AN INVESTIGATION INTO INEFFICIENCY IN THE CONDITION BASED MAINTENANCE PROCESS

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Current figures indicate that approximately half of the UK Construction Industry output is carried out in the repairs and maintenance of existing buildings. Despite this building maintenance is still generally perceived as the "poor relation" in the construction cycle. The evolution of maintenance management methodologies endorses the prevention is better than cure thinking that culminates in the development of Planned Preventative Maintenance (PPM) programs. These are seen as the industries standard 'cost effective' method of managing repairs to building fabric and plant. Current PPM strategies rely heavily on the use of condition surveys. These subjective methods of condition assessment do not support the more desirable whole life performance (sustainable) approach. It could be argued that several factors, including the performance of the component in relation to the client's needs/expectation, should be taken more fully into account. This Project aims to outline the position, at the current time, of planned and responsive maintenance. In particular it considers the deficiencies and problems inherent in planned maintenance. It also considers the key problem of the inability of maintenance management systems to forecast or accurately predict maintenance requirements. This is validated with raw data from Residential, Commercial and Leisure sectors. It is hypothesised that significant amounts of waste are inherent within the PPM system and that condition based maintenance strategies may not be the epitome of efficiency. If successful the project will scrutinise the relationship between user, building and environment. It will also provide a conceptual model that is perceived to be more accurate and predictive of maintenance inefficiencies and applies sustainable whole life performance principles to the maintenance process.

Keywords: maintenance management, management systems, modelling, Stock Condition Survey, Sustainability.

INTRODUCTION

The UK construction industry accounts for approximately 10% GDP and employs 1.5 million people. The built environment continues in an endless cycle of construction, use, repair, maintenance, and demolition. The affect of the above cyclical process causes waste and consumes energy like no other sector (DTI, 2001). In recognising these inefficiencies the UK government has identified the construction industry as a large contributor in achieving its aims of improving the collective quality of life of UK citizens.

The UK construction industry has begun to address the inefficiencies identified above and the need for a more sustainable environment, however, the vast majority of work

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to date has focused on the design and construction phases of the building lifecycle. It is currently estimated that 50% of the UK construction output consists of repairs and maintenance to existing built facilities. It is well documented that maintenance has always been seen as the poor relation to construction represented as ‘‘unattractive’’ (Seeley 1976), ‘‘slightly inferior’’ (Milne 1985), a ‘‘Cinderella’’ activity (How Son and Yuen 1993) ‘‘the poor relation of the new-build sector of the construction industry’’ (Michel 1994).

Given that the maintenance sector does indeed form such a large slice of the construction industries total output it is surprising to note that there has been a marked lack of development in the measures used to assess the maintenance requirements of building stock, both in national terms and with individual buildings.

Background

The project being developed by members of the Sustainable Buildings Research Group at the University of Greenwich aims to review the currently accepted methods and practices of built asset maintenance management, develop a progressive conceptual model that is predictive of maintenance inefficiencies and applies sustainable whole life performance principles.

The project bridges three specific areas of study and builds on previous works by the Authors in each of the following topic areas.

1. Performance versus Condition based maintenance.
2. The integration of IT systems in Maintenance Management and Performance Monitoring.
3. Determining Waste and Inefficiencies in Building Maintenance.

The over arching objective of the collaboration was to provide a strategic framework on which to study current maintenance management practices within the built environment. The project focuses on three specific industry sectors - Housing, Leisure and Commercial. However it is anticipated that the findings and subsequent recommendations could be applied to built assets in other sectors.

Initial studies into maintenance strategies adopted by other industries, including marine and aerospace industries, clearly indicate that lessons could be learnt and applied to the maintenance of built assets. In such industries the maintenance regimens are driven by the consequence of failure. The failure of a key component and subsequent consequences of that failure applied to a plane at 20,000 feet focuses the aerospace engineer to achieve a level of maintenance as yet not found in the building industry. Quite clearly the engineer sees the monitoring of the continued performance of a component as a key factor within the maintenance regimen. In built asset management, we still place unnerving faith in subjective condition based maintenance strategies without full consideration of either the performance criteria expected or the true consequences of a failure.

Another aspect the project aims to study the integration of IT systems in the monitoring and performance of the building components. Previous work by Jones et al (1999) indicates that in comparison with other industries, the building maintenance sector has not integrated IT into its maintenance management systems to an effective degree. Such technology is seen as simply a 'bolt on' to traditional manual methods. An example being that whilst facility and maintenance management software is widely available, enabling the user to schedule a repair program, the condition of the building components forming the data for the software program still have to be assessed manually. In the Automotive industry, IT has been developed to an extent that virtually all modern cars have performance monitoring chips that that are plugged into diagnostic analysis hardware at the service station. The services engineer can then target the cars maintenance requirements based on any deviations away from expected performance. Again to do this successfully one must have a clear understanding of what the expected performance is.

Maintenance – Condition based Performance?

Maintenance can be defined as ''the combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function'' (BSI 1991).

For the purposes of clarity and focus, the administrative action and its associated functions (both fiscal and organisational) are not discussed in great detail within the context of this paper. The full coverage required to do justice to these elements within the context of the framework proposal will be included by the projects conclusion.

In focusing on the technical aspects of the BSI definition we move towards:

"the notion of an acceptable condition, which implies an understanding of the requirements for the effective usage of the building and its parts, which in turn compels broader consideration of building performance" (Chanter & Swallow 1996).

As can be seen, the key words condition and performance are closely associated and reflect the maintenance sectors current attitude that acceptable condition meets the required performance criteria expected by the Client/Customer stakeholder. However the question arises – Are we over specifying repairs and maintenance based on condition or misinterpreting the stakeholder's requirements in terms of performance?

A key aspect in determining performance is the assessment of performance failure especially in terms of cost and impact on the core business. The effectiveness of maintenance systems and the impact of component failures are effectively assessed in built asset maintenance. Most maintenance managers will be able to quote the cost of the materials and labour for a maintenance operation but not the cost in terms of lost

service provision, disruption to production and loss of credibility by the user or customer. A different approach is taken to failure impact assessment in the manufacturing industry. The failure of plant on an assembly line has the potential to stop work to all operations "down line", effectively grinding production to a halt. Performance is actively monitored and the consequences of performance failures scrutinised and understood.

Planned Preventative Maintenance

It is still very much an accepted adage that prevention is better than cure. This philosophy remains true in the maintenance of buildings and for the most part it is clearly deemed financially efficient to carry out repairs in a planned manner than to allow a failure and replacement strategy to dominate any maintenance policy.

A wide range of management methodologies have been used over time for maintenance, each of which claims to offer a more efficient maintenance management system than the system they are replacing. Wood has identified various examples of maintenance management systems, such as "Just in time maintenance"(Smyth & Wood 1995), "Intelligent building maintenance" (Wood 1998), "Sustainable building maintenance" (Wood 1999a), and Call-centred maintenance" (Wood 1999b). All of which the author claims are meeting the need of the user rather than just the process of technical data collection, however there is no evidence that these paradigms are workable, or are for the benefit of the stakeholders involved.

The main exemplar used by the industry as a viable solution to the problem of efficient maintenance management is Planned Preventative Maintenance.

PPM has long been established as a 'cost effective' means of maintenance. However under scrutiny there is little evidence of this 'cost effectiveness' given the mismatch of condition and performance against the clients expectations. Generally PPM strategies dictate a schedule of maintenance actions carried out either (a) at predetermined intervals after the construction and handover of the new building or (b) after initial and subsequent condition surveys.

a) Maintenance based on predetermined intervals

Given the bespoke nature of buildings, the application of maintenance regimens based on maintenance actions carried out at predetermined intervals is at best difficult to manage. Predicting wear on building components and plant without a true and ongoing assessment of factors such as the buildings daily usage, internal and external environmental conditions and user interaction leads to an incomplete picture of the actual maintenance requirements and subsequent inefficiencies appear. Many of the maintenance regimens are set up soon after building completion and focus on the "servicing" element of plant and equipment. Building fabric tends to be left off the agenda because of the longer intervals between maintenance cycles and difficulties in accurately predicting failure.

It is recognized that a major disadvantage of time based systems is the completion of maintenance, be it repair or component replacement, regardless of its actual condition with work being carried out because it is due not necessarily because it is needed.

b) Condition based assessment.

Stock and Building Condition Surveys are the mainstay of the majority of PPM strategies when applied to older, existing properties. The assessment of the condition of the buildings components is completed in cycles with the cycle being determined by the nature of the building type and its use. Each component of the building is examined and a subjective appraisal by the examiner leads to a determination of whether repair or replacement is required, either immediately or as part of a future maintenance program.

The main weakness of the condition survey is its subjectivity. The tendency for the assessor to concentrate on the material condition of the component rather than the condition in relation to the performance requirements in use leads to difficulties in prioritizing repairs.

An overwhelming point to consider so far is the fact that none the current systems favoured by the maintenance industry as standard practice place any great significance on how the buildings performance meets the needs of the building user or users.

Assessment of Maintenance Needs

Given that it is conceivable that the current thinking on maintenance needs may be flawed, further consideration should be given towards current data collection process and its integration into PPM regimes.

To date, those associated with data collection have focused their attention on the technical assessment of the condition base, the rectification of faults and the measurement of defects in terms of time and quality of the rectification of these defects (BRE 1983; NBA 1987; Richardson 2000) alongside large programs of PPM (Finch 1988; Jones and Collis 1996; Pitt 1996). Consequently there has been a “continual emphasis on the correct publication of technical solutions” (Atkinson 1998) and that “managerial influences underlie many errors leading to defects”.

It is clear that identifying the optimum production system for maintenance will require the resolution of a number of fundamental questions, the most significant of which is that of whether maintenance is in fact a production process at all.

Initial analyses carried out by the University of Greenwich' Sustainable Research Group (SBRG) has characterised maintenance as a low volume, many products activity with a jumbled flow and loosely linked project segments. As a result it has raised a number of maintenance management challenges in respect of how to reliably schedule activities, materials and capacity considering the lack of flow, ensuring effective delivery, and flexibility. There is however also equally significant logic and evidence to suggest that it can be managed as a production process of some description. Ultimately, the research will determine the nature of maintenance and its management in terms of a production system, as the first stage in developing a new optimised maintenance management system. Inevitably economics will be a major determining factor.

Building Life

The life of the building must be taken in to consideration at this point along with design. The maintenance of the building is inextricable linked with design alongside the determinable length of time the building will actually last. In social housing terms it was common in the UK to assume a design life of 60 years simply because that was the repayment term of the finance to the Public Works Loan Board. This in itself is now under considerable debate as there is no evidential basis for the assumption that a building will assume a design life of this short term.

The building life is also dependant on it usage and the type of inhabitants that occupy the building. The comparison between the residential, commercial and leisure industries is based purely on the condition-based assessment of the stock condition survey of the relevant portfolios.

For the purpose of this project the residential, commercial and leisure data is acquired from a medium sized local authority that provides social housing for some six thousand houses, a commercial collaborator (details withheld for commercial reasons), a blue chip company that has one of the largest building portfolios in the country and Greenwich Leisure who maintains property primarily throughout the south east of England provides.

The organisations that provided the data have all identified the stock condition process as a possible cause of inefficiency in their PPM system.

The residential provider spends up to 1.57% of its budget on the stock condition survey process, the commercial provider spends 1.66% of its budget and the leisure provider up to 2% of its maintenance budget on the process.

At first viewing these figures do not seem excessive, however, when they are considered in monetary terms they represent large, and to the various organisations, significant sums of money.

A series of workshops/interviews with the commercial organisation identified the stock condition survey's cyclical process as fundamentally inefficient and in particular they considered the need to survey 100% of their built asset base (whether undertaken as a single activity or spread over time) in order to identify only a small number of maintenance/repair issues as un-sustainable. The organisation are currently developing new maintenance needs prediction systems which rely on the concept of 'SMART Maintenance Planning'. In this context SMART is perceived as more for less, both in terms of the money spent to identify problems and the value of the information that results from the 'survey' approach.

The Leisure provider had also recognised that the stock condition process was inefficient and, when the costs for their particular process reached 2%, they decided to take action to reduce the cost burden of this process. The leisure provider decided purely to look at historical data and produce predictive charts per building in order to set their macro level budgets. It must be said however that most of the buildings in this organisations portfolio was in local authority care prior to its privatisation and so a lot of historical data was available in order to analyse the condition of the portfolio. This ad-hoc approach is currently being extended in line with the principles of SMART maintenance planning.

Finally, whilst the residential sector also recognised that the stock condition survey process was inefficient (89% of respondents to a questionnaire indicated that the process was inefficient) they did believe that it had a role to play as a macro level budget setting tool. However, on further review it appeared that the primary reason for this acceptance was more to do with a lack of knowledge of other possible approaches rather than a positive endorsement of the quality of the stock condition survey approach. Again the concept of SMART maintenance planning is currently being examined within the context of social housing maintenance, with in this case the emphasis being more on its use as a vehicle to improve the quality (sustainability) of the stock rather than reducing maintenance costs. This aspect of the SBRG work is being funded by the Engineering and Physical Sciences Research Council through their Sustainable Urban Environments programme.

CONCLUSION

In order to achieve this new holistic approach to maintenance a process is needed in order to ensure that the life of the building reaches its definitive age. This is to be achieved not through the process of an absolute mathematical solution, but rather recognising that a new paradigm in time will replace the existing model through innovative theories and hypotheses through which new accepted methods and changes in building uses, design and methodologies become the 'norm'.

For e.g. nobody could have predicted the impact of communication systems through out the built environment and the subsequent changes this impact has had on the design and use of buildings both within the built environment and that which is yet to come.

The stock condition process identified above shows that although there are differences in building types, its uses, range and scope of individual programs and organisations however there is universal agreement between all of the different types of organisations that there needs to be a more efficient approach in the way that maintenance needs are identified.

The three projects have identified issues in line with the maintenance process that will lead to projects that look at how this new paradigm will be researched and although there is evidence across three different organisational types with different portfolios, the stock condition survey process is expensive inefficient and subjective.

Inevitably the current work in progress requires further definition in order that a new model can be developed.

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