Automation and Robotics in Construction XI
D.A. Chamberlain (Editor)

Essay: The conflict between accepted maintenance practice and evolving robotic and automated system maintenance on large groups of tower blocks.

R. Weston

Birmingham City Council Housing Department, Technical Services, Portland Road, Birmingham. B17 8LX. U.K

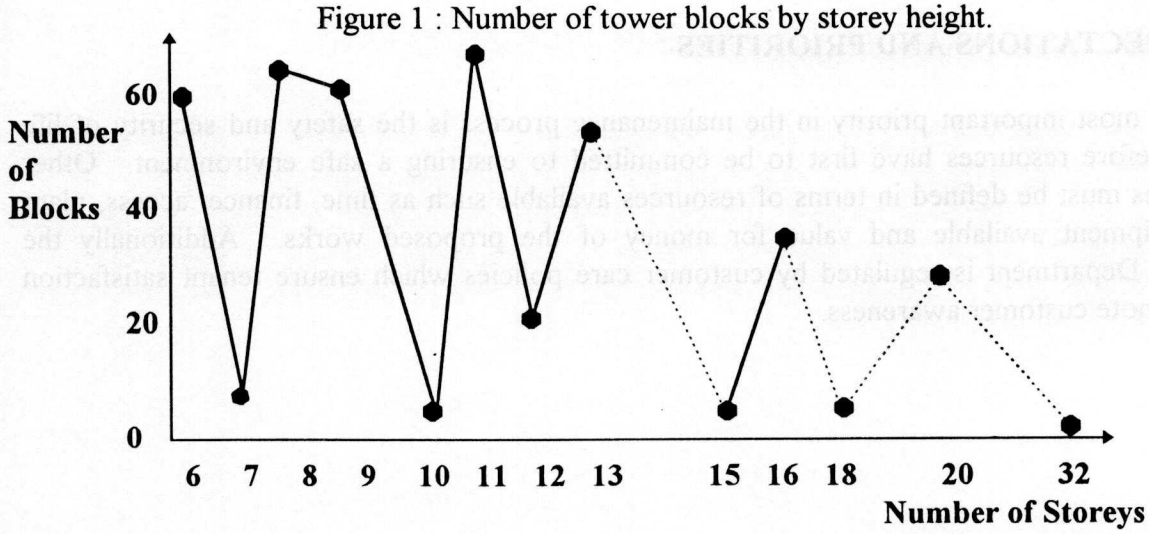
Abstract

This paper highlights the current conflict between accepted maintenance practices and evolving automated inspection techniques. Examples are cited from the experiences of Birmingham's City Council Housing Department which is responsible for the upkeep of over four hundred aging tower blocks.

1. INTRODUCTION

In Birmingham City Council Housing Department there are 414 residential housing multi storey tower blocks of six or more storeys in height. These blocks incorporate some 22,000 dwellings representing an approximate annual rental income of approximately £40 million. Of the total housing stock, multi storey flats are one fifth of all housing so any advances or developments in access technology or the use of robotics or automation would have a substantial impact on future maintenance practice (Fig 1). Particularly as most of the blocks were constructed in two building booms, one of the late 50's and the other in the late 60's, and therefore the blocks are now reaching a more intense period of the maintenance cycle.

Figure 1 : Number of tower blocks by storey height.



2. EXISTING MAINTENANCE TECHNOLOGY

The use of mechanisation in the repair and maintenance of tower blocks is extensive with the use of power tools, lifting equipment and access platforms.

Automation is generally limited to the monitoring of services such as the operation of permanent lift equipment. The Housing Department has up to now invested £1.5 million in such monitoring equipment in every tower block, also automated flat roof leak monitoring systems are currently being investigated. The use of robotics has not yet been used on blocks in Birmingham, but serious consideration is being given to the repair of vertical service pipes with an internal diameter of less that 150mm.

3. TOWER BLOCK CONSTRUCTION

Tower block construction in Birmingham can be categorized by generic structural type, one third are concrete large panel construction and the remainder are mostly concrete frame construction. The claddings vary widely, concrete panels are finished with mosaic or exposed aggregate, the masonry claddings are usually brick or blockwork and sand/cement render.

Externally the blocks have recesses, projecting balconies, satellite equipment, glazing, parapets and non standard alterations and additions.

Internally the shape of the blocks include ventilation ducts, service ducts and cores, lift shafts and stairwells.

4. MAINTENANCE REQUIREMENTS

Ignoring the major upgrading and refurbishment projects that are beyond the scope of this paper, the maintenance of tower blocks can be broke up into numerous categories varying greatly in cost and sophistication. The external categories include routine maintenance where isolated one off minor repairs are completed, planned maintenance, for example painting programmes for windows, palliative repairs where the work of a holding nature is carried out usually to one elevation only, for example the repair of spalling concrete. Across all of these categories span the requirements for inspection, scheduling, specification, testing of proposals and re-inspection of the completed works.

5. EXPECTATIONS AND PRIORITIES

The most important priority in the maintenance process is the safety and security of life and therefore resources have first to be committed to ensuring a safe environment. Other objectives must be defined in terms of resources available such as time, finance, access, plant and equipment available and value for money of the proposed works. Additionally the Housing Department is regulated by customer care policies which ensure tenant satisfaction and promote customer awareness.

6. EXISTING METHODS AND COST THRESHOLDS

The current recession within the United Kingdom building industry has created a glut of resources in terms of equipment, materials and labour. Even so, the cost of access on a simple external maintenance scheme to remove loose cladding materials or apply waterproofing materials can average 60 to 70% of the total cost of the works. In some cases the cost of access can make the work prohibitive financially (Table 1).

The materials used in the current maintenance market have been improved over recent years with particular reference to polymer science, but essentially the basic technology has not changed dramatically with the backbone still manual and craft skills. There is a locked in cycle of materials designed for craft skills that then require extensive access facilities. It must be clear that a system that has lasted this long must have powerful vested interests in access equipment, materials suppliers and low pay labour organisations.

Table 1 : Approximate Access Costs January 1994

ACCESS TYPES	HIRE RATES £	FIXED COSTS*	REMARKS
Abseiling	250	-	per day
Bosuns Chair	250	-	per day
Hydraulic Platform	600	-	per day
Cradle (15m)	100	200	per week
Mast Platform	200	800	per week
Isolated Scaffolds (10m)	1500	-	per week

* Fixed costs are for the erection and removal of equipment on a once only charge basis.

It is usual for the equipment to be hired in for a particular task or application, installation, site maintenance and removal on completion of the works is carried out by a specialist contractor. One of the very few cases where there is no alternative but to use a single system type for inspection purposes is the camera surveying of drains, but in this instance there are numerous competing companies offering similar services and prices tend to be restrained.

7. THE CONFLICT

To envisage the conflict between accepted maintenance practice and evolving automated and robotic system maintenance on large groups of tower blocks may seem alien to some industrial cultures where an atmosphere of consensus is more familiar. But unfortunately such antagonism does exist, particularly contentious is the introduction and management of change.

7.1 Points of Conflict

It would seem reasonable to assume that automated and robotic systems would be best suited to large uniform populations of tower blocks. Unfortunately, although many tower blocks in Birmingham are very similar in shape and construction, significant variances in surface cladding, texture and materials do exist creating a large number of small clusters of uniform populations of tower blocks.

7.2 Development Resources

Automated and robotic systems require a large investment in research and development even for the most basic of systems, frequently the client or his consultants are not in a position to provide the necessary resources, the small size of the contractors involved in the building maintenance industry and their fragmented nature also limits the ability of contractors to fund research and development work. Materials suppliers and manufacturers are the one section of the building maintenance industry with the critical mass and homogeneity to finance such research and development work, unfortunately materials manufacturers and suppliers prefer to invest their available resources in production rather than application.

7.3 Perceived Need

The perceived need for automated and robotic systems and understanding of the basic concepts of such systems is generally very low in the building maintenance industry. With key decision makers who have the authority and ability to promote the use of automated and robotic systems combining a lack of understanding with conservative attitudes to innovative techniques is a major barrier to the use of automated and robotic systems.

7.4 Building Services

Approximately 40% of the cost of a new building is in the building services such as lift equipment, drainage, gas, electricity, heating and ventilation. In maintenance terms such services have equal priority as the general building structure when considering safety and occupants' welfare, but the failure of services has a far greater impact on the flat dwellers' life style than the normal deterioration of the external structure. It is also far easier to build a robotic or automated system on a framework of building services engineering than one of general building maintenance, not least because of the intense political need for well maintained building services.

7.5 Replacement Cladding

With investment in the recladding of tower blocks costing in the region of £1 million per block or in the region of £120-£280 per square metre depending on the type of system used and the size and shape of the block, and not least because of the strict environmental regulations regarding energy consumption, the potential market for external recladding of tower blocks appears to be good, but more importantly the market will be continuous and steady for the foreseeable future.

With these market conditions it would seem appropriate to develop automated and robotic systems particularly in the surveying, inspection, design, manufacture, installation and future maintenance of cladding systems.

7.6 Comparative Advantage

Existing maintenance practice for tower blocks, although craft based and heavily dependent on costly access systems, is relatively inexpensive and simple, particularly with the current market conditions within the United Kingdom. Evolving robotic and automated maintenance systems would find it difficult to compete on a financial basis alone and must therefore have some other significant comparative advantage other than cost, for example on grounds of safety or the special requirements of a building which cannot be clad in scaffold.

7.7 Redundancy

The more traditional craft based maintenance methods for tower blocks are not frozen, but continually evolving and advancing with improved access techniques and new materials becoming more affordable and widespread. The market is not going to stand politely by and allow robotic automated maintenance to take a significant hold in the market without intense competition. In any case it may be that a very sophisticated and technically successful robotic system may be made completely redundant, when a change in maintenance practice renders the robot designed task no longer necessary.

7.8 Time and Site Progress

There is currently no real evidence that existing robotic or automated systems would provide significant savings in production time on site or dramatically improve site productivity. It could be that with automated monitoring systems some management time and costs could be reduced or management procedures speeded up, especially with automated scheduling which would not reduce scheduling time, but would reduce significantly data input times and input errors, usually found in keyboard input. There could also be benefits in the use of automated systems relaying emergency instructions or orders directly into contractors' offices. Claims that robots could work longer hours than men or operate in weather conditions unacceptable for men are hard to justify in terms of Birmingham's tower blocks. Robotic operations outside the normal working day would not be acceptable because of noise worries and the general alarm that the work may create in a residential situation. In any case it would not be safe for operatives to be operating equipment in derelict or isolated areas during the night.

7.9 Labour

With consideration to the typical environment on high rise housing estates, with poverty and high unemployment, the operators of sophisticated equipment would be required to operate in small groups, the assumption of one technician operating all the equipment would not be possible. There are also significant psychological benefits to be had by not isolating individuals in lonely areas. Building maintenance operatives are accustomed to the privation and harsh environmental conditions of sitework, usually well able to cope with a range of difficulties, being well self-motivated and determined. It must be said that a better paid sophisticated and educated technician would find site working a far more intimidating and uncomfortable environment.

7.10 Prestige and High Technology.

The political benefits of 'prestige' cannot be understated, often financial arguments are laid aside because of the esteem of being the first or the best at a given achievement. The problem is that frequently technical considerations are also thrown out. The use of Non-Destructive Techniques is often cited as an objective when designing robotic systems, it is totally forgotten that in building maintenance techniques such as infra-red thermography, ultrasound, potential measurement and magnetic testing are still very much experimental and at best unreliable in many situations. It must also be remembered that all these so called NDT's require extensive extensive destruction investigation of the structure to calibrate the instruments initially. The question also has to be asked "do we need such detailed and such a huge quantity of information - is it of any practical use". Claims that greater amounts of detailed information will lead to improved cost control on repair contracts or enable more understanding of building defects can be misleading. The case for complicated systems of building maintenance is also

undermined by the question of what happens if the system fails, do you repeat the survey with delays and disruptions that this may cause, or do you switch to another survey method and write off the costs of the first method with a corresponding loss of prestige.

CONCLUSION

The conclusion is that, although existing maintenance requirements can be met by current building maintenance systems, the tower blocks of the 50's and 60's will require greater and greater maintenance and therefore more sophisticated maintenance methods will evolve. As these new systems develop emphasis will be placed on reductions or at least control of the most significant cost elements within the work programme and as access costs are usually the single largest element in high rise maintenace budgets, this will come under pressure first.

The path of least resistance and therefore the least conflict will be in the combination of existing and evolving maintenance systems and not in a war between the new and the old in a direct replacement of methods.