical Service: Service which deals with Repair and Maintenance of Hospital and Medical Equipment

1. Introduction

It is generally accepted that in order to provide efficient, effective, safe and affordable health care at all levels, it is essential to establish an efficient and professionally organized infrastructure of Health Care Technical Services.

The above situation has long been recognized by governments, international agencies and non-governmental organizations. However, in practice the problem has received very limited attention. As a result there is at present in most countries a lack of adequate repair and maintenance facilities, infrastructure, professionally trained staff and logistics support, resulting in the wastage of limited resources and/or in their ineffective use. This situation contributes to the lowering of the expected standards of health service being offered, particularly at primary level. Paradoxically the influx of high technology, particularly micro-electronics, is tending to worsen an already bad situation, because the new technology requires a different technical background and expertise, which must be obtained through specialist training.

It must be emphasized that any action aimed at rectifying the problem of repair and maintenance will have little chance of success if countries do not establish, as a pressing priority, committed policy and action in this field. As a counterpart to national policy, concurrent action and support at international agency level is essential in order to complement and reinforce national policy.

In the collaborative effort of achieving the goal of Health for All by the Year 2000, well-defined repair and maintenance policies and strategies have a very important role to play. Due to this fact it is imperative that a regional and global, well-organized and coordinated approach be undertaken in order to assist countries to establish efficient health care technical services, with adequate facilities, infrastructure and trained staff, having at their disposal the necessary high level governmental support and logistics backing, which are of paramount importance for their successful operation.

In order to commence the process of assistance to countries it is essential to identify the extent of the problem and set out a well-defined strategy for action on behalf of the interested parties involved, primarily international agencies and governments. The combined experiences of available expertise throughout the world must be involved in such an operation, particularly of those centres with previous experience, as is already available, for example, in the Eastern Mediterranean Region. Because of inter-regional as well as inter-country variations concerning repair and maintenance needs, policy and practice, any plan of action must be flexible so that it can be easily adapted to particular countries.

The final goal of such an effort would be to make countries self-reliant in logistics support, training and experience so that the tremendous wastage due to inoperative or inappropriate equipment is reduced to acceptable levels.

2. The Problem at Present

2.1 General Background: Repair and Maintenance in Health Care Systems based on Primary Health Care

Due to the unavailability of reliable and accurate data, cost estimates concerning the percentage of wasted resources due to the lack of proper repair and maintenance facilities vary; however even conservative estimates indicate an inadmissibly high waste of national health service expenditure. The usual factors contributing to the wastage of resources are:

- Purchase of sophisticated equipment, which is under-utilized or is never used, due to lack of operating staff, maintenance staff and medical expertise to support and use it (20%-40% of equipment).

- Limitation of the useful life time of equipment due to inexperience of operators and lack of R & M (reduced by 30%-80%).
- Additional purchase of accessories, extras, specialized spare parts and testing equipment and building modifications, initially unforeseen due to lack of expertise in choosing appropriate systems in the first place (10%-30% of value of equipment).
- Lack of standardization resulting in increased spare parts costs and extra work load on the limited competent staff (30%-50% extra spare parts costs).
- Excessive down time of equipment, i.e., time they remain inoperative, due to lack of spare parts and inexperience in repair and absence of preventive maintenance (25%-50% of equipment).
- Lack of liquidity in foreign exchange reserves which forces countries to accept unfavourable purchasing contracts (10%-30% extra purchasing costs of equipment and spares).

Figure 3 shows the different factors which are encountered during the lifetime of equipment. The effect of an ineffective repair and maintenance service shows the negative impact on these factors. The inadequacy of repair and maintenance facilities also contribute to lowering the quality of health services and even endangers patients' lives. This is particularly grave in rural hospitals and primary health care centres. It is obvious that any efforts aimed at improving the situation will not only save resources but increase the safety and quality of the health care offered.

2.2 Current situation

Some countries with the encouragement and support of the WHO regional offices, have taken steps in securing specialized training for maintenance personnel and creating the beginnings of a health care technical service infrastructure by establishing pilot hospital workshops in main hospitals or centralized workshops in large cities, which may also cater for satellite health care clinics.

In general, however, the problem is mainly the lack of any organized maintenance service, with adequately trained staff, tools and spare parts, coupled with poor career prospects and job security. Even in countries where the rudiments of such a service exist, the personnel usually lack high level policy, managerial and technical support and interest, resulting in loss of good staff to private enterprise, inefficient use of manpower and materials and general wastage of resources.

2.3 Health care system failures and their effect on repair and maintenance

In a collaborative effort such as this it is necessary to identify first the major common needs of countries and secondly to set out clear and realisable objectives towards which any future efforts must be aimed. In setting out the main health care system needs and failures it must be realized that regional variations exist, which should be taken into consideration at national/regional level.

2.3.1 The place of repair and maintenance in the health technology cycle

Health needs and their associated back-up services and planning do not operate in isolation to the remainder of the national system but on the contrary they form part of a closely interacting network of systems. Due to this complicated and interrelated complex of systems it is essential to clearly identify the role and place in the cycle of events of technology in health care. In this cycle, external factors such as financing, communication, logistics support, availability, level and usage of national educational establishments, mechanisms for determining wage structures and parities are important influencing factors for the efficient operation and impact of a health care technical service.

Even within the health ministry set-up, repair and maintenance cannot be considered in isolation but as part of a larger health technology cycle which encompasses many other interacting factors as shown in Figure 4. The health needs are the main deciding factor and final objective of the cycle since they set the level and objectives of the inputs of all the other contributing parameters whose aim is to satisfy the health needs. Some of the main factors of the cycle are the programming and planning, manpower, equipment and supplies needs, financing, equipment selection, logistics support and the health care technical service.

In such a cycle a series of events occur for which at every stage decisions and commitments must be made at the correct time in the cycle, for the remainder of the cycle to function correctly. Identification, planning and programming of needs is an essential starting point, followed by corresponding financial, manpower and facilities planning and commitments. Selection and procurement of equipment in which all interested parties participate with collective action and consideration of needs and requirements is essential if all aspects are to be catered for. The practical implementation of policy actions is the responsibility of services such as the medical stores and health care technical service, which must have the infrastructure, manpower, expertise and policy backing so that they can produce the desired results. The cycle is completed with the use of equipment by operating staff. This is usually the last stage of events, where problems and their corresponding effects, concerning staff training for operating and servicing equipment appear (see Figure 3). However, this stage is the end of the cycle, and the events influencing this stage must have already taken place.

The following are the commonest identifiable system failures at:

- a. Failures at policy and management level due to:
 - Lack of clear, dedicated government policy towards understanding or managing the situation concerning health care technical services.
 - Inadequate allocation of funds committed to salaries and procurement of the right type of equipment or spare parts.
 - Unavailability of technical management staff at key middle-management positions to advise on planning, programming and policy both for higher level management and political authority, as well as towards technical specialist staff.
 - Inadequate provisions for an effective, structured health care technical service with career prospects, status, security and the right working conditions.
 - Failure due to administrative complications and lack of efficient inter-ministerial liaison and procedures, contributing towards the slow, insecure and inefficient customs clearances and supply deliveries to hospitals and health centres.
 - The lack, in medical stores, of adequately trained staff, inventories, records, space and (where necessary) climatization. Mishandling of equipment and spares results in delaying even more the delivery of goods.
 - The deficient quality and quantity of the transport (both vehicles and roads) is another factor which considerably adds to delays in delivery, damage and losses.
 - The absence of contingency plans for emergency situations such as natural disasters, political unrest and economic difficulties adds to an already frail situation.
 - Acceptance of inappropriate donor equipment whose priorities and choice are determined on the basis of the needs and politico-economic interests of the donor country.
 - Financial, planning, budgeting and other restrictions which lie at the root of the inability to secure in time the foreign currency required for the purchase of spare parts.

- Inappropriate selection and procurement policies due to inexperience of staff, and lack of interdepartmental liaison and policy.
- Inadequate health facilities planning and buildings which adds to the problems of the repair and maintenance service.
- b. Failures at technical level, due to:
 - Unorganized or badly structured service without clear career prospects with low salaries, bad working conditions and inadequacy or complete lack of tools and service instruments.
 - Unavailability of professionally qualified staff able to plan, organize, supervise and train other staff.
 - Lack of liaison between medical, managerial and technical staff.
 - Isolated decision-making policy, divorced from knowledge of the real situation, for instance, with regard to the capability of operating (para-medical) staff and of the technical staff.
 - Purchases based on the preferences of individuals or on an ad hoc rather than a planned approach, resulting in acquisition of technologically complicated equipment, totally alien to the priority medical needs of the country and beyond the efficient and full operational capabilities of staff.
 - Lack of training both for operating and technical staff. Where training is made available inability to adapt the curriculae and methods to the needs of the country and the capabilities of the candidates.
 - Failure to secure training of national staff by the manufacturer as part of the purchasing contracts, before the delivery of equipment.
 - When feasible and advantageous, little or no use is made of servicing contracts (maintenance and repair) with manufacturers or their agents, agreed to as part of the purchasing contract.
 - Insufficient skills and experience of technical staff resulting in erroneous decisions concerning location of equipment, installation, electrical and other supply needs.
 - Lack of standardization of equipment resulting in added strain on technical expertise of staff and spare parts availability.
 - Ad hoc spare parts policy or none at all resulting in delays in repair of equipment, wastage of resources.
 - Lack of a sufficiently complete library of operating and service manuals of manufacturer's recommended spare parts lists and of installation instructions where necessary. Even in cases where these exist, lack of adequate copies for the appropriate staff.
 - Lack of knowledge of good technical English, French or other required languages results in the inability to use manuals where they exist. It is also an obstacle to following courses in foreign countries.
 - Inadequate or non-existent inventories of equipment and plants resulting in inefficient management of equipment and inability to plan for renewals, spare parts purchases, calibration and testing instruments and routine maintenance procedures.

- The quick changing trends in technology, particularly micro-electronics, has resulted in the need for different technical skills and backgrounds, requiring the retraining of experienced staff and upgrading of selection for new staff. This does not take place.
- Inability or unwillingness to use already available national educational establishments for even the basic technical, knowledge needs of the staff.
- Quality assurance through calibration and testing, which is vital for safe and efficient use of equipment, is not feasible under the present circumstances.
- Research and development work on fields related to the needs of the country seems a very remote possibility for the vast majority of countries.

From the list of system failures at all levels given above, it is clear that a high degree of intersectoral collaboration is essential, not only between the different departments of the ministry of health but with other key ministries also. Figure 1 gives the necessary national infrastructure required in order to have an efficiently operating health care service. It is therefore important to identify the various links with different sectors such as Customs, Finance and Planning, Transport, Post and Telecommunications. The situation, which would be invariably unique to each country must be examined in order to suggest methods of smoother, more efficient collaboration. Inter-agency collaboration may prove useful in assisting in this respect, typically with ILO, UNESCO, ITU, World Bank, UNDP, UNIDO and TCDC.

3. Proposed Plan of Action and Objectives

In attempting to programme a plan of action on a global basis in order to improve the situation concerning repair and maintenance a step by step approach is vital since the factors which constitute the problem are complicated, interacting and varied. In tackling the problem it will also be necessary to adopt short, medium and perhaps long-term strategies with clear objectives for each stage. The four main problem areas identifiable from section 2.3 concerning repair and maintenance are the lack of:

- i. committed government policy, practice and support;
- ii. adequate funds for the running of a health care technical service, particularly foreign exchange for the purchase of equipment and spare parts.
- iii. Adequate numbers of experienced and technically competent staff at middle management (technical managers) and at engineer and technician level to formulate and execute technical policy, determine selection and procurement, liaise between interested parties and execute the daily engineering work.
- iv. Specialized training facilities at national and regional level in order to train staff on technical management, medical equipment and logistics support.

No programme adopted will have any chance of success if interested governments, and particularly policy makers, are not made aware of the problem and convinced to full-heartedly adopt it as a pressing priority. Hence a vital starting point of such a campaign must be with the policy makers.

The following plan of action is proposed, given as far as it is possible in order of priority. The objectives for which it is intended are:

- Initiate and encourage the commitment by all parties of policy on repair and maintenance and to adopt it as a pressing priority.
- Investigate the different problems concerning the situation of repair and maintenance at country, regional and global levels.

- Identify training needs and suitable staff for appropriate specialist training at existing training centres.
- Assess available training programmes and to suggest appropriate modifications or additions.

3.1 Short-term strategy

Suggested Plan of Action

- Use of various forums where high level policy makers meet (such as the World Health Assembly and regional committees), in order to present the problem and try to adopt it as national policy by means of:
 - Global and regional situation analyses and guidelines concerning the facts on repair and maintenance.
 - Holding information seminars and conferences at regional and global level for top and middle-managers to encourage the implementation of government policy (Annex I for details).
 - Situation analysis by the regional offices (with WHO staff or STCs) in order to determine the quality and level of the available infrastructure and hence advise on relevant actions accordingly (see Annex II for details).
 - Promoting the already available training establishments for use by all countries in order to begin the process of training staff in technical management, medical equipment and logistics support (see Annex III for details).
 - Supporting the collaboration and exchange of experiences between the various training centres.
 - Encouraging the adoption of "appreciation of equipment" as a topic in the courses given to para-medical staff.
 - Writing simple-to-use handbooks on basic, routine repair and maintenance of standard equipment for use by operators at peripheral level.
 - Adoption by WHO of repair and maintenance as a global priority and the assignment at HQ and regional offices of corresponding focal points to coordinate and support policy programmes.

3.2 Medium-term strategy

Assuming that governments quickly adopt and become committed to the principle of establishing a repair and maintenance system, it will require the collection of data from the initial studies and visits to enable WHO to assist them in establishing, adopting and implementing the relevant policies. The time schedule for this will also vary from country to country depending on their infrastructure and ability to formulate and implement policy. Also due to the different levels and standards in each country (or groups of them) the action to be taken and starting point for each will necessarily have to be different.

Some countries, particularly in the Eastern Mediterranean Region, have already adopted the need for action in the field of R & M and have established hospital workshops in their main hospitals, which also serve satellite health centres. This is particularly the case for Cyprus, South Yemen and Sudan. The situation concerning R & M in the countries of the Eastern Mediterranean Region, who have taken advantage of the training offered and implemented policies on hospital workshops, and provided for their tools and equipment, the situation has shown a noticeable improvement.

The following medium-term plan of action is given below, since it contains suggestions which are relevant to the majority of countries whose corresponding objectives are to:

- Commit funds and practical action in establishing the nuclei for: technical (technology) management, health care technical services and the mechanisms of selection and procurement of equipment and spare parts.
- Improve the contribution and back-up of the medical stores which is necessary for the efficient operation of a health care technical service.
- Strengthen the already available structures, particularly of: specification of equipment, service infrastructure, inventory, security of equipment and spare parts, training and technical management.

Suggested Plan of Action

- To establish, where they do not exist, bilateral agreements between WHO and governments on repair and maintenance. Such agreements to include provisions for:
 - training of staff
 - tools and test equipment
 - establishment of pilot workshop(s), in suitable main district hospitals (see Annex VI for details).
- To ascertain priority needs in spare parts and set up mechanisms for their procurement.
- To identify suitable posts for technical management.
- As part of a sister project or through the above to identify the needs and problems of the medical stores and logistics supply and particularly:
 - Planning and programming
 - Inventory control
 - Budgeting
 - Customs clearances
 - Storage requirements
 - Transport needs
 - Training needs
- To use technical colleges or universities as translation services for technical manuals, their printing and distribution.
- In the case of the Arab world or Latin America where a common language prevails, these may take the form of regional translation centres.
- Evaluation surveys of countries in order to ascertain the progress made in implementing the provisions of the agreements. To take corrective action where necessary and stimulate impetus in areas which require assistance. To carry out complementary surveys of the situation as appropriate. To provide incentives for countries which have successfully completed the provisions agreed to in the agreements.
- To draw from related experiences of EPI, RAD and other specialist WHO units in drafting a handbook of generic specifications for the most common medical and hospital equipment (see Annex IV for details). This could be undertaken by one or more collaborative centres dealing with R & M.
- Follow-up agreements will be aimed at consolidating the existing situation and where appropriate to proceed to the next level of assistance.
- Typical areas of needs that may be identified are:
 - i. Establish national inventory system.
 - ii. Establishing specialist committees for the selection and procurement of equipment and spare parts.

- iii. Establishing planning, staffing and budgeting committees to identify needs, carry out planning and programming and coordinate action for the needs (medical stores).
- To establish training courses leading to appropriate professional qualifications for technical managers and hospital engineers and technicians (hospital and medical equipment engineers and technicians).
 - To hold follow-up exchange of information meetings and seminars at regional and global level.
 - To evaluate the different forms of training being offered, exchange experiences between the various training centres and formulate training policy for future needs.

3.3 Long-term strategy

Implementation of the long-term part of the programme will depend on the successful establishment of the basic infrastructure, conditions and adequately trained, qualified personnel. The time of applying this part of the programme will greatly vary from region/region and country/country. At present only a few countries may be considered for this type of collaboration whose objectives are to:

- Ensure the safe, controlled and monitored use of medical equipment.
- Enhance in developing countries research and development work on appropriate technology thus contributing to the promotion of employment and savings of foreign exchange.

Suggested Plan of Action

- Establishing national legislation concerning the safety, calibration and testing of equipment (see Annex V for details).
- Establishing calibration and testing laboratories in order to enforce the provisions foreseen by the legislation (Annex V).
- Establishing collaborative centres to carry out development work for manufacturing appropriate technology equipment on a national or regional basis, probably in collaboration with other agencies such as UNIDO, UNICEF, UNDP, WHO and TCDC (see Annex V).

3.4 Repair and maintenance of peripheral facilities

As can be seen from Annex VI, peripheral facilities need to be supported with technical input, according to their size and needs, by their corresponding district workshop. Present experience, however, indicates that for various reasons such back-up support from the district in many cases is unreliable or not available. Under these circumstances the peripheral units suffer from a lack of maintenance input. A solution to the problem may be to train medical and para-medical staff in these units to carry out simple repair and maintenance of standard equipment (such as: sterilizers, microscopes, stethoscopes, sphygmomanometers, etc.). Such training may be achieved by:

- inclusion in para-medical staff training programmes of the "appreciation of technical equipment" as a subject in their curriculum.
- setting-up a technical committee to prepare instruction handbooks for the trainers and "service" manuals of the units for the staff.

The above action is intended as a stop-gap measure having as its objective:

- To train staff to carry out basic maintenance and repair in peripheral units, thus providing them with basic technical support.

4. Conclusions

The plan of action given in section 3 is intended to form the basic guidelines for action by WHO on a global basis. Due to the vast variations from region/region and even country/country it is inevitable that there will be different starting points for various groups of countries.

However, given the situation globally, the vast majority of countries will fall under the short and medium-term strategy.

For any action to be successful, particularly on a global basis, would require two factors:

- i. WHO commitment at HQ level to the programme.
- ii. Government policy commitment in practice.

The first requirement could best be achieved if at HQ and regional offices focal reference sources are assigned which can coordinate and support policy and action programmes. Their main function would be to coordinate the different specialist groups within WHO, call upon other groups with parallel past experience, who will be useful in overcoming many common problems that will arise. Plan collective action with other regions and governments, organize seminars, set-up expert committees, etc.

The second requirement is for governments to practically commit policy and funds towards R & M. To make the necessary adjustments so as to assign suitable staff and facilities for the technical health care service and modify impediments in their administrative set-up in order that the collaboration would have maximum benefit.

In this context a second document addressed to high-level policy-makers will be prepared emphasizing the major advantages and benefits of a structured, organized R & M policy.

In order to have a regular review on developments concerning the progress of repair and maintenance policies and actions around the globe, an advisory group on repair and maintenance activities may be formed. Such a group may be used to set up specialist sub-committees, identify areas of particular attention, suggest work for collaborative centres or for short-term consultants that may be needed, carry out coordination with other aspects of technology. Members for such a group should be drawn from HQ, the regions and suitable STCs.

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ANNEX I

Information Seminars on R & M Projects and Technical Manager Posts

Policy makers and other high level managers in ministries of health should participate in these seminars in which the following would be covered:

Explaining the advantages of bilateral projects between WHO and governments on repair and maintenance in order to promote the setting up of repair and maintenance infrastructure and save resources.

Particular emphasis should be given to the following areas:

- Need for R & M and ultimate savings
- Training fellowships for suitable staff
- Setting-up of pilot workshops
- Equipping workshops with tools and test equipment

However in order to implement such a project governments should assist in the completion of the questionnaire given in Annex II.

Follow-up agreements will ensure the strengthening of the R & M effort and special assistance will be offered to countries who manage to fulfil satisfactorily the provisions of the original project agreement.

The main role of technical managers post at ministries of health are to:

- i. Liaise between health care technical service and high-level ministry management.
- ii. Coordinate national or district action in selection and procurement, training, logistics, etc., and act as focal reference point for the various agencies involved (i.e., engineering, medical stores, building services).
- iii. Estimate and submit budgets for approval.
- iv. Formulate policy for planning, training, spare parts and logistics support.
- v. Determine medium and long-term needs and programming, etc.

Suitable courses may be run at selected collaborative centres for engineers requiring management experience or for managers requiring technical background. The former may be a more suitable candidate.

The level of the post should be that of a middle management grade, i.e., equivalent to assistant director of services.

ANNEX II

Survey of the Actual Situation concerning
Repair and Maintenance Activities

Before proceeding with the allocation of funds for pilot workshops, training and equipment, it would be necessary, in cases where this has not been done, to carry out the above survey. This may be done through visits by regional officers, STCs or WHO/HQ staff or by questionnaire to governments.

The aim of the survey will be to determine:

- i. Existence of any policy regarding repair and maintenance.
- ii. Allocation of funds, for R & M, spare parts, training and facilities.
- iii. Existence and structure of a health care technical service.
- iv. Staff situation, including salary, numbers, training, expertise, experience and working conditions.
- v. Available facilities, tools, test equipment, inventory, spare parts and technical manuals.
- vi. Routine maintenance procedures and necessary administrative infrastructure.
- vii. Availability of local educational institutions and their capability for use as training centres, particularly for general training initially.
- viii. Inputs by other UN agencies and non-governmental organizations.
- ix. Situation concerning medical stores, including level of staff experience and training, adequacy of staff and facilities, planning and service being offered, inventory and general logistics support.
- x. Capacity, specializations, plants, and main equipment of main hospitals.
- xi. Numbers and types of rural and primary health care centres.
- xii. Quality, support and expertise of local market and manufacturers' agents.
- xiii. Suitable locations for the setting-up of pilot workshops.
- xiv. Suitable candidates for training as technical managers and technicians or engineers.

A suggested questionnaire is available from WHO/HQ which can be completed on visits to countries. The aim is to use a common questionnaire for all countries so that data may be easily compared.

A synopsis of the above, in simplified form, should be sent to governments with a short covering letter, which should include the following questionnaire to be completed:

Questionnaire to be completed by governments or
regional committee task force

1. Is there a health care technical service dealing with repair and maintenance of medical and hospital equipment available.

NO: _____ YES: _____

If YES, please give following details:

- Under whom does it operate?
- How many staff employed?
 - Engineers:
 - Technicians:
 - Craftsmen:
 - Others:

2. Annual budget allocated to:

Repair and maintenance:
Spare parts:
Purchases of equipment:

3. Type of training, if any, received by staff of health care technical service. Please specify:

Type:
Duration:
Place:
Speciality:

4. List number of workshops available in your country in order to carry out repair and maintenance. Please specify:

In capital city:
In district capitals:
In rural areas:
Other:

5. Is there an inventory of equipment?

NO: _____ YES: _____

If YES, could you please specify number of:

- X-Ray equipment:
- ECG and intensive care:
- Operating theatre:
- Dental units:
- Hospital laboratory equipment:
- Other:

6. Specify type of maintenance and repair approach:

- Routine maintenance (give examples if possible):
- Emergency repair only:

ANNEX III

Training Centre Activities

1. At present training centres operating on a regional or national basis exist in:

- Cyprus)
- Iraq)
- Syria) EMRO
- Bahrain)
- Egypt)
- Pakistan)

- Sierra Leone AFRO
- India SEARO
- Manila WPRO
- Lyon EURO
- Several countries in AMRO

The centre with the longest and continuous record of work is Cyprus and its courses may be taken as a common ground for others to use, without excluding any courses from other centres. In fact a meeting of the heads of the different centres is necessary if experiences are to be exchanged, duplication and mistakes avoided and a coordinated training effort established.

It is, however, based on the Cyprus experience that emphasis is placed on training in the following areas:

- General (polyvalent) technicians (10 months): First line technician carrying out supervised routine and simple repair and maintenance work.
- Specialised technician courses (5 months) in:
 - Diagnostic X-Ray
 - Dental equipment
 - Operating Theatre Equipment
 - Electro-medical equipment
 - Standard hospital laboratory equipment

The above training is for higher level technicians able to carry out unsupervised routine work and under professional supervision technically more complicated work.

As national expertise develops and higher level candidates become available, higher level courses in medical electronics and at professional level, hospital engineer courses, may be organized.

2. The hospital engineer courses would aim to produce graduates who will be able to:

- Lead a large hospital workshop and carry out its administrative and technical supervision
- Train lower level technicians
- Keep inventory and spare parts records needed by the workshop
- Liaise with medical and non-medical staff
- Estimate budget needs, facilities, tools and test equipment requirements for the workshop
- Participate in select committees on general planning, tendering, selection and procurement of equipment
- Report and advise the director of the hospital technical service, etc.

Status: Diploma graduate at assistant engineer or engineer level

Post: Low managerial

3. Logistics support courses (mainly dealing with the function of medical stores) have mainly been dealt on a national basis (SHS/85.6 Report on Logistics Support to PHC including Communications and Transport). Countries which have had good experiences in this field or other centres may be used to run courses on logistics support, which should include the following (from SHS/85.6 report):

- Planning and budgeting
- Procurement
- Receipt and inspection
- Storage and warehousing
- Inventory control
- Requisition and distribution
- Transport
- Medical stores infrastructure
- Communications
- Environmental management of health facilities
- Records and reporting-inventory
- Training and supervision
- Research and Evaluation
- Role of computer systems

The course will be aimed at medical stores managers and lower-management personnel.

4. The medical electronics course is aimed at higher level technicians (and its objective is to introduce students to the new micro-electronics technology which is now available in almost all equipment. Paradoxically, although this technology has meant simpler operating procedures it is technically more complicated or at least different from orthodox electronics technology, requiring special skills and background.

ANNEX IV

Generic Specifications of Common Hospital and Medical Equipment:
Need for a handbook

The aim of such a handbook would be to make available general specifications of common hospital and medical equipment to national selection and procurement committees so that suppliers will be forced to compete and hence lower prices. Such a handbook predetermines that national staff have the necessary expertise to oversee such procurement. This approach has been used by DAP with very good results.

The form of the handbook may be based on the experiences of WHO groups such as EPI, RAD, DAP, etc. (Ref. EPI: The Cold Chain Product Information Sheets, Annotated Cold Chain Bibliography, ref. RAD TR723).

Committees may be formed comprising of engineers, doctors and para-medical (operating) staff of the equipment in order to set out the objectives for each specification. The work of RAD on the BRS X-Ray unit and imaging equipment may be very relevant and form a basis for use.

Typical equipment that needs to be considered are:

Operating theatre lamps
Operating theatre trolleys
Operating theatre standby batteries
Surgical diathermy
Sterilizers
Suction pumps
Medical gases
Ventilators
Dialysis machines
Infant incubators
ECGs
Monitoring equipment
Short wave diathermy
Defibrillators
Dental chair units
Amalgam stirrers
Dental X-Ray film processors
X-Ray film processors
X-Ray equipment (where not already covered)
ph-meters
Spectrophotometers
Centrifuges
Hot air ovens
Balances
Microscopes
Flame photometers
Water softeners
Water distillers

Hospital plants such as:

Standby diesel generators
Ventilation units
Boiler units
Public address system/internal telephone system
Incinerators

Morgue equipment
Standard hospital workshop tools and equipment
etc.

Where necessary calibration and testing accessories must be included either as a separate item or as part of the equipment requirements. Such cases are:

ECG simulators
X-Ray phantoms
Densitometers
Thermometers
Spectrophotometer wavelength calibration filters
pH-meter standard, buffer electrodes
etc.

ANNEX V

Establishing Collaborative Centres for Calibration and Testing
and Research and Development Work

As expertise builds up, a few countries may be at this stage already, it would be necessary in order to cover all aspects of R & M to consider legislation, calibration and testing for medical equipment, which would directly contribute towards patient safety. This is achieved because operators and technicians will be aware that standards, backed-up by legislation, are available and may be enforced with consequences in case of an accident or inspection.

Also as experience develops in a country or group of them they may undertake R & D work related directly to the needs of developing countries. This may take the form of making simple prototypes for testing equipment, applying existing or new technology to available equipment, look into aspects of safety and quality assurance, etc. Also lesser developed countries, who have suitable candidates may use these centres and hence develop the nucleus of expertise which they would eventually require.

Such activity may be undertaken through a collaborative effort with other agencies such as UNIDO, UNICEF, UNDP, etc.

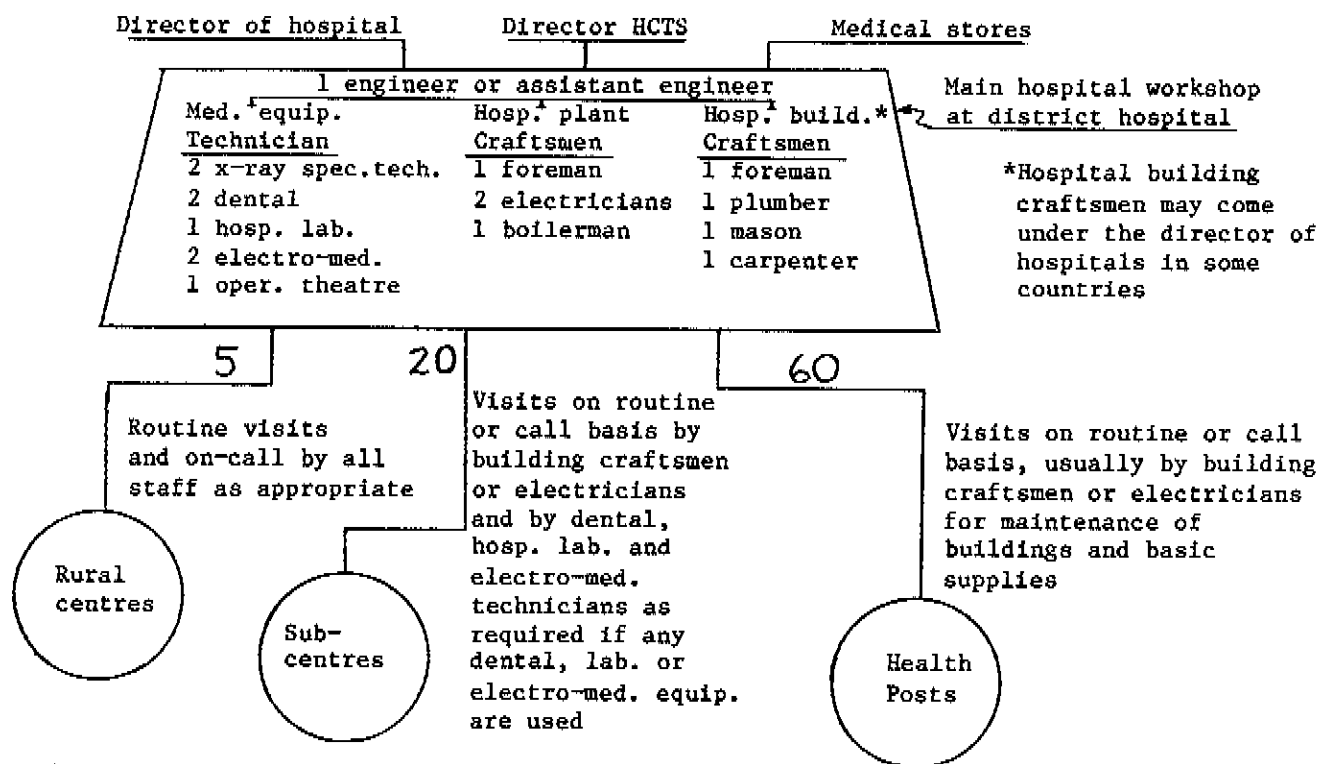
ANNEX VI

Typical Organogramme of a R & M Workshop serving a District

The proposed workshop assumes that it receives specialist support from a central workshop and that medical stores, policy and other required backing exists.

The typical district consists of:

Population: 100-150,000
 General hospital: 200 beds
 Rural health centres: 5 (with some beds)
 Sub-centres: (dispensaries): 20
 health posts: 60



1. Tools

Outlined below are the main categories of tools and test equipment for such a workshop. Details for each category may be obtained from EMRO or the regional training centre, Cyprus.

Basic tools:

General sets of screw drivers, pliers, cutters, round nose pliers both for heavy duty and electronic work.

Selection of hammers, steel and rubber, sets of metric and imperial spanners, including pocket size. Adjustable spanners and wrenches. Taps and dies - metric and imperial. Steel saws, small hacksaws, files (large and pocket). Sets of Allen keys - metric and imperial.

ii. Test equipment

General purpose multimeters, basic oscilloscope, soldering irons - general purpose, PCB work and heavy duty - solder suckers, general purpose, stabilised, protected workshop DC power supplies 0-40V DC, general purpose signal generator. Grinder, vices, small worktop lathe (optional). Portable toolkits for fieldwork, inspection lamps, hand drills, permanent drill and stand, landrover type vehicle with typical spares. Welding machine, portable welding stand complete, pipe bending and fitting machine, large drill.

iii. Spare parts

(Preferred values) Full set, at different power ratings, of resistors, and capacitors. General purpose transistors and integrated circuits with catalogues of equivalent components. General set of multi-purpose screws, bolts and washers. Common rubber O-rings.

Workshop facilities

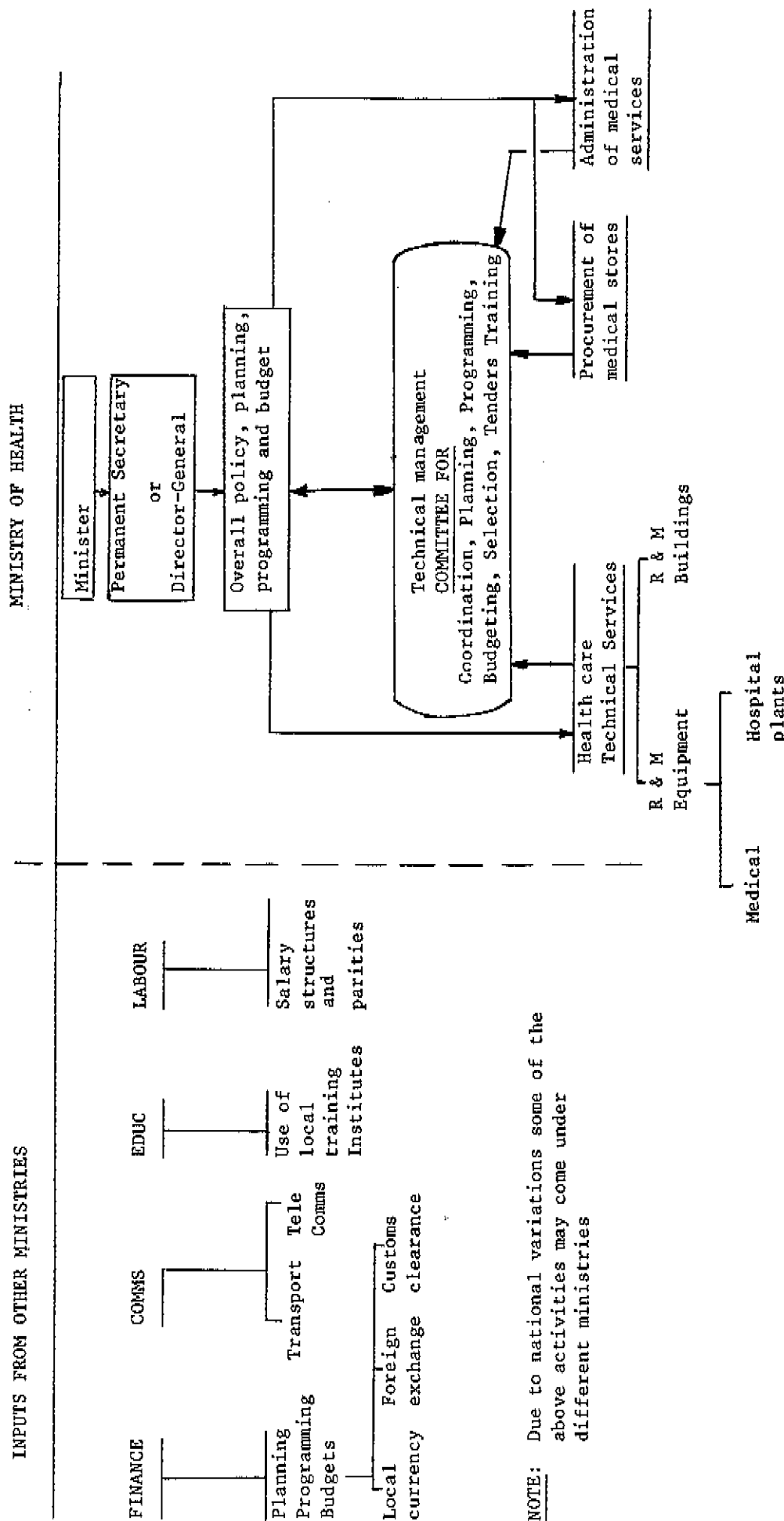
The typical layout of such a workshop is on the following page, showing dimensions, furniture and other requirements.

From a central workshop, situated in a large general hospital or provincial or national capital, support in specialist trained personnel, engineers, spare parts and test equipment will be given to this district workshop.

In turn the district workshop, using its vehicle and staff will support with routine maintenance and repair the rural clinics and other installations under its authority. Typical support may be as follows:

- Health posts Craftsmen support, i.e., electrician, plumber, mason, carpenter. Depending on the medical equipment available, which should be of standard nature (stethoscopes, sphygmo-manometers, examination tables and lamps, basic instrument, etc.), support with appropriate medical equipment technicians as appropriate or for routine maintenance.
- Dispensaries
or sub-centres As for above with craftsmen but with more involved medical equipment technician support, particularly dental and probably basic laboratory equipment, such as blood stirers, centrifuges, water baths, ovens, etc.
- Rural centres For craftsmen as above, however, on a regular basis all disciplines of medical technicians should offer cover.

Figure 1: National infrastructure required for the support of a health care system



NOTE: Figure 1a gives a more detailed explanation of the above three Services

Figure 1a: Health care technical services and associated services responsibilities

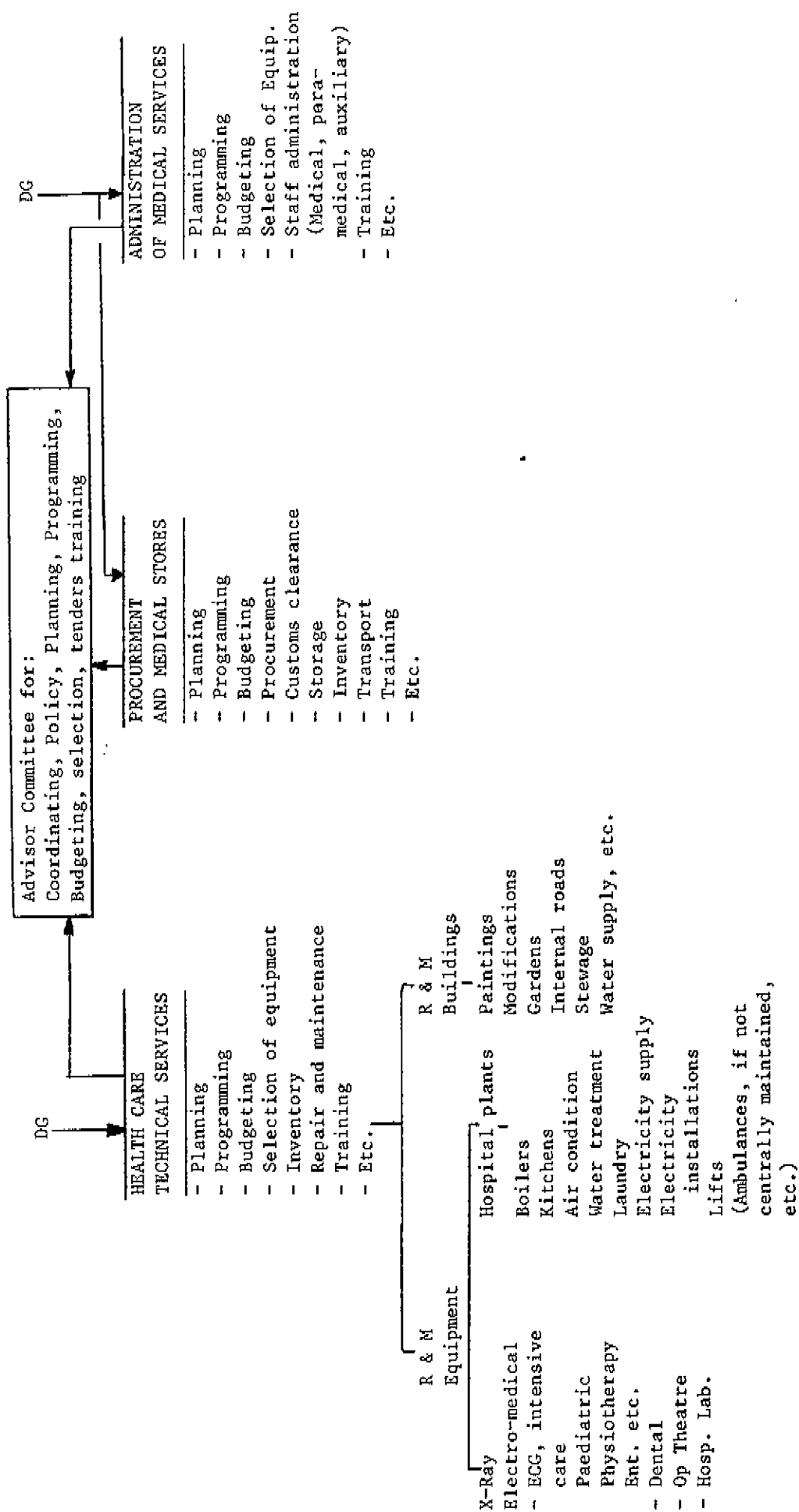


Figure 2: Main system inputs and outputs of a health care technical service

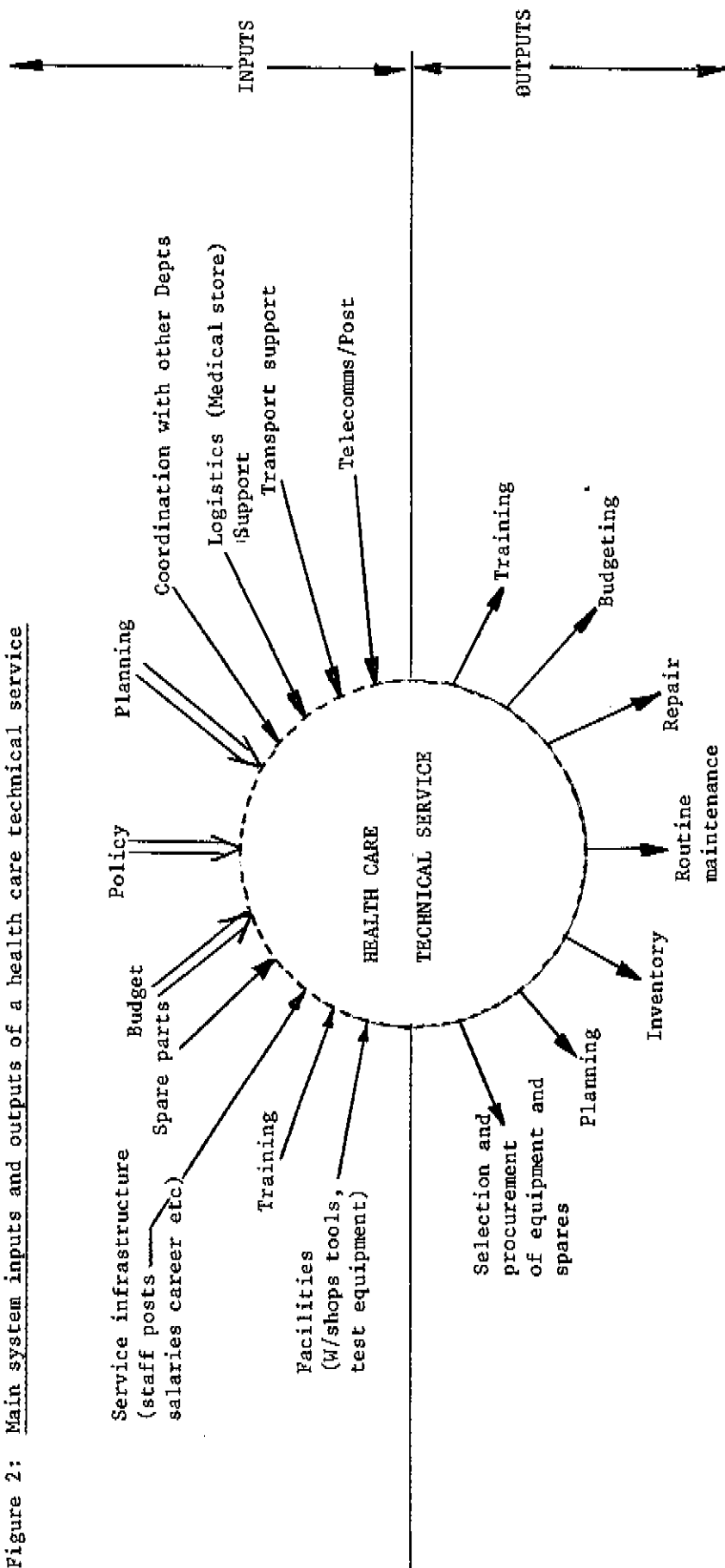
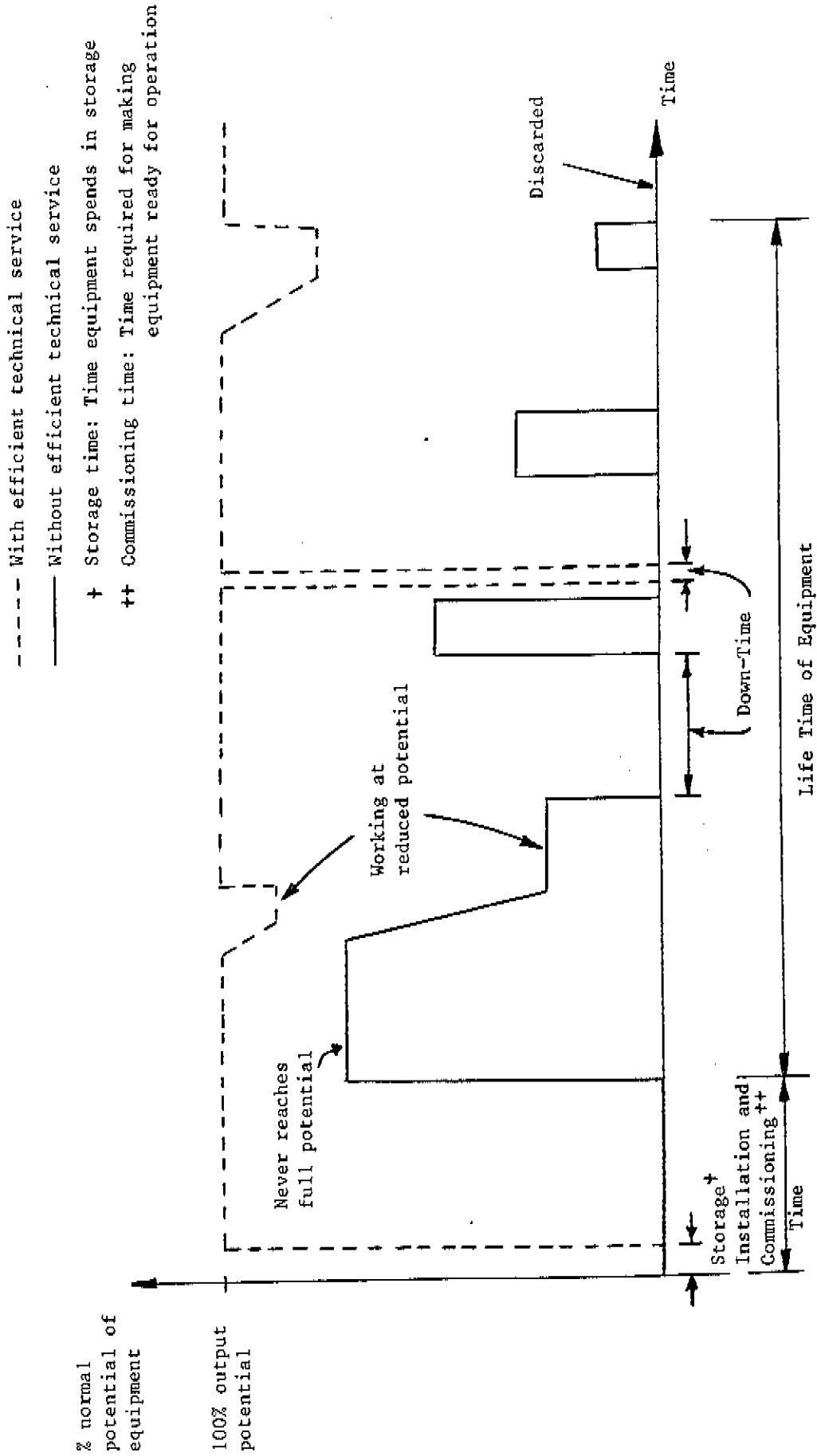


Figure 3 : Chart of Potential of Equipment versus Time



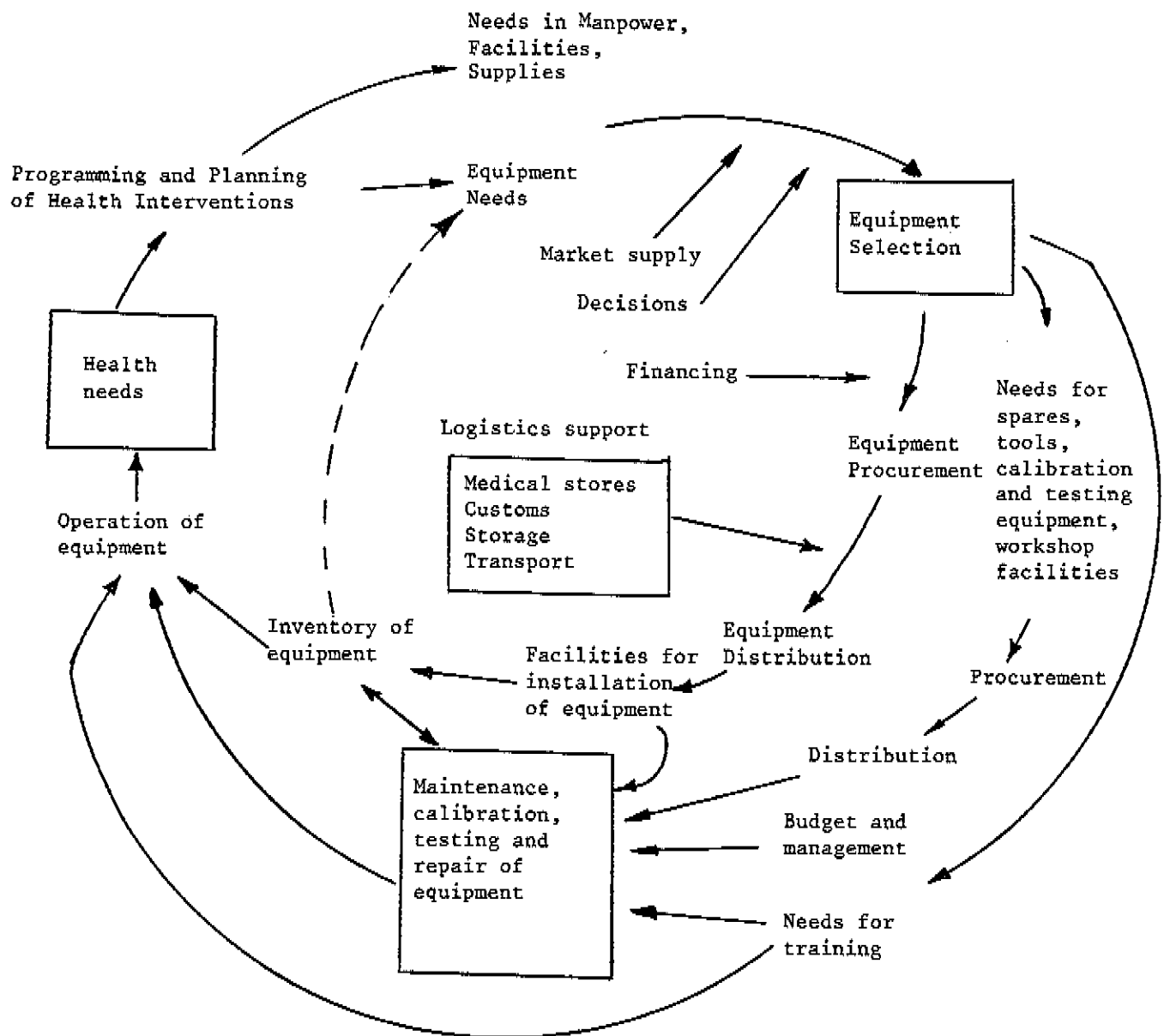
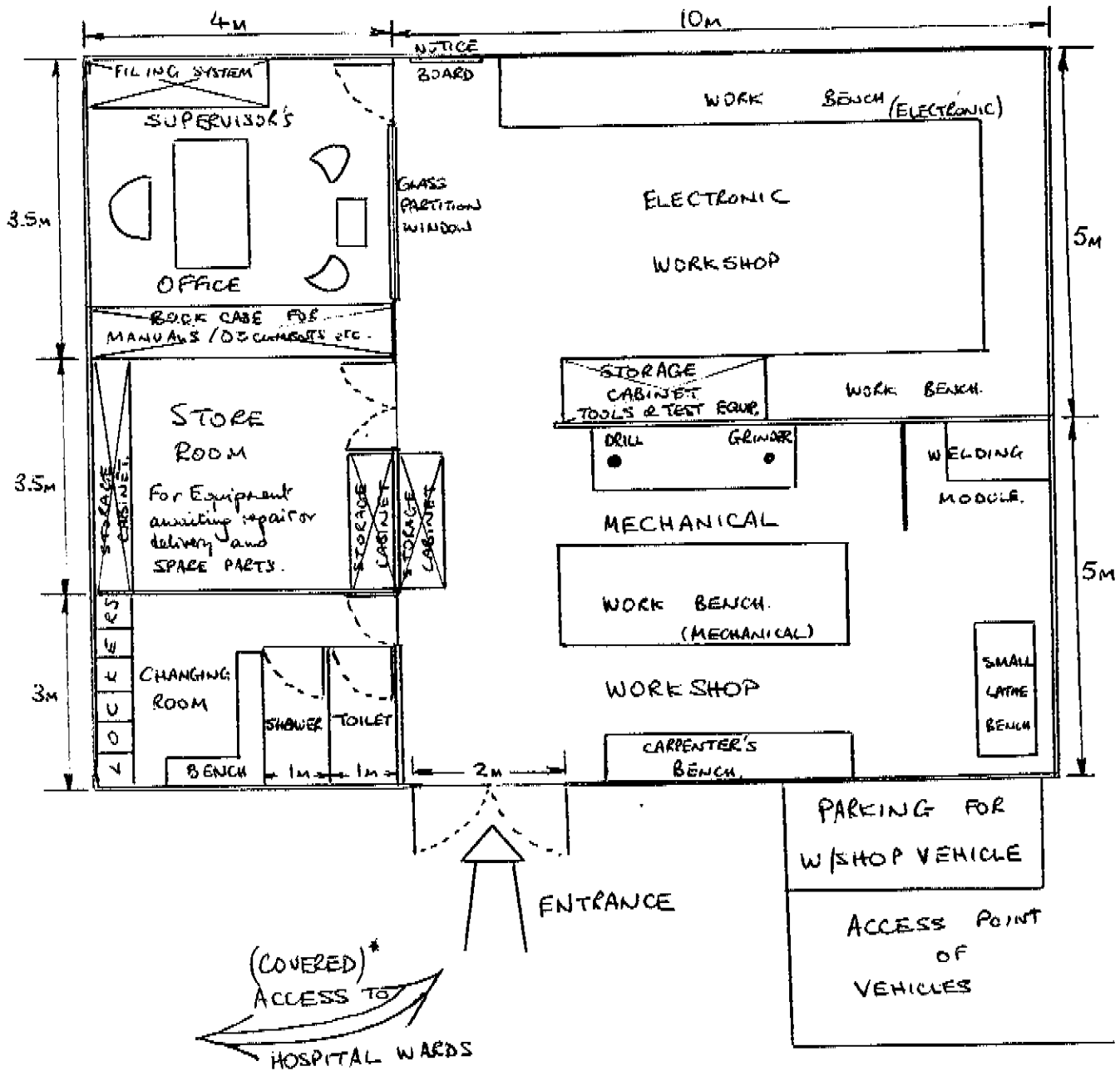


Figure 4 : The Place of Maintenance and Repair of Equipment in the Health Technology Cycle



* IF POSSIBLE.

TYPICAL LAYOUT FOR DISTRICT WORKSHOP

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