# Design factors affecting building maintenance

**The factors of design which will influence the levels of future maintenance of public buildings and works.**

# 1. Introduction

Maintenance of public buildings is concern for the continuous development and preservation of the major infrastructure systems such as public and private-owned buildings within the county which includes janitorial services, heating, ventilation and air conditioning (HVAC), plumbing, electrical, landscaping, and lawn care services. Public works, on the other hand, deals with safeguarding of sewer, solid waste, drainage and parks, etc. Both public buildings and works are grouped together and represented by the County Administrator. Their activities are inter-connected and require cross-departmental and pre-maintenance coordination.

As the community grows constantly with time, the challenge facing the public buildings and works department at the County Council is to provide and maintain the above adequate infrastructure and facilities regularly. Assuring and completing maintenance to keep pace with concurrency requirements for a variety of works continues to be a huge problem for the County. The County has historically been unable to keep up with the need of society within its premises. Although the public works is still partially funded by the UK Government, the County's Public Works Trust Fund (PWTF) loans remained at near high record levels. In this report, we will be discussing the design factors influencing the levels of maintenance of public buildings and works.

## 2. Different levels of maintenance for public works at different zones

The County has tried to maintain a uniform and consistent level of maintenance throughout, for example, the more important and prominent landscaped areas and parks around public and private-owned buildings. Under County Council regulations, it can only use funds collected from neighbourhood property owners and private agencies within a zone for costs associated directly and within that specified zone. In some zone areas, the evaluations allowed by law have not been sufficient to pay for basic maintenance costs, so essentially, some zones have been less funded for maintenance coverage. This is especially true when considering the costs necessary to replace dying plants and trees, replace or repair vandalized equipment or renovate older parks and irrigation systems [1]

Decisions for funding in certain zones were based on mailed ballots while others were not in favour of paying for extra maintenance and repair covers. Therefore, in order to keep the maintenance budget balanced, cuts and reductions have been made in the frequency and type of maintenance being performed in each of the under-funded zones. Essentially, the maintenance levels (or standards) are different as a result of the variance in available funds. Property owners and agencies will continue to see a difference in the levels of maintenance being provided throughout the various zones in the County.

The Council has developed priorities for services that most affect the community, particularly when budgets are tight. In those zones where funding is not sufficient to pay for all of the maintenance required, the

County Council has set the following levels of maintenance: low, medium and high, based on maintenance priorities: (i) safety items considered first and primary, (ii) keeping parks safe, open and available to the public, (ii) responding to vandalism, (iii) keeping turf and plant materials in healthy condition and (iv) removing, but not replacing, dead and dying plant materials and (v) thinning and scaling back landscaping to lower maintenance requirements [2].

The County will also be making some enhancements to a number of median landscaped areas. The aim is to make a one-time improvement, such as the installation of low-maintenance ground covering. These efforts will eventually reduce future maintenance costs and help all zones to remain within their own budgets.

## 3. Factors of design for public buildings: A Case-Study Approach

Successfully designing, constructing and operating high-performance buildings requires the building owner and all members of the design team to set goals to minimize future levels of maintenance via minimization of energy consumption and environmental impact. The team should establish these goals as early as possible in the design process and maintain them through the building occupation. One method for achieving high-performance building goals is to follow the energy design process. This process begins in the pre-design phase and continues after the building is commissioned and occupied. Understanding which strategies are best suited for the building site and function, setting aggressive energy targets early and relying on advanced computer simulations to evaluate building design options are essential to the overall reliability process. The building envelope is designed first to minimize energy consumption. The mechanical, electrical and control systems are designed after optimizing the envelope design. Detailed specifications must accurately reflect the design intent. After construction, the building is commissioned, the owner and operators are instructed on the optimal operation of the building and building operation documents are provided for future maintenance reference. A case-study on an actual high-performance building demonstrates how to apply the design process to all public buildings of the future This building incorporates energy-efficient and renewable energy design features including day-lighting, passive heating and cooling and improved thermal envelope. All this energy saving considerations is being intentionally put in place to significantly reduce future maintenance needs and increase reliability of building functionalities [5]

In a traditional design process, the architectural team determines the building form and articulation of the façade, including orientation, colour, window area and window placement. This architectural design is then handed off to the engineering team, who designs the heating, ventilating, and air-conditioning (HVAC) system, ensures compliance with applicable energy codes, and ensures acceptable levels of environmental comfort for building occupants. From an engineer’s point of view, energy dependability occurs by improving the design of the HVAC system. It is then the engineer’s goal to create an efficient system within the context of the building envelope that has been previously designed—the architectural decisions have been finalized and few changes can be made to the envelope design [4]

For successful realization of low-energy buildings which are less susceptible to failures, an efficient design team must establish a cost-effective energy goal. Once a commitment to energy minimization has been made, the energy-design process can be used to guide the team towards good decision making and trade-off analysis without sacrificing the building's programmatic requirements. The building must incorporate disaster resistant (e. g., able to function if no grid-power is available). The design should meet or exceed all the functional and comfort requirements of the building. Low-energy design does not imply that building occupants endure conditions that are considered unacceptable in traditional buildings.

The design team develops a thorough understanding of the building site and building functional requirements. A qualitative evaluation of these issues early in the design process often leads to later solutions for minimizing potential building maintenance needs Many design strategies are applicable to most buildings however, each building is unique, and thus, will have unique reliability design solutions [9].

Simulation of a base-case model of the building is done to identify maintenance minimization opportunities via low energy consumption using an hourly building simulation computer tool. This computer model simulates annual loads and peak demands for heating, cooling, lighting, plug loads and for HVAC system fans and pumps to determine the energy-use profile and the likelihood of possible failures of the base-case building.

The design team brainstorms possible solutions to dependability problems. At this stage, the emphasis is on solutions relating to building geometry.

Simulations are performed on variants of the base-case building relating to the list of possible solutions. Issues that will have a profound influence on the architectural aspects of the building are quantitatively explored prior to the conceptual design phase. The energy impact of each variant is determined by comparison to the original base-case building and to the other variants. Computerized design tools bring all the architectural and engineering pieces together to predict how the building's components will interact. In other words, day-lighting systems, thermal issues and building control strategies may be addressed by different

building disciplines but successful integrated building performance can only be achieved by examining the interrelation between these components.

The conceptual design is the most difficult part of the building design process. It is essential that the dependability features be integrated into the architecture of the building. The objective is to use the architectural and envelope features to minimize energy costs for heating, cooling, and lighting. Often, energy features that effect the visual impact of the building can also serve as the main architectural aesthetic features, thereby saving costs. If the addition of an energy feature substantially increases the building cost, it is evaluated with the cost-effectiveness criteria already established [6]

After the architectural features impacting energy use have been determined, the computer model simulating the performance of the proposed building is updated to reflect those decisions. A set of simulations is then performed to guide decisions regarding the HVAC system and associated controls. These simulations are primarily to optimize annual dependability of building lighting functions and the occupant comfort. The simulations can also be used to help properly size the equipment. Low-energy buildings defy the industry norms used for equipment sizing. First cost savings in substantially downsized equipment can often be used to pay for improved envelope energy features. At this point, there will be some iteration or trade-off between mechanical system decisions and architectural features; however, it is best to optimize the architectural features first. Although the energy design process may increase the cost to design the building compared to the traditional design process, the increased design cost is often offset by reductions in errors and decreased mechanical system cost. Fewer errors occur because careful attention was paid throughout the design process and more effort is placed on checking and review. Also, small mechanical systems require less space in the building (requiring less building to be built), and therefore, lower capital costs.

Once the simulation work has been completed, occasional simulations will need to be performed as needed in response to unanticipated circumstances. This might include the need to determine if a substitute component really meets the energy related specifications or review of a construction detail that must be modified because of a problem on the construction site. Scheduled plan reviews and site inspections are crucial to ensure that specified details omitted from the plans do not compromise the energy design. A clear communication path between the constructor, building operator and the design team will help ensure that components are installed properly [10] In many cases, once construction on a particular area is incorrectly completed, it cannot be reinstalled and the building owner is forced to live with the reliability performance consequences.

The commissioning process includes testing all subsystems in the building to ensure that they operate as intended. For example, poorly calibrated economizer controls can bring in excess air or poorly calibrated daylight sensors may not turn off the lights, thus causing failure to the equipments. Occasional simulations will be required to help solve problems that emerge during this final phase and to respond to changes in building use that may occur once the building is occupied. The key is that the controls function with the design intent of the building. A good building quickly becomes a bad building with improper control strategies. In addition, it is important to educate the building owner, occupants and the maintenance staff to properly use the building systems as conceived by the design team. The building's performance can only be optimized if the people running the systems understand how the systems interact. This would save cost of system errors leading to malfunctions and would eventually reduce the need for future building maintenance.

## 4. Conclusion

Good construction practices provide protection and minimum maintenance required for existing high-tech buildings and other features. Continued good appearance of these buildings depends upon the extent and quality of maintenance. The choice of materials and their use, together with the types of finishes and other protective measures should be conducive to easy maintenance and upkeep.

An integrated design approach for private high performance buildings have been discussed from construction to commission. A low energy cost reduction was ideally established early and maintained throughout the design process. An integrated set of solutions for architectural design and energy efficiency was determined, including extensive day-lighting, natural ventilation, evaporative cooling and passive solar radiant heating. It is important to design a building that works with the environment in which it is located to minimize the need for maintenance in the long run. The building architecture was formed based on the programmatic and energy goals for the project. Tall vertical elements are naturally preferred to harmonize the building with the surrounding natural environment. The towers were also used to passively cool the building. An HVAC system was designed to work with the building. A PV system was installed to provide emergency power and supplemental power when utility power is available. The building construction and energy costs was significantly less and more reliable than a conventional one. This shows that sustainable buildings need not cost more with no level maintenance requirements

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