

**BOMA CHINA PREVENTIVE  
MAINTENANCE  
PRESENTATION**

**国际建筑业主与管理者协会（中国）  
专题演讲：预防性维护**

## Preventive Maintenance Systems

### Outline

CPMS (computer based preventive maintenance systems) have become a crucial tool for owner/managers to record, manage, document and execute their day-to-day operations. The system can provide reports used in managing the needed resources, assembling KPI for evaluating the effectiveness of the current program and for making owner/manager decisions.

Prior to the computer age, paper records were maintained to track the work. Reports were simple but time consuming and costly to prepare. As the capacity of computers improved it was recognized that well engineered computer software applications could be used to record work requirements, track the status of the work and analyze the recorded data for managing the work, producing reports, controlling costs and ensuring reliable service delivery. In addition historical data may be assembled and analyzed with an eye toward migrating maintenance doctrine from a preventive to a predictive philosophy which is a more efficient use of resources.

### 预防性维护系统

#### 大纲

CPMS（基于计算机的预防性维护系统）已经成为业主/经理记录、管理、执行他们日常工作的一个重要工具。该系统可提供各种报告，用于管理所需的资源、收集KPI评估当前计划的有效性、制定业主/管理者决策。

在计算机时代到来前，主要通过纸质记录来追踪工作。报告很简单，但准备起来费时又费钱。随着计算机功能的提高，人们认识到，精心设计的计算机应用软件可以用来记录工作要求、追踪工作状态和分析记录数据，方便管理工作、生成报告、控制成本，确保交付可靠的服务。此外，历史数据可以被收集起来进行分析，在此基础上改变维护原则，从预防性维护变成更高效利用资源的预测性维护。

## THE DESIRE AND MISSION

The goal for an owner/manager is to deploy a CPMS which optimizes the use of available data and resources to maintain the building and equipment. The system should provide for an integrated process giving the operator control over the maintenance of all the building equipment from first commissioning through disposal and replacement.

- Document all required resources
- Maintain maintenance inventory as required
- Record and maintain work history,
- Include work tasks and frequencies,
- Accommodate all methods of task execution
- Effectively interface and communicate with related and supporting systems ranging from work generation through work performance and evaluation,
- Support each owner/managers mission,
- Provide feedback and information for analysis
- Reduce costs and unplanned outages through effective maintenance planning.

A well designed CPMS meets these requirements and assists the building operator with task creation, planning, control, performance, evaluation, and reporting. Such a system will also maintain historical information for management planning and budgeting. The following paragraphs include details of capabilities that may be desirable in a modern CPMS.

### 愿望和使命

业主/管理者的目标是部署CPMS，优化可用数据与资源的使用，进行建筑 and 设备的维护。这一系统应提供一体化流程，从首次调试到设备处置和更换，让操作人员全面掌控所有建筑设备维护。

- 记录所有需要的资源
- 根据要求对维护清单进行维护
- 记录和维护工作历史
- 包括工作任务和频率
- 配合所有任务执行方法
- 与工作生成、绩效和评估等相关支持系统有效对接及沟通
- 支持每个业主/经营者的职能
- 为分析提供反馈和信息
- 通过有效的维护规划降低成本和计划外停机。

一个设计良好的CPMS不但符合这些要求，还能在创建任务、计划、控制、性能、评估和报告等方面协助建筑运营商。这一系统还可用于对维护计划和管理预算的历史信息。下面将介绍现代CPMS应该具备的具体功能。

## Equipment Locations

The CPMS should include an application that allows an operator to enter detailed information and track locations of equipment (physical location in the building) and organize these locations into logical hierarchies by equipment type or system type. Work orders can then be automatically generated based on manufacturer recommended maintenance frequencies for the equipment or system concerned. As maintenance history and performance are added to the database it will enable the building operator to modify and improve the maintenance procedures.

## Equipment

The CPMS should include the ability for an operator to keep accurate and detailed records of each piece of equipment. This module would include equipment related data, including manufacturer's specifications and details, recommended service schedule, safety procedures, measurement points, multiple meters, routine inspection routes, specification data (name plate), equipment downtime due to unplanned outages, and related documentation. This equipment data is used for managing day-to-day operations and historical data that can be used to help make cost effective replace or repair decisions. The data can also be used to develop additional management information, such as building equipment downtime failure for use in creating maintenance management metrics and KPI.

## 设备位置

所述CPMS应包括一个应用程序，允许操作员输入设备的详细信息、跟踪设备位置（楼宇中的物理位置），并根据设备类型或系统类型将这些位置按逻辑层次结构排列。然后，可根据制造商推荐的相关设备或系统维护频率自动生成工作单。随着维护历史和性能被添加到数据库中，楼宇运营人员可以通过系统修改和完善维护程序。

## 设备

CPMS的功能应该包括允许操作人员保存每件设备的准确详细记录。这个模块将包括设备相关数据，制造商的说明和细节、服务时间建议表、安全规程、监测点、多个量表、例行检查路线、规格数据（铭牌）、意外停电导致的设备停机，以及相关文档。这些设备数据用于管理日常操作和历史数据，可帮助制定提高成本效益的设备替换和维修决定。这些数据还可用于楼宇设备停机故障等其他管理信息的分析，帮助创建维护管理指标和KPI。

## Resources

Depending on the owner/manager objectives the CPMS may include an ability to track and document labor resources. This module should include records for all maintenance personnel, including their craft or trade categories, such as an engineer, mechanic, electrician, or plumber etc. Additionally, this module may include labor rates in order to capture and track true labor costs to implement the maintenance program for each piece of equipment.

## Safety Plans

With the emphasis placed on safety through best practices and government mandate, a capability for safety planning should be included in a CPMS. The following capabilities should be available:

- Manual or automatic safety plan numbering.
- Building safety plans for special work.
- Track hazards for multiple equipment and locations.
- Documenting precautions to be taken
- Track hazardous materials and conditions
- Once hazards and precautions are entered they should be available for reference and data entry.
- Track data for health, flammability, reactivity, contact, and Material Safety Data Sheets for hazardous materials.
- Define lock-out/tag-out procedures for electrical equipment.
- Define tag identifications for specific equipment and locations.
- Define safety plans for specific equipment or environments
- Ability to link and view external documents available on the internet
- Print safety plans automatically on work orders.
- Allow tag-out procedures to be associated to hazards or directly to locations, equipment, and safety plans or work orders.

## 资源

基于业主 / 管理者的目标，CPMS可包括跟踪和记录人事资源的功能。这个模块应该包括全部维护人员的档案，包括他们的专业技术或行业类别，如工程师、机械师、电工、水管工等。此外，这个模块还可包括劳务工资，以便记录并跟踪维护每件设备的劳动力成本。

## 安全计划

最佳实践和政府法规都凸显了对安全的重视，CPMS还需包含安全规划功能。具体应包含以下功能：

- 手动或自动安全计划编号。
- 为专项工作制定安全计划。
- 跟踪多个设备和位置的安全风险。
- 记录需要采取的预防措施
- 跟踪有害材料和条件
- 危险和预防措施输入后可用于参考和数据录入。
- 跟踪有害材料的健康、易燃性、反应性、联系人数据和材料安全数据表。
- 界定电气设备的上锁/挂签操作。
- 界定具体设备和位置的标签标识。
- 界定特定设备或环境的安全计划
- 链接和查看互联网外部文档的功能
- 自动打印工单安全计划。
- 允许与危险、或地点、设备、安全计划，或工单直接关联的挂签操作

## Inventory Control

As an option an inventory control module may be included to allow an operator to track inventory movement such as items being moved in or out of inventory, or from one location to another. Stocked, non-stocked, and special order items could be tracked. Some CPMS may also provide the ability to track the tools and equipment required to perform specific maintenance tasks. Such a feature will allow operators the ability to reduce the time devoted to the research and preparation effort on the part of mechanics and technicians working in the field.

## Work Request

A work request module should be an integral part of a CPMS. The module can provide the capability for a requestor to input a request, such as a trouble call, or it can be entered by the owner/manager administrative personnel. The data entry screen should be designed for minimal data entry. The work order number can be assigned manually or automatically. A requester can enter minimal data and work control can enter additional information as required. Data should be entered once, and pop-up tables in the system should eliminate the need to memorize codes.

## Work Order Tracking

A CPMS must include work order tracking because it is the heart of a work order system. The data should require entry only once, and pop-up tables should eliminate the need to memorize codes. The tracking system should provide instant access to all of the information needed for detailed planning and scheduling, including work plan operations, labor, materials, tools, costs, equipment, blueprints, related documents, and failure analysis.

## 库存控制

作为一种选择，可以包含库存控制模块，方便操作人员动态跟踪库存移动，比如物品进出库存或从一个地点转移到另一个地点。可以对库存、非库存和特别订购物品进行跟踪。一些CPMS还提供跟踪需要执行特定维护工作的工具和设备的的能力。这个功能有助于运营商减少因技工和技术人员为做好现场工作所需的准备时间。

## 工作申请

工作申请模块应是CPMS必不可少的一部分。这个模块允许申请者输入申请内容，比如呼叫故障。或者，工作申请也可以由业主/管理者输入。数据输入屏幕的设计应考虑最小数据输入。工单号码可以手动或自动分配。申请者可以输入最少量数据，然后，工作控制根据需要提供其他信息。数据只应输入一次，系统的弹出表省去记忆代码的需要。

## 工单跟踪

CPMS必须包含工单跟踪功能，因为这是工单系统的核心。数据只需录入一次，并通过弹出表消除记忆代码的要求。跟踪系统应该能够立即访问详细规划和安排所需的全部信息，包括工作计划操作、人工、材料、工具、成本、设备、图纸、相关文档和故障分析。

## Work Management

A task management module may be a part of the CPMS. The module could provide the capability that would let an operator specify which labor to apply to specific work orders and when. The module should facilitate planning and dispatching.

- Planning—in planning, labor assignments would be planned for future shifts. The tasks could be created and distributed sequentially over a shift, filling each person's daily schedule with priority work. It could even split larger jobs over multiple shifts—automatically.
- Dispatching—In a properly designed and implemented CPMS system the majority of maintenance assignments would be automatically generated and dispatched by the system, so that each assignment would be carried out as soon as possible. Once the maintenance assignment is completed, the operator would make a data entry closing out the work order.

## Quick Reporting

The CPMS should provide a rapid and easy means for opening, reporting on, and closing work orders, and reporting work on small jobs after-the-fact. Labor, materials, failure details, completion date, and downtime may all be reported.

### 工作管理

CPMS可包括任务管理模块。这个模块的作用是让操作人员指定什么时候将哪个工单指派给哪个工人。这个模块可以取代人工规划和调度。

- 规划——规划包括指派未来值班人员。值班时段内的任务创建和分配可进行优先排序，使每个员工首先执行优先工作。它甚至可以自动拆分大型任务，分成多个班次完成。
- 调度——在一个设计和实施得当的CPMS系统中，系统将自动生成并自动调度大多数维护任务，使每个任务得以尽快完成。维护任务一旦完成分配，操作人员就可通过输入数据关闭工单。

### 快速报告

CPMS应提供快捷简单的途径，方便工单的打开、报告和关闭以及事后工作报告。报告内容可能包括人工、材料、故障详细信息、完成日期和停机时间等等。

## Preventive Maintenance

The following capabilities should be considered in a CPMS to manage a Building Preventive Maintenance (PM) program:

- Support multiple criteria for generating PM work orders. If a PM Master-schedule has both time-based and meter-based frequency information, the program should use whichever becomes due first, and then update the other.
- Generate time-based PM work orders based upon last generation or last completion date. Next due date and tasks should be displayed.
- Permit and track PM extensions with adjustments to next due date.
- Print sequence job plans when wanted.
- Create a PM task against an item so new parts have PM automatically generated on purchase. (optional)
- Specify the number of days ahead to generate work orders from PM Master-schedule
- Consolidate weekly, monthly, and quarterly tasks and work orders on a single master schedule.
- Assign sequence numbers to job plans to tell the system which job plan to use when a PM work order is generated from a PM Master-schedule.
- Generate work orders in batch or individually for only the equipment specified
- Should have the capability to be used with the system operator to forecast resources and budgets.

## Utilities

A utilities module may be included that contains detailed information on utilities consumption, distribution, use, metering, allocation to users, and cost. It could include modeling capability and link to utility control systems.

## 预防性维护

管理楼宇预防性维护（PM）计划的CPMS应考虑包含下列功能：

- 支持生成PM工单的多种标准。如果PM主时间表同时包含基于时间和基于量表的频率信息，程序应该使用首先到期的一个，再对另一个进行更新。
- 根据上次工单生成或完成日期生成基于时间的PM工单。应显示下一个到期日和任务。
- 通过调整下一个到期日实现PM延伸跟踪。
- 按需打印顺序工作计划。
- 针对物品创建PM任务，新采购的部件可自动生成PM。（可选）
- 指定距离从PM总日程表生成工单还有多少天。
- 将每周、每月和每季度的任务和工单合并到同一个总日程表上。
- 给工作计划分配序列号，告诉系统当PM总日程表生成工单后，该使用哪个工作计划。
- 批量生成工单或单独为指定设备生成工单
- 应该具有帮助系统操作人员预测资源和预算的功能。

## 水电

可选的水电模块包含水电消费、分配、使用、计量、向用户分配和成本的详细信息。它可能包括建模能力并连接水电控制系统。



## Building/Equipment History

A history module may be included that would contain the maintenance histories of the building equipment. It would contain summaries of PM, repairs, rehabilitation, modifications, additions, construction, and other work affecting the configuration or condition of the items. It would include completed and canceled work orders. The maintenance history records can be used to support proactive and predictive maintenance techniques and failure analysis.

## Key Performance Indicators (KPI)/Metrics

The CPMS can be utilized to accumulate the data for KPI or use in evaluating the owner/manager maintenance program. The owner/manager must select the metrics to utilize in establishing their goals and to measure progress in meeting those goals. The importance of developing and selecting the correct KPI can not be overstated. The KPIs must be based on data that can be obtained and provide meaningful information that will be utilized in managing the maintenance program.

## Lessons Learned

A well designed and implemented preventive maintenance program is valued added and crucial to the long term financial performance of a property.

Such a program will ensure beneficial use of equipment and systems throughout their expected lifecycle while avoiding the negative reputational and financial consequences of the premature failure of equipment. This will better enable the owner/manger to create an operating and capital replacement plan with realistic cash flows that are closely aligned with the projected building occupancy and revenue stream.

## 建筑/设备历史

可选的历史模块包含建筑设备的维护历史。它将包括PM、维修、改造、改建、增加、施工和影响设备配置或状态的其他工作概况，同时亦包括完成并取消工单。维护历史记录可以用于支持主动和预测性维护技术和故障分析。

## 关键绩效指标 (KPI) /指标

CPMS可被用于收集KPI数据或者用于评估业主/管理者维护计划。业主/管理者必须选择指标，用于建立他们的目标并衡量工作进展。制定和选择正确的KPI非常重要。KPI必须基于能够获取有用的数据并将其提供给维护管理计划。

## 教训总结

一个精心设计并得到正确实施的预防性维护计划有增值作用，对物业的长期财务表现至关重要。

这样的方案将确保设备和系统在整个使用周期都能高效利用，同时避免设备过早失效导致的不良声誉和财产损失。这将帮助业主/经理结合预计入住率和收入流并根据实际现金流创建运营和资本替换计划。