COLLEGE OF ENVIRONMENTAL DESIGN

PRINCIPLES OF MAINTENANCE

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INTRODUCTION

"That which is taken from the ground tends to return to the ground"

- **This statement of fact does explain why some form of maintenance is required.**
- **In addition, it sums up the problems of deterioration and the care needed for its prevention.**
- **All elements of buildings deteriorate at a greater or lesser rate dependent generally on:**
  - * **Material and methods of construction**
  - * **Environmental conditions, and**
  - * **The use of the buildings**

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INTRODUCTION (continued)

* **Property owners normally make an effort to keep maintenance expenditure to a minimum, ignoring or misunderstanding the adverse long term effect of such decisions.**
* **Neglect of maintenance has accumulative results with rapidly increasing deterioration of the Fabric and finishes of a building accompanied by harmful effects on contents and occupants.**
* **In Western countries, over one-third of the total output of the construction industry is devoted to maintenance of buildings, just to keep buildings in satisfactory condition.**

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DEFINITION OF MAINTENANANCE

* **In general, Maintenance means to hold, keep, sustain or preserve the building or structure to an acceptable standard.**
* **Acceptable standard is defined as one which sustains the Utility and value of the facility.**
* **The question of what is an acceptable standard? is a matter of conjecture and is generally subjective.**
* **Each owner or tenant will have to establish his own standards based on many factors, such as:**
  * **Usage of building**
  * **Anticipated life**
  * **Availability of capital, materials and manpower**
  * **Change in Usage and personal**
  * **Business prestige.**

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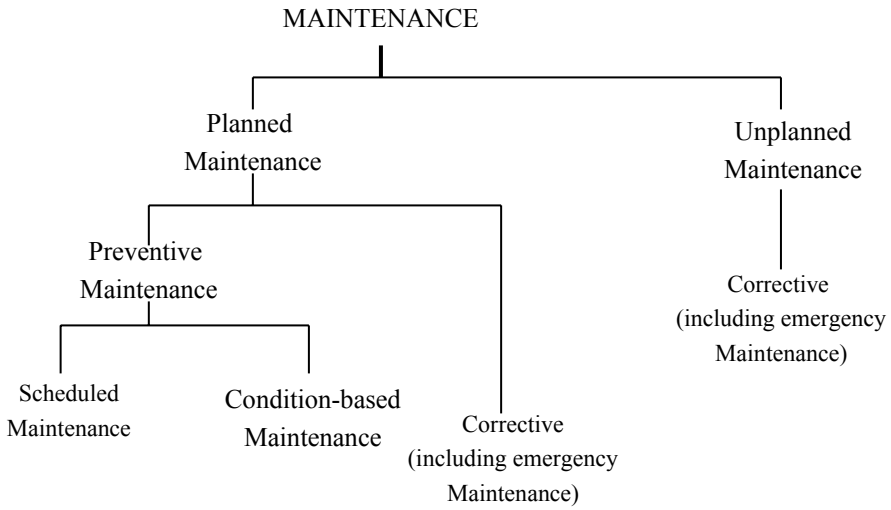
TYPES OF MAINTENANCE

* British Standard 3811 classified building maintenance as the followings:



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TYPES OF MAINTENANCE (continued)

1. **Planned Maintenance:** "The maintenance organized and carried out with forethought, control and the use of records to a predetermined plan."

2. **Unplanned Maintenance:** "The maintenance carried out to no predetermined plan."

3. **Preventive Maintenance:** "The maintenance carried at pre-determined intervals or corresponding to prescribed criteria and intended to reduce the probability of failure or the performance degradation of an item."

4. **Corrective Maintenance:** "The maintenance carried out after a failure has occurred and intended to restore an item to a state in which it can perform its required function."

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TYPES OF MAINTENANCE (continued)

5. **Emergency Maintenance:** "The maintenance which it is necessary to put in hand immediately to avoid serious consequences." This is sometimes referred to as day-to-day maintenance, resulting from such incidents as gas leaks and gale damage.

6. **Condition-based Maintenance:** "The preventive maintenance initiated as a result of knowledge of the condition of an item from routine or continuous monitoring."

7. **Scheduled Maintenance:** "The preventive maintenance carried out to a predetermined interval of time, number of operations, mileage, etc.

Preventive Maintenance

Scheduled Maintenance

- Inspection
- Lubrication and Servicing
- along with
- Cleaning
- Adjusting
- Component replacement

Condition-based Maintenance

Continuous periodic on demand

Predictive maintenance techniques

1-vibration monitoring

2-infrared testing

3-sonic testing

4-ultra-sonic testing

5-non destructive testing

A-oil analysis B-magnetic particle inspection

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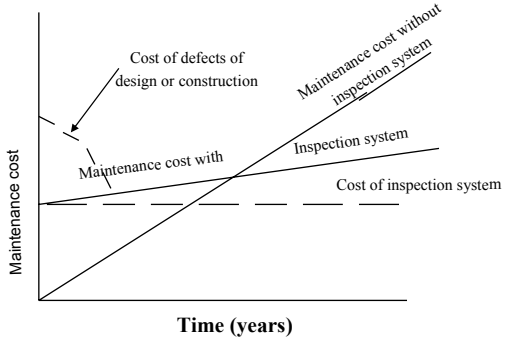
* **In general maintenance classification could be as:**

1. **Major repair or restoration**
2. **Periodic maintenance**
3. **Routine or day-to-day maintenance**

* **A system which is based on planned inspections and maintenance will have higher overhead costs than the one that is not, but the planned lead to lower maintenance expenditure.**



Cost relationship between planned and unplanned system
(Source: Managing Building Maintenance)

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FACTORS INFLUENCING THE DECISION TO CARRY OUT MAINTENANCE

MAINTENANCE NEEDS

The prime aim of maintenance is to preserve a building in its initial stage, as far as practicable, so that it effectively serves its purpose. Some of the main purposes of maintaining buildings are:

1. **retaining value of investment**
2. **maintaining the building in a condition in which it continues to fulfill its function, and**
3. **presenting a good appearance.**

The amount of necessary building maintenance work could be reduced by improved methods of design, specification, construction, and feed back of maintenance data to designers.

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MAINTENANCE NEEDS (continued)

- **Also, effective maintenance management embraces many skills including:**
  - *** The technical knowledge and experience necessary to identify maintenance needs and to specify the right remedies**
  - *** An understanding of modern management techniques**
  - *** A knowledge of property and contract law**
  - *** An appreciation of the relevant sociological and economic aspect:**
- **Every buildings, through neglect and deterioration, faces certain death from progressive decay.**
- **Proper maintenance is cheaper, quicker and easier than major repairs.**

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PRINCIPAL CRITERIA INFLUENCING THE DECISION TO CARRY OUT MAINTENANCE

These could be listed as follows:

1. **Costs**
2. **Age of property**
3. **Availability of Physical resources**
4. **Urgency**
5. **Future use**
6. **Social considerations**

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ASSESSING MAINTENANCE PRIORITIES

* It is difficult to formulate a precise order of priorities of maintenance activities as they are so diverse and any assessment is likely to be a subjective evaluation.

* Some of the principal functions of maintenance are:

  * To ensure the safety of occupants, visitors and the general public
  * To maintain services, such as heating, lighting, escalators and fire alarm systems
  * To maintain decorative surfaces and carry out adequate cleaning
  * To prevent or diminish significantly deterioration of the fabric.

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ASSESSING MAINTENANCE PRIORITIES (continued)

* Some organizations have formulated maintenance priority guidelines to be used for financial stringency on how monies are to be spent. Typical is the following approaches, adopted by a country code:

  1. Work required for health and safety, such as emergency exits and fire precautions
  2. Work required to preserve the structure, such as essential roof repairs and external paintings.
  3. Work required for occupational efficiency, such as increased lighting.
  4. Amenity work, mainly internal, such as interior decorations.

NATURE OF MAINTENANCE

Main Components:

- **Servicing**
- **Rectification**
- **Replacement**
- **Renovations**

1. <u>Servicing:</u>

A cleaning operation undertaken at regular intervals of vary frequency and is sometimes termed day to day maintenance.

Typical frequencies could be:

- *** Floor swept daily and polished weekly**
- *** Windows washed monthly**
- *** Painting for decoration and protection every 5 years.**

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2. Rectification:

Occurs early in the life of the building and arises from default in design, inherent faults or unsuitability of components, damage of goods in transit or installation and incorrect assembly.

Objective of rectification is to ensure that components and materials are suitable for their purpose and are correctly installed.

Frequently, the same component must fulfill many functions, such as:

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2. Rectification (continued):

Walls (External)

Weather - Shield	**Failure to perform any**
Load bearing	**one of these functions**
Thermal Insulant, and	**satisfactorily can result**
be of good appearance.	**In maintenance works.**

Example:

- **Failure of joints between large slabs in wall cladding to exclude wind and rain.**

Rectification Work can be reduced by the use of:

- **Performance specifications, and**
- **Codes of installation.**

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3. Replacement:

It is inevitable because service conditions cause materials to decay at different rates.

Most replacement work is carried out not so much from Physical breakdown of the materials or element as from deterioration of appearance.

Thus, the length of acceptable life often involves a subjective judgment of aesthetics of change.

* **Determining the durability or length of life of a material is a very difficult technological problem.**

Can be obtained:
- **Observing materials in Building.**
- **Simulated exposure or use**

3. **Replacement (continued):**

   - **Replacement can be reduced by the use of better quality of materials and components.**

4. **Renovations:**

   It consists of work done to restore a structure,service and equipment by a major overhaul to the original design and specification, or to improve on the original design.

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RELATIONSHIP OF CAPITAL, MAINTENANCE & RUNNING COSTS

* **A building owner expect a designer to provide a building which will satisfactorily meet his needs and will secure a reasonable balance between first and future costs.**

* **Thus, the design team is expected to develop more effective methods of predicting the functional and economic consequences of designs and to obtain the best value for money.**

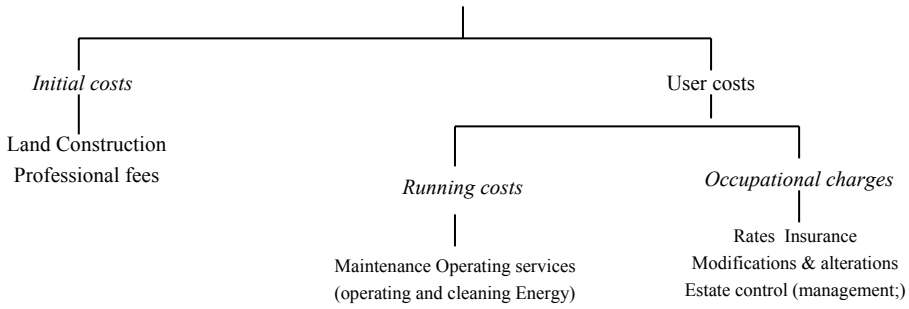
* **Unfortunately, the total occupancy costs of buildings are frequently difficult to assess and feed back of accurate information is very limited.**

RELATIONSHIP OF CAPITAL, MAINTENANCE & RUNNING COSTS
(continued)

A variety of payments are made from different funds at different times and in different ways.

Breakdown of total costs

Total costs
(life span of building)



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Difficulties in Assessing Total costs at design stage

1) **It is difficult to assess the probable maintenance costs of different materials, processes and systems.**
   - * **There is a great scarity of reliable maintenance cost data tabulated in a meaningful way.**
   - * **It is not easy to predicate the lives of materials and components in a variety of situations.**

     Even lives of commonly used material like paint show surprising variation.
     - * **type of paint**
     - * **number of coats**
     - * **condition of base**
     - * **method of application, exposure etc.**

Difficulties in Assessing Total costs at design stage **(continued)**

2) **There are three types of payment involved (initial, annual and periodical). All these have to be related to a common basis for comparison purposes.**
Required knowledge of discounted cash flow techniques (life cycling)

3) **The selection of a suitable long term interest rate is difficult.**
   * **Rates may rise or drop a long period of time.**

4) **Inflationary trends may not affect all costs in a uniform manner, thus distorting significantly the results of costs in use calculations.**

5) **When there is limited initial funds for the owner, it is difficult to convince him that spending more on initial construction will lead to saving on the future.**

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Current and future payments

As mentioned above, payment over a long period of time for the building -

usually the life of the building involve:

1) **Present payments** - **Cost of site, construction, and design**
2) **Annual payments** - **Relating to minor repairs, cleaning, and heating (cooling) and lighting.**
3) **Periodic payments** - **Such as full internal redecoration**
   * **Possibly every 10 years**
   * **External redecoration every 5 years**
   * **Replacement of boilers and electrical every 25 years.**

Current and future payments(continued)

* **All these varying types of payment have to be converted to a common method of expression to permit a meaningful comparison to be made between alternative designs.**

  By —> Utilization of discounted cash flow techniques with proper interest rate.

The comparison can be made by one of the following methods.

1) **Discount all future costs at an appropriate rate of interest to convert all payments to present value (PV).**

2) **Express all costs in the form of annual equivalents by using appropriate rate of interest..**

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Initial and Future Cost relationships

* **As mentioned earlier, most design decisions affect running costs as well as first costs.**

  * **What appears to be a cheaper building at the design stage may in the long term be far more expensive than one with much higher initial costs.**

* **To shed light on the above point, the following table express the breakdown of costs in use for various types of buildings.**

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Initial and Future Cost relationships(continued)

Breakdown of costs in use for various types of buildings

Type of annual cost	*House*	*High flats*	Industrial *buildings (percentages)*	*Schools*	*Offices*
Maintenance	14	12	18	18	13
Fuel and attendance for heating and lighting	24	24	30	18	29
Initial costs (amortized)					
a) Building	48	56	47	51	47
b) Land& development	14	8	5	15	11
Total *costs in use*	*100*	*100*	*100*	*100*	*100*

* This table shows that running costs may amount to about one-half of annual equivalent of first costs.
* Life Cycle cost planning is concerned with examining the economic of the life cycle of a building to ensure that there is a balance between the use of capital resources in design and construction and the consumption of future resources (including maintenance by the building in use.

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THANK YOU