PREPARATION AND PRIORITIZATION OF MAINTENANCE PROGRAMS

Maintenance programs

M.R. JOHNSON, Technical Policy Branch, Building Regulations Division, Department of the Environment, Transport and the Regions, London, England
D. P. WYATT, School of the Environment, University of Brighton, Brighton, England

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Abstract

The maintenance requirements of any asset particularly buildings need a structured process of justification to ensure that funds are available to develop programs to identify preparatory work as well as the timescale for physical execution. Condition appraisals alone will not do this as the operational requirements of the organization using the building need to be assessed as well as the technical needs of the structure and its equipment. A systematic review of maintenance needs will also indicate whether the value of the building warrants the level of expenditure or if there are any potential benefits such as energy savings which could lead to one scheme being given preference over another. Once the value against expense appraisal has been done judgments can be taken using specific criteria such as those affecting safety and operational effectiveness are likely to be of the highest merit. Disruptiveness of the work in progress is a major consideration as it may be desirable to group medium term building maintenance activities in a given building with the most urgent needs. This enables all the disturbing activities to be carried out at the same time. Economies on access, contractor's plant and management costs are possible but the principal purpose of this exercise is to get the building to a state where intrusive maintenance activities are unlikely to recur for several years. Programs need to be reviewed at least annually but this need not involve looking at the whole portfolio. Once the essential framework has been developed it should only be a matter of responding to programmed events as they move towards their date for execution or accommodating unanticipated work.

Keywords: programs, condition appraisals, prioritization, maintenance, operational effectiveness, disruption, serviceability.

1 Introduction

Most building maintenance managers have and prepare works programs for the building for which they are responsible. In some aspects such programs may demonstrate an objective approach in response to the stewardship they are entrusted with and at the same time provide a basis for funding work under consideration and approvals. One of the inherent weakness of such programs are the procedures which are followed mainly to provide cost forecasts or budgets tend to identify work on a largely technical and critical basis.

Condition appraisal can lose credibility if they lack accuracy or flexibility [Smith, 1985]. The causes may be that too broad an approach was used, the system is difficult to use or revise or that the appraisal does not show an appreciation of the needs of the estate as a whole but concentrates on items of work but makes no judgment of how they impinge on the functioning of the building.

Other aspects of the operation of the estate come into play when more important work items have been identified. Economies in future running or energy costs, prevention of cost escalation due to disrepair and savings in management or contract costs by grouping work items together play an important part. Some maintenance operations can be severely disruptive to building users, but may be overcome by grouping a number of schemes together to reduce disturbance to occupiers [Ahonandoy, 1994]. In some cases less urgent work may be carried out before its normally programmed date in order to prevent future disturbance. The needs of the organization using the building will often play a large part in the timing of major work. Work may be delayed because disruption cannot be tolerated at a given time or brought forward to link with the start of new activities in the building or for public relations reasons.

The use of some formally agreed criteria may help to establish links between the base condition of part of a building in need of repair and the urgency of doing the work. Surprisingly condition alone is not always the most important vector. Often legal, safety or operational considerations provide the grounds for the final decision of when and how the repair is carried out. If something is no longer performing satisfactorily and needs occasional running repair but does not create risks of disruption to the activities of the organization occupying the building it is unlikely to attract a high priority for major repair or replacement.

Maintenance programs need to be dependable. The criteria used in maintenance audits after work has been carried out[Robertson, 1983] provide maintenance managers with a good indication of how to defend their proposals.

A programme which can demonstrate that objective criteria have been used will have greater credibility and a better chance of securing funding for its execution. The type of questions an auditor may ask should be considered by the maintenance managers to test the decisions being taken when preparing schedules. They will be better able to justify their actions after the work has been done if it can demonstrated how choices were made in planning the work.

Table 1: Comparison of Maintenance Manager's and Auditors criteria for prioritization

Maintenance manager's criteria	Maintenance auditor's questions
What needs to be done Is it necessary When should it be done	How much has been achieved
Are the right standards being set Is a higher specification justified to give longer service life and/or lower running cost	How good was it
Was the expense justified Could cheaper alternatives provide value over time	How much did it cost
Are appropriate technical, legal and organizational considerations being used to set priorities Should work be linked to other activities either co-incidentally or sequentially	Was the job a priority item

2 Development of maintenance priority systems

In many organizations the priority of general repair tasks is reactive and responds to either breakdowns which appear to be giving the greatest problems or to silence those who complain the loudest. In the right context responsive or breakdown maintenance is an acceptable strategy . There are some items whose failure is not predictable and do not cause great inconvenience whilst waiting to be repaired. When the work is random and low cost it may be cheaper to repair on breakdown than to take preventive action on all similar items some of which may have different rates of failure rendering the preventive strategy uneconomic.

For more substantial maintenance activities a management strategy is imperative. Currently in the United Kingdom there is a number of large estate portfolios in health care, social housings and education. Each of these sectors have had maintenance planning strategies for sometime and since the 1980's have developed system for assessing maintenance priorities. In fact the health sector took the lead in setting down priority factors [Bushell, 1981]. Strategies were developed for council housing and schools and these were reported on by the Audit Commission in the late 1980's.

Early priority factors tended to be descriptive and even when ranked they did not provide a simple means of sorting the work items. Following a review of the UK defense estate maintenance, estate condition reports were required to be supported by a forward maintenance register classified using urgency criteria. [PSA, 1985.a]. The ranking system had four main groupings with a sub-set of deciding factors, usually

applied to the two highest classes. (See Table 2 below). A similar system was adapted when a separate defence works administration was set up in 1990 [DWS, 1990].

Table 2: 2 level prioritization system as used for government buildings in the United Kingdom

Class	Level	Description
Main Priority Classifications	Priority 1	UNAVOIDABLE SERVICES: Schemes which cannot be deferred without breaching statutory obligations, health and safety or seriously affecting occupier's operations and functions.
	Priority 2	ESSENTIAL SERVICES: Schemes which cannot be deferred without serious penalties such as damage to property or increased costs.
	Priority 3	URGENT SERVICES: Schemes which are highly desirable to maintain the value and utility of the estate.
	Priority 4	DESIRABLE SERVICES: Schemes which are necessary to maintain property standards or which would show a saving in running or operational costs.
Priority Sub-classifications	(a)	Meet Statutory obligations
	(b)	Meet Health and Safety requirements
	(c)	Avoid serious disruption

An example of the approach adopted in the priority classification system in Table 2 would be an electrical distribution centre with a leaking roof causing damage to the switchgear. this would be priority 1 as it is essential to sustain the power supply to the site. It would have an (a) sub-code because of the legal requirement to keep high voltage systems safe and a contractual duty to maintain supply to occupiers. A (c) sub-code would also be appropriate as loss of power supply would disrupt the activities of occupiers; also some switch gear has to be built to order so it is imperative to stabilize the environment to reduce the risk of failure.

The two most urgent classes (Levels 1 & 2 in Table 2) usually need to be addressed within two years. However, certain work needs preparatory activities, for example in depth appraisals or design studies. Often these cannot be prepared in a short time. In such situations holding repairs may be required but for complex works the time factors and cost of preparing option studies and designs for major repair work need to be built into the work programme and the general maintenance policy.

When the most urgent work has been identified the period of time over which less urgent work may be placed can be determined. Start years can be allocated to work items shown in condition surveys or other appraisals as being justified to be new starts within the next five years. Start dates for projects which are forecast to occur more than 5 years hence may become nominal as they may have , in any event, to be rescheduled to accommodate more urgent work which may identified in the intervening period.

The nominal start dates for later start jobs have some value as it permits expenditure over time curves to be drawn. In an estate of varied age and type which has not been grossly neglected the profile may tend to taper off after a few years or may undulate. In such cases smoothing by shifting some starts may be desirable.

If the property portfolio has several similar buildings of roughly the same age expenditure curves may rise suddenly when the buildings are about 20 years old raising the scepter of a "maintenance time bomb" [Spedding, 1994]. The cause is often related to simultaneous expiry of external elements such as windows or felt flat roofs with engineering items such as heating plant and light fittings.

3 Use of other attributes for prioritizing maintenance

The use that the building or accommodation is put to, may influence the prioritization of work as much as its physical condition. Indeed six major criteria have been identified [Spedding, 1994]. These criteria are Building Status, Physical Condition, Importance of Usage, Effect on Users, Cost Implications and Effects on Service Provision. (These terms are described in Addendum A).

Such attributes enable rankings and weightings to be placed on individual schemes and provide the basis for decision making and finer tuning of programmes. A score range of 5 is usually adequate for most criteria to cover the range from essential to desirable but not critical. It is imperative that the order of ascendancy of the score is uniform to permit them to be added. If all other criteria are of rising importance; very poor physical condition must be 5 rather than using the high score to mean 'excellent no work required'.

These standard attributes may need to be expanded to accommodate special features of the building. Additional points can, however, be added to cover specific buildings or needs such as legal requirements, keeping historic buildings in good order, maintaining a facility of regional or national importance or to avoid criticisms or political consequences of repeating previous failures. If it is believed criteria are not of equal relative importance they can be separated by weighting factors. Generally condition or cost scores will tend to have a low rating than those related to usage or public service factors.

It should be noted that the attributes used to fine tune priorities relate more to how the building is used than to physical condition or cost. Maintenance managers require a good understanding of how the buildings are used and should involve the users in the decision making process. A procedure for discussing the prioritizing of the most urgent work with clients was introduced for the management of the UK government estate in 1985 in order to make sure that occupiers and building managers were aware of the impact of the proposed work [PSA, 1985.b].

4 Minimization of disruption

The actual condition of the building or some of its elements may cause a maintenance scheme to be identified and prioritized. However, the needs of the building user are a deciding factor of when and how the work is done [Kubo et al, 1994]. Timing in order to minimize difficulties to the occupier is a major consideration. Some building users have closed or quiet periods when work can be accommodated. For example, schools closing for holidays, food processing plants which handle season crops and may close down process line, or energy installations where plant can be shut down during periods of low demand. Most other building types do not offer this facility.

If inconvenience of maintenance activities cannot be avoided careful planning is needed to reduce its effects and mistakes in planning and execution. Disruption is a consideration which is part of the prioritization system used for UK government offices [Property Holdings, 1992] - See Addendum B.

The degree and cause of disruption varies with the type of work. Noise can be controlled by scheduling the noisiest activities to early morning, lunchtime and late afternoon. Moderate dust levels can be controlled by screens. If the noise levels are high and cannot be limited at justifiable cost or if dust may include toxic substances the safest approach is to relocate the occupiers.

Disruption may be reduced by grouping activities. The logic for grouping them may be that work items have similar service lives and need replacing at about the same time. The reasoning for carrying out the works together may be reinforced if they are in close proximity. Another reason may be the availability of access equipment or contractors plant, substantial saving in used charges and contractor's mobilization costs if such equipment is shared on one contract rather than being brought back a short time later if the jobs run separately. The effects of noise, increased fire risk, health hazards or obstruction to movement will often cause occupiers to be moved out. Savings can be made if the current occupier is expected to depart at end of the tenancy or if they are planning to move in anticipation of a refit of their accommodation for other reasons. Refits and refurbishments may be driven by needs of the occupiers where a building needs to be in sound condition for the installation of new equipment.

One case of building elements having similar life spans is windows and some services installations. The linkage is more noticeable in the case of heating systems, simultaneous replacement may be easier to arrange in summer when the heat producing plant is not in service and the effects of reduced weather enclosure can be more easily tolerated. In some cases the heat emitters may be on the perimeter of the building. If occupier has to be moved away from the windows to permit their replacement, access can be provided to the heat emitters at the same time. If the new windows are double glazed units in place of single ones it may be possible to down rate the output of the heating systems to achieve savings in capital cost and make energy economies.

Many roof repairs require access equipment on the facade usually in the form of scaffolding. The additional cost of modifying the scaffold to permit other work to proceed is marginal compared to that of erecting it a few years later to do other work on the exterior of the building. Repair or replacement of windows, external decoration

or maintenance of cladding systems can be undertaken along with roofing work whilst the scaffold is in place.

Some installations require a good internal environment if they are not to deteriorate quickly. If an internal refit is planned the state of the external envelope of the building should be checked first. There is little purpose in replacing elements like ceilings and lighting
systems if the roof leaks. In some cases it may be necessary to bring forward re-roofing and similar work if it is expected that replacement will be necessary within the first third of the internal work's expected life span.

Improved techniques have been developed for estimating service life [ISO, 1998]. These can assist maintenance managers in predicting when work may be required and to identify simultaneously or closely occurring repair events. In some cases service lives can be adjusted by changes in specification or in use maintenance so that service lives coincide. If one element may cause another to fail it may be possible to ensure the one which could cause more general deterioration has a linger service life than the vulnerable element or at least is capable of being kept to a satisfactory level of performance by unintrusive maintenance procedures. If there is a long life critical non-building installation the building may need to be more durable than usual so that building operation which could disturb the installations are kept to a minimum. This would have applied to computer suites in the days of main frames but there are similar requirements for communications centres and medical facilities.

Service life planning and forecasting systems can be used as part of the design and facility management process. If elements are close together and influence each others performance it may be worth adjusting their service lives so that they are similar. This can be done by improved specification, weather protection or maintenance. In some cases it may be worth reducing the specification of the system with the longer life if it is more cost effective that extending the life of the other. This can be tested through value engineering or service life design and performance audits. This procedure could be used for non-structural external elements such as cladding panels or windows set against heating systems. Both systems are near the building perimeter and the thermal performance of the cladding determines the output of the heating system.

Major internal rearrangement is often seen as having a great impact on lighting systems and heating controls. This may lead maintenance managers to review the adequacy of these elements during such a refit. However such changes often have affects on movement in and around the building and impinge on fire protection and evacuation procedures. These systems must not be overlooked at such times. The changes in the electronic functioning of fire detection and alarm systems over a relatively short timescale is such that it may be difficult to modify these systems. Accelerated replacement to sections of the system or sometimes the whole of it, may be needed during even a modest refit operation.

One of the risks of combining maintenance schemes into one project is the overall cost. This may create difficulties in accommodating such a large item into an annual programme or if it is not of the highest priority it may be a target for delay to assist budget changes. If necessary these should be backed up by investment appraisals, schedules of short term savings and statements showing the impact on

corporate operations. These will improve the programme's chances of survival intact when presented to management boards.

5 Conclusion

Although maintenance requirements may be identified through building inspections and condition audits, the prioritizing of the work may be decided through other criteria. The needs of the organization can be shown to be as important as the condition of the building. Accommodating the work at reasonable overall cost and with minimum physical impact on occupiers is of increasing importance.

A novel approach bringing in value engineering and attribute driven selection and weighting can assist the maintenance manager in making optimum decisions for the benefit of both the estate and the user organization. This can also be linked to value engineering and service life planning so that optimum performance, serviceability and return on investment can be delivered to the client.

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Addendum A

Criteria for attribute based prioritization

Attribute	Code	Description
Building Status	**BS**	The relative importance of the building (where the defective element is examine) compared to others, in terms of function, current and intended future usage, e.g. an infant school might have higher status than a leisure building.
Physical Condition	**PC**	The physical condition of the defective element being examined, and its possibility of breakdown or failure, e.g. elements in very bad condition would be given higher priorities than those in fair condition.
Importance of Usage	**IU**	The importance of the functional unit (in relation to other units within the same building) where the defect is situated, e.g. the reception area would be more important than storage rooms.
Effect on Users	**EU**	The effect of breakdown or failure of the defective element(s) on the occupant and users of the building (including staff and members of the public), e.g. a problem relating to health and safety would be more important than an aesthetic problem.
Cost Implications	**CI**	The cost implication of breakdown or failure of the defective element(s) on maintaining the overall condition of the building fabric and building services, e.g. a defective roof would be given priority because if not repaired promptly, the eventual cost will be higher due to possible damage to other building elements
Effects on Service Provision	**ESP**	The cost implication of the breakdown of the defective element(s) on the provision of services for which the building is designed and used.

(After Spedding et al - "Prioritising Major Maintenance items of Maintenance in large Organisations.")

Addendum B

Maintenance Prioritization - Action and Effect Classifications

Class/Group	Priority Code/ Sub-class	Description
Maintenance Priority Classification	Priority 1	UNAVOIDABLE WORK: Schemes which cannot be deferred, without breaching statutory obligations , health and safety, seriously affecting occupier's operations and functions, security or to meet lease or covenant obligations to landlords.
	Priority 2	ESSENTIAL WORK: Schemes which cannot be deferred without serious penalties such as damage to property or increased cost.
	Priority 3	URGENT WORK: Schemes which are highly desirable to maintain the value and utility of the estate.
	Priority 4	DESIRABLE WORK: Schemes which are necessary to maintain property standards, or which would show a saving in running or operational costs of the property.
Maintenance sub-classes	A	Meet statutory obligations
	B	Meet Health and Safety requirements
	C	Avoid serious disruption and effect on client operations
	D	Prevent severe physical deterioration of property, or to meet requirements of lease.
	E	Avoid disruption of client operations
Effect if deferred	1	Failure to rectify defect or undertake ,maintenance work will result in RAPID, consequential or subsequent cost or nuisance to use of building
	2	Failure to rectify defect will have a SIGNIFICANT effect
	3	Effect of delay will be MARGINAL
	4	Effect of delay will be NEGLIGIBLE
Disruptive Effect on Occupant	X	Major inconvenience/disruption to occupants' activities.
	Y	Minor inconvenience/disruption to occupants' activities
	Z	Minimal inconvenience/disruption to occupants and will not affect to any degree occupants' activities

Example: Priority 2D1Z categorizes the requirement for Serious Non-Structural Fabric Defects being Essential//Prevent Physical deterioration/Rapid cost penalty/Minimal effect on occupant.

Based on the maintenance classification system in Property Holdings Commissioning Code (Property Holdings, London, 1992)