MANAGEMENT OF FEEDBACK INFORMATION

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1. Introduction

Building performance and management of feedback information have become increasingly important in respect of built asset management. Among the reasons for this is the fact that 'new build' work has diminished over the past decade and maintenance and refurbishing work has taken on a new role. As a result the maintenance expenditure for buildings is rising rapidly whilst funds to meet the perceived need are becoming increasingly difficult to secure. The building stock is extremely varied in design and complex in the variety of components and specifications used, therefore there is a need to establish a 'feedback' system which will prioritise the types of construction, or components, which require attention; such a system is necessary for improving built asset management. This paper deals with some of the problems, as seen in terms of variety of buildings and building specifications and then goes on to show how data can be collected and analysed to produce valuable feedback information. The paper is based on research into asset management, by the Research Unit (RU), in particular it deals with feedback of elemental data for schools and houses; details of the working system are also discussed.

The management of feedback at the RU started with the development of a coding system for building maintenance work, this proved capable of facilitating analysis down to very detailed levels. This hierarchical coding system is based on functional elements of buildings which can be broken down via sub-elements to individual components if desired. In one study it was used to monitor expenditure and it was found that a high proportion of expenditure went on roofs, joinery, sanitary fittings, electrical installations, and certain external works elements. Clearly, the rate of component failure applied to a large

stock of buildings can provide useful indications of budget trends for future maintenance work.

Feedback can be produced for various management functions, for example, the identification of particularly high numbers of failures, this can be followed up by interrogation into specifications. The advantage of a hierarchical code is that the level of analysis can be varied to suit the management function. In particular it greatly enhances the programming and budgeting process.

However, the coding system is only one aspect of the overall feedback system; another aspect is the condition survey, this allows instant feedback on performance, and highlights those elements which need detailed inspection or inclusion in the maintenance programme. A third aspect is the property file, this provides a data base which allows all buildings to be checked for 'like' elements or type of construction. The complete system can be developed in stages and is suitable for all building types. Currently it is being developed to produce day-to-day performance data together with data for long term maintenance strategies; a statistical package which will use the information for the calculation of elemental life is also under consideration.

The application of such a system is now considered, first for school buildings and then for housing.

2. School buildings

School buildings represent a substantial part of the United Kingdom's building assets. A wide range of constructional solutions emerged in the post-war era, some of these solutions were significantly affected by developments in aesthetic perception and changes in teaching methods. The latter had a great influence, particularly in the 1960s and early 1970s, on the layout of schools, which in turn affected design solutions. All types of constructional solutions were officially encouraged, ranging from traditional construction to timber, steel framed, and concrete systems. Over two dozen systems were used in the U.K. to build schools, including eight 'schools consortia' systems formed by groups of like-minded county authorities.

The investment in school building was controlled by a system of overall

cost-limits per pupil place and detailed cost-planning of individual school design solutions, which resulted in wide variations in quality of buildings and area provided per pupil place.

In the last decade there has been a reduction in U.K. school construction activity and a fall in pupil numbers which presents problems of under-utilised buildings in some parts of the United Kingdom.

Some schools, particularly the small rural schools, have been under threat of closure because of the high pupil place costs involved; this is due to the very low teacher/pupil ratios in such schools. A low pupil ratio is also reflected in the non-teaching costs, particularly the cost of maintenance, it is necessary therefore to have a feedback system which enables authorities to monitor costs for schools of varying size and occupancy.

Because of the large number of schools built during the 1960s and 1970s the peaking of 'major replacement' maintenance is upon us, the problem is exacerbated by severe restraint in public sector expenditure. This means that the maintenance of building assets has taken on a greater importance and as a result there is a need to apply management expertise and the use of computer-based systems to the problem.

3. Capital costs and quality of school buildings

Capital cost differences for apparently comparable schools were found to vary as much as 200 per cent (1). These cost differences appeared in spite of the fact that the Ministry of Education had provided a system of cost planning (2).

One of the effects of the Ministry cost planning system was to reduce circulation space, thereby achieving cost reductions. After examining initial capital cost data from over two thousand Primary Schools, Spedding (3) concluded that quite wide variations had occurred in the quality provided in school buildings due, in many cases, to economies made in construction in order to achieve a satisfactory amount of floor area. This was not an acute problem when resources were available to rectify the problems of construction but in recent years increased pressure on County Authority expenditure has highlighted the

maintenance problem.

4. Maintenance expenditure on schools

As a result of the increased importance in maintenance of schools a study (4) was carried out by the RU for the Department of Education and Science (DES). The study involved extracting maintenance cost data, for the period 1977 to 1982, from the works order files and cost ledgers of a large County Authority and then coding them for computer analysis. To do this a coding system for building maintenance cost analysis was developed (5), the code is hierarchical in nature and is based on functional elements and sub-elements of buildings. Figure 1 below indicates in histogram form the relative costs of the elements examined in the DES study.

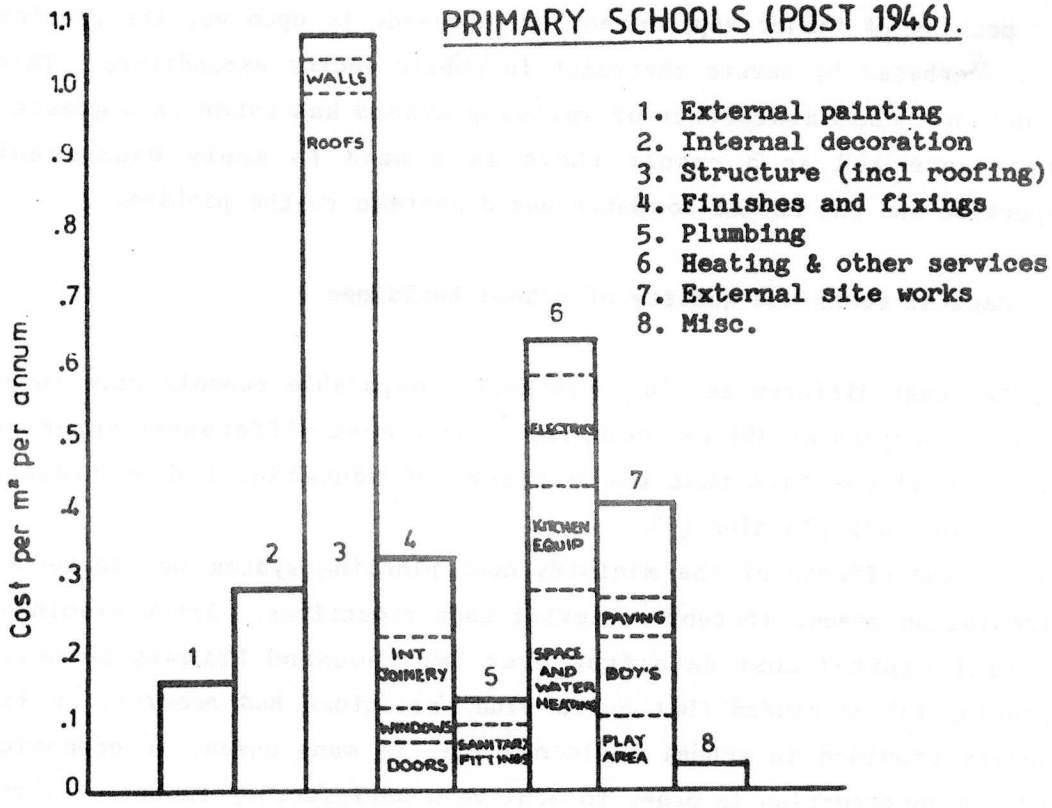


Figure 1 Elemental maintenance costs (1977-82)

In a study of maintenance on Scottish schools the coding system was used to produce feedback on elemental costs and job frequency for various types, ages and sizes of schools, Table 1 shows maintenance frequency (jobs per 1000 m2 floor area) for various sizes of school. Table 2 shows the number of jobs (by broad element) per 100 pupils. This kind of feedback and analysis is necessary if efficient asset management is to be pursued. A detailed coding system is the pre-requisite to good asset management and this is well established for dealing with schools, however, the other aspects of feedback, namely, condition surveys and property files are still at the development stage and research is currently being undertaken to determine the most cost-effective method of dealing with the information.

5. Housing in the UK

The RU at Bristol Polytechnic is heavily committed to asset management in local authority housing. Various projects have been carried out to determine the level and detail of feedback required to produce meaningful data to help with policy making and budgeting. The current move in the public sector, in the UK, is to provide long-term programmes for maintenance so that various methods of management and funding can be monitored. In a move towards such a plan the RU has suggested that the following aspects be considered:

5.1 Recording maintenance costs
5.2 Coding maintenance work
5.3 Assessing stock condition
5.4 Establish total maintenance need
5.5 Formulating maintenance policy

All the factors are linked in some way and the order of the list will vary amongst authorities, nevertheless each of these factors has to be considered to produce an effective maintenance plan. These factors are now considered in the order listed above.

TABLE 1 JOBS PER 1000m^2 FLOOR AREA (1982/85) - LEVEL 3 CODING - BY SIZE OF SCHOOL.

Code	Job	Small	Medium	Large	V. Large
342	Roof coverings	16.9	10.3	8.2	1.6
411	Doors & frames	10.0	5.2	5.7	2.3
412	Door ironmongery	11.2	8.4	8.8	4.0
423	Window glazing	5.7	11.0	19.5	2.8
431	Wall finishes (int)	4.0	2.4	2.3	1.2
433	Floor finishes	2.0	3.8	4.1	1.3
448	Other joinery	2.0	3.4	3.6	1.0
524	W.C. cisterns	3.4	3.0	5.1	1.2
535	W.C's	4.9	4.2	5.5	1.0
610	Heating unspecified	11.5	6.7	6.8	1.8

TABLE 2 JOBS PER 100 PUPILS - PRIMARY AND SECONDARY SCHOOLS

Element	Code	Jobs per 100 pupil	
P = PUPIL NUMBERS		Primary (p= 11590)	Secondary (p= 7652)
Structural repairs	3	9.3	4.4
Structural finishes & fixings	4	22.6	19.1
Plumbing	5	9.5	7.0
Heating & Lighting	6	7.3	6.2
External works	7	4.7	1.7
Ancillary services	8	0.2	0.4

5.1 Recording maintenance costs

There are a number of options available when it comes to recording maintenance work and costs. Some authorities record their maintenance work by trade, they find this method useful because they can develop schedules by trade and obtain tenders from contractors who operate in a single trade, say, plumbing; and the DLO's have plenty of experience in tendering for trade schedules - so there is much to commend this way of dealing with the work.

Others record their work by element, e.g. work to walls, to roofing, to windows etc. - by this method costs can be obtained for the performance of the structure which may not be possible if data is stored by trade. Clearly, one could use a mixture of these options but this could be difficult to manage in terms of data analysis.

The recording system at Bristol deals with elements but there is no problem in linking specific trade schedules to these elements. In other words when a job is recorded as, say, 'repair broken ridge tile', - then the computer could print the required trade detail on the job ticket, it is merely a matter of the job code triggering the job description and the materials schedule.

Suitable cost feedback is necessary to determine maintenance trends. It is necessary to know whether costs increase with age and by how much, it is also necessary to know specific costs, such as the cost of maintaining elderly person's dwellings or high-rise dwellings.

Planned maintenance is normally based on elements, rather than on trades, therefore the option of elemental feedback has much to commend it.

Most managers are too busy to find out what they can achieve, in terms of feedback, from their maintenance system and many systems are very limited in their ability to handle data. Many authorities have computerised information systems which improve the process of recording and issuing of works orders, but few have developed the potential for analysing the mass of available data.

This leads us to consider the second factor, namely, coding the work.

5.2 Coding maintenance work

One of the most important features of any information system is the method of coding. The options here are linked to the initial concept of feedback, however, many authorities have introduced systems which primarily satisfy accounting procedures and some authorities are now realising the restrictions. The coding system developed at Bristol was developed in the first place for housing and then extended for other buildings. It was tested on many thousands of jobs for both houses and schools (6). The analysis of the data, from the testing, showed that a great deal of information can be assembled quickly to give an overview of the stock. Because the code is hierarchical in nature one can stop the analysis at a particular level to suit the investigation. For example, Figure 2 shows repair and painting costs over a ten year period. Figure 3 shows repair costs for dwellings built in particular age bands.

Providing the various house types are recorded one can easily assess the costs over a period of time and locate the worst performers - see Figure 4. However, the code is intended to do much more than that, for example Figure 5 shows the expenditure, per dwelling, by element. Two things will be noticed from Figure 5, first, that the painting costs are very high; secondly, that expenditure on finishes and fixings is higher than any other repair element. Clearly, the latter can be investigated, by simply going to the next level of coding.

The principle of having a flexible coding system is that one can code to whatever level one wishes, in fact after a period of time a specific number of codes will dominate, say about forty codes in the case of schools and say twenty for housing. These codes will provide feedback on both incidence and cost and can be used for plotting trends and preparing maintenance strategies. Concerning the latter, planned maintenance should be influenced by the trends for 'response' or day-to-day maintenance. A rising pattern of repair costs for a particular element might necessitate a condition survey for that element. Maintenance managers should make a positive move towards obtaining detailed analyses of their maintenance data and using such data to formulate strategies and budgets.

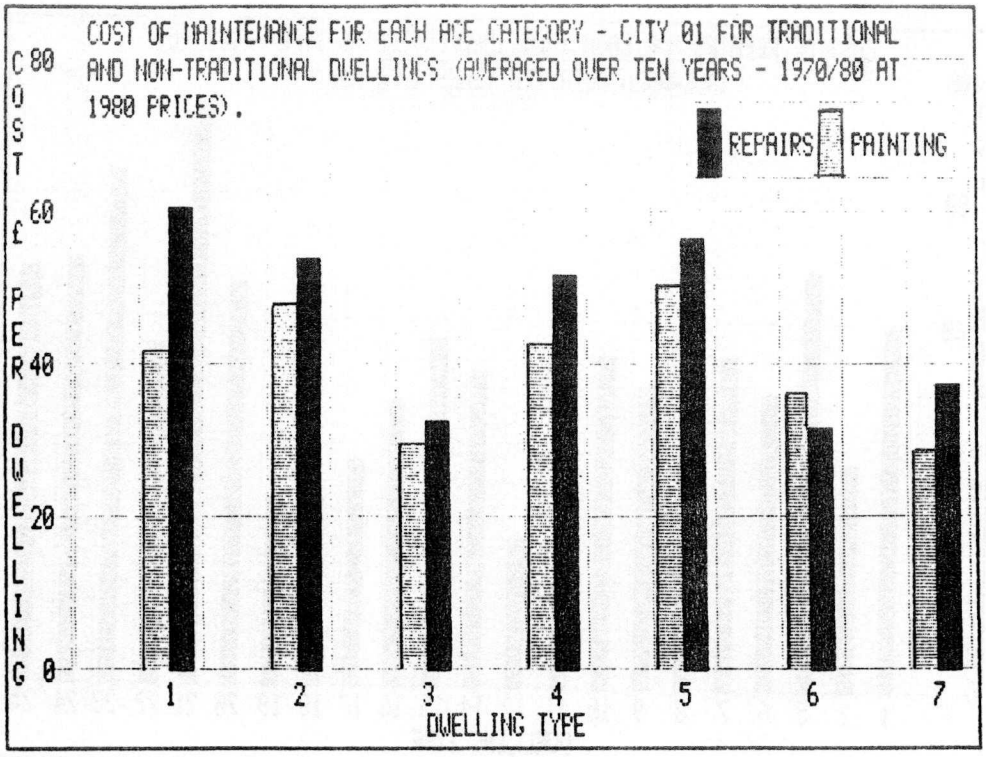
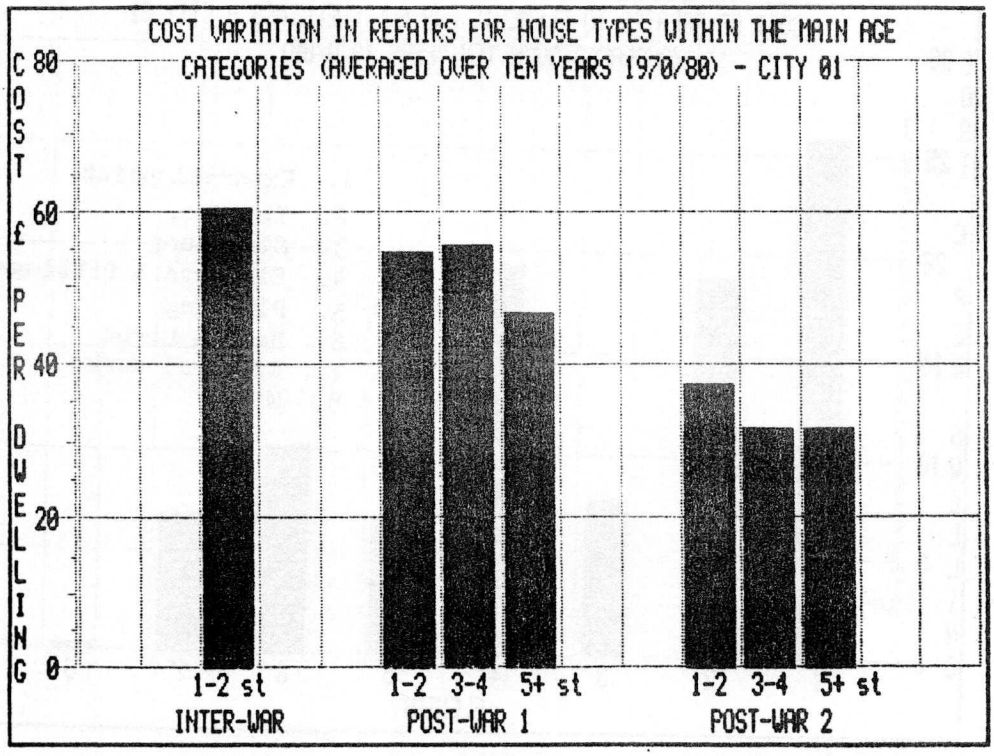


FIGURE 2



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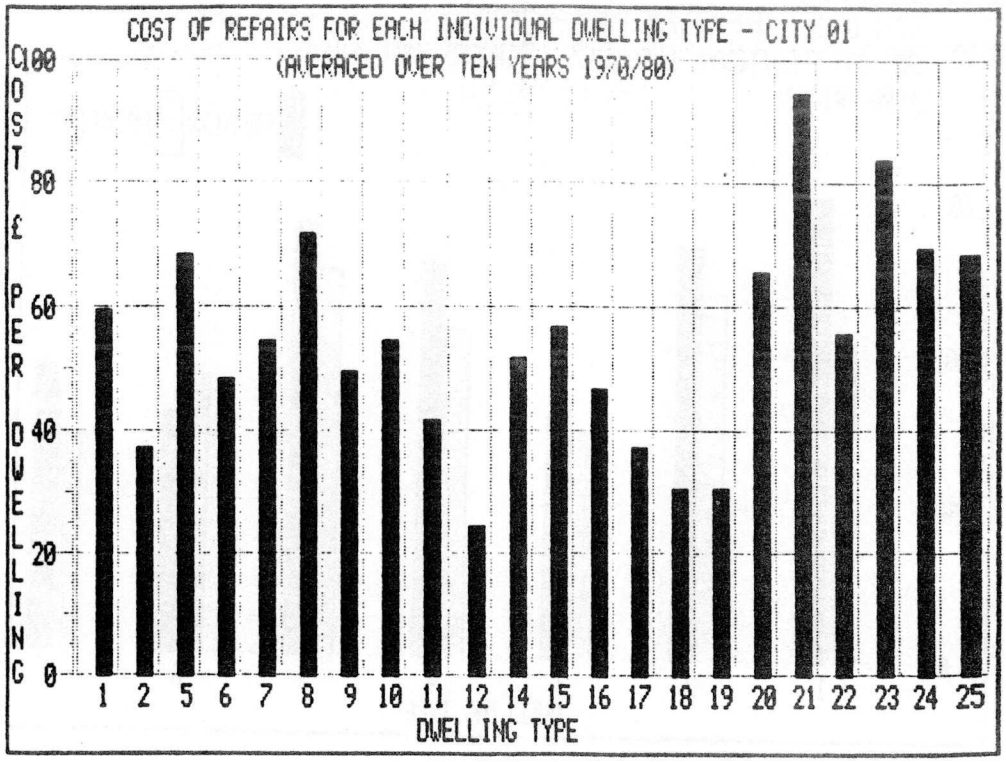

FIGURE 4

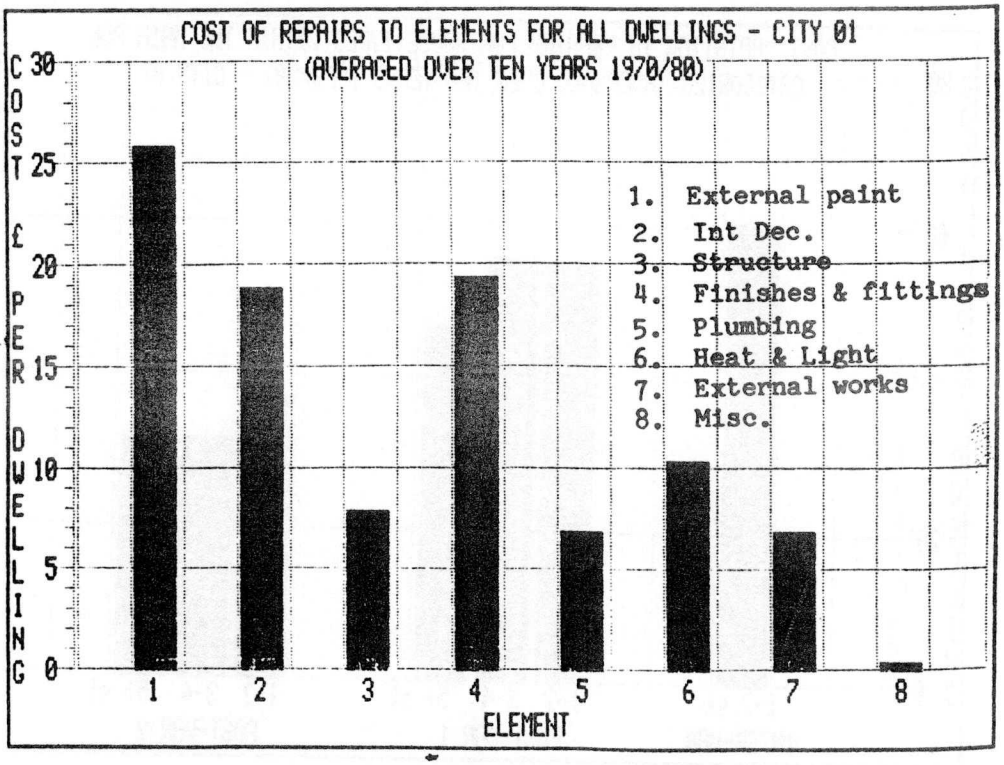

FIGURE 5

5.3 Assessing stock condition

The second aspect of feedback information deals with condition surveys. Options here are concerned with scale of operation and use of data. A number of housing authorities have employed the expertise of specialists to do a 'one off' survey of their stock. However, before undertaking a condition survey there is a need to consider the purpose behind such surveys. Building surveys may have a specific purpose, such as checking the stability of particular building structures or specific elements within a building. However, in this paper the general purpose is one of assessing the condition of building and services elements with a view to producing a programme for maintenance work. The purpose should determine the level of detail, but other factors also have influence; these factors include the manpower available for the survey and data entry (if being used for on-going assessment), the storage capacity and type of analysis required.

The amount of data and type of element being assessed must be considered carefully, this will influence the design of the survey forms and the method of storing data. There is a tendency to collect too much detail.

One problem to be addressed is the number of categories of condition that we use. In one survey the condition was recorded in categories 1 to 8, category 1 being 'very poor' and category 8 being 'excellent', or words to that effect; the grading may of course be the other way round. There is a case for making the condition scale simple and meaningful in respect of the priority required. The grades could reflect the action required rather than the detailed condition. Take, for example, 5 categories; Condition 1 could denote maintenance being required in the next year, condition 2, an element requires attention within two years and so on. If necessary two extra categories, say 10 and 20, can be inserted for long term planning. In this way condition surveys will express the need in terms of 'this years, next years' maintenance strategy. The rationale for this is simple, while there is a need for long-term strategies, and that need can be accommodated by using a suitable category, the main purpose is to prepare the planned maintenance programme for the next five years. Moreover, the main

value of the survey is to help senior managers to decide where to spend the limited budget to get best value for money. The latter has to do with 'comparative need' as opposed to 'perceived need'.
When surveyors carry out condition surveys they are recording 'perceived need', and the simple grading tells us what their perceptions are. However, we would rarely, if ever, have the money to do much more than all the 'category 1' work. The immediate budget therefore will be concerned only with those elements graded at that level. The problem is that we may not have enough funding to deal with all 'perceived' category 1 jobs and therefore someone has to compare the various needs to establish which estate, building or element should go into the programme. The 'comparative need' assessment will involve a senior member of the maintenance team. Extra visits may be necessary, to specific estates, so that a second opinion can be given and a final priority established.

5.3.1 Maintenance feedback and condition surveys

Maintenance feedback can be of great assistance to the design of a condition survey form, for example, an analysis of the top twenty jobs, in terms of incidence or cost, might show that they cover the bulk of the elements that we should be monitoring. Moreover, maintenance feedback will indicate the value of earlier maintenance decisions and therefore should be used in conjunction with condition surveys when preparing the maintenance strategy. Figure 6 shows part of a typical condition survey form which has been designed from maintenance feedback.

5.3.2 A practical approach with condition surveys

There are options in the way such surveys are organised, the survey can be organised by estate, by area, or any other division.
On large estates, which have repetitive designs, a sampling technique can be adopted, say, 10% sample; though clearly if there is a problem with the structure, e.g. settlement cracks, then a full survey will be necessary.

FIGURE 6 SAMPLE OF CONDITION SURVEY

Notes: The categories for assessing condition, i.e. 1 to 5 and 10, indicate the likely time that work should be carried out. For example condition 1 means that work is necessary in the first year of planned work after the date of the survey, 2 means the second year and so on. Condition 10 has been included to indicate that no work is envisaged within the next five or six years (or painting cycle), rather than a strict condition of ten years. In other words all elements can be assessed in terms of work that needs doing within a five year plan - in year five a further survey can be carried out. This means that the condition survey can be done at the same time as the inspection for 'repairs prior to painting (RPTP).

2.0 EXTERNAL WORK	DESCRIPTION	CONDITION 1	2	3	4	5	10
2.1	Roof	Flat - felt	✓					
2.2	Chimney							
2.3	Flashings							
2.4	Fascias & bargebds							
2.5	Gutters	Plastic		✓				
2.6	RW pipes	"		✓				
2.7	Doors							✓
2.8	Windows							✓
2.9	External decoration							
2.10	Paths							✓
2.11	Gullies							✓
2.12	Manhole covers							✓
2.13	Fences/Walls	Timber	✓					
2.14	Outbuildings							
2.15	Window boxes							
2.16	Balconies	Conc.						✓
2.17	Railings							✓
2.18	Canopies	Conc	✓					

The survey should be simple to conduct and easy to translate to the computer. All category 1 work should include an estimate of the work involved, a data base containing a standard list of prices can be used for that purpose. A programme of work should be produced for each area or estate, this programme will cover a five year period, possibly with a ten year forecast, if required.

An initial budget can be prepared for all the category 1 work, if this comes within the limits of an overall budget forecast then specifications can be produced and tenders obtained. If the initial budget is likely to be outside the limits then a 'comparative need' appraisal is necessary; this means that the needs of one building or estate is compared with the needs of another building or estate and the priority agreed. Each year the computer upgrades the condition rating by deducting one year from the surveyor's assessment, so, in the second year condition 2 has the rating of 1. This allows the financial commitment to be calculated on the computer. Spot checks on the computer assessment can be made, by surveyors, before the programme is assembled.

5.4 Establishing total maintenance need

Condition surveys are linked to the concept of programmed maintenance, and many believe that authorities should be moving more in that direction. However, there are other areas of maintenance, besides planned maintenance, that need to be assessed and managed and these form part of the total need.

These other areas of maintenance include tenant requested maintenance, or 'response maintenance', which can account for 50% of all maintenance expenditure, and work due to change of tenancy (COT).

Concerning the first, often called day-to-day work, maintenance feedback should be used. From this feedback it should be possible to produce a forecast for the next two years for the likely number and types of job that may occur. This is best done either on a group or estate assessment. Group assessment will include such things as: age of dwellings - how much did plumbing cost last year on the pre-war dwellings?, or type - how much did plumbing cost on non-trad

dwellings?, or height - how much did plumbing cost for 2 storey dwellings compared with 3-4 storey dwellings, or function - how much did plumbing cost for elderly person's dwellings?

By analysing these data cost trends can be produced for each specific group of dwellings; not only will it show the high cost elements, which may lead to planned maintenance but it will also give an indication of the state of the stock and the likely demand for the following year. Perhaps the best indicator is to simply print out the top twenty jobs, in terms of number of repairs per 1000 units, together with the average costs, for various groups of dwellings.

The alternative is to assess this need by estate, and there are good reasons for doing so, particularly if decentralisation of management is being considered. It has been noted, by the RU, that even with central control there are wide differences in performance across estates and these should be examined when forecasting the need or demand for the following year.

Secondly, the demand caused by COT must be considered. In this case the estate approach has much to commend it because the rise and fall of the number of COT's can often be linked to estates. Feedback from a number of housing projects indicates that every COT is equal to three years day-to-day work, in other words if there is an average of 3 jobs per dwelling, per annum, for day-to-day work, then one can expect to do nine jobs for every COT. The above figure is only a rough rule of thumb and authorities would need to check this with their own feedback data. Ratios for certain conditions can be produced so that needs can be established. The reason for the higher figure for COT work is based on 'perceived need', the inspector who visits the dwelling is likely to report much more work than the tenant simply because of the inspector's expertise.

So, in assessing total need and producing a meaningful maintenance plan we have to set down the various areas of operation e.g. day-to-day, planned, emergency, COT etc. and produce feedback on those operations so that trends and estimates can be forecast.

5.5 Formulating maintenance policy

Policy has been found to be the most influential determinant in asset management (8), it is often reflected in the following areas:

a) Technical decisions
b) Operational decisions
c) Socio-environmental decisions

Technical decisions

These should be based on break-even points, the maintenance feedback should show whether it is economic to repair or replace components. Information on the 'life-span' of components should be produced from the data base. If feedback information is well managed there will be a wealth of information that will help with technical decisions.

Operational decisions

Should work be done by DLO or Contractor?, the Audit Commission (7) say that this is not a matter of ideology but of capacity, cost and service. Some measure of these factors is needed. The average job cost or time can be calculated from feedback information. A good recording system will produce such figures quickly. Then there is cost and service, what is the true cost of pre and post inspection? What does it actually cost to ensure that a labour-force is performing well? How are priorities maintained? Feedback information should be developed to check these factors so that operational decisions have a sound base.

Socio-environmental decisions

This covers the factors that influence tenants and estates. Why do some estates appear to be less well maintained than others? What is the response to tenants who want low priority work done?
How is the 'maintenance spend' determined for an estate?, how are the

external works, such as painting, fences, pavings etc., prioritised so that the whole estate benefits, rather than an individual dwelling?
All these factors can be assessed if the information system is carefully managed.
The final aspect to be considered is the property file, this should have a direct link with the maintenance recording system and may also be linked to the condition survey.

6. Property files

In a current study the research team at Bristol is finding that few authorities have found it worthwhile to collect and collate detailed data on their properties, although many are now considering some kind of computerised system for such data. One of the questions being asked is 'what type of information should we collect', it appears that by concensus two aspects of property data need attention:-

1. The physical details of the property, including the amount, the type and location of elements and components.

2. The condition of these elements and components, updated as they are repaired or replaced.

Clearly, it is not economical to record information on every aspect of a building at the level of detail which may be useful at some time in the future. Therefore, for detail, it might be worth considering those elements or components which move or are subject to the effects of the weather. Such detail would include data to identify or order a specific component.
In addition to element or component detail it will be an advantage to record the location by block or specific part of the building. This will, in the case of schools, take into account the age factor; often a school has extensions of varying ages and one cannot anticipate the failure rate of components if the location and age factor is not recorded.
Having got all this information all one needs is the actual condition

so that an analysis can reveal the potential work ahead. This information is obtained from condition surveys.

7. Conclusions

The stock of buildings is varied and complex, in terms of design options and components used, therefore to achieve cost effectiveness in built asset management it is necessary to have a well managed information system which can produce detailed feedback. A logical method of coding maintenance data must be developed so that maintenance cost trends can be plotted and cost-effect solutions prepared. Programmes of work, together with accurate budgets can be enhanced if such coding is comprehensive. The management function is further enhanced if condition surveys and property files are employed, this allows 'comparative needs' to be determined by senior staff; without such comparison there is a danger of maintenance expenditure being 'surveyor' led. An information system which allows rapid analysis of data is essential for cost-effective maintenance management.

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