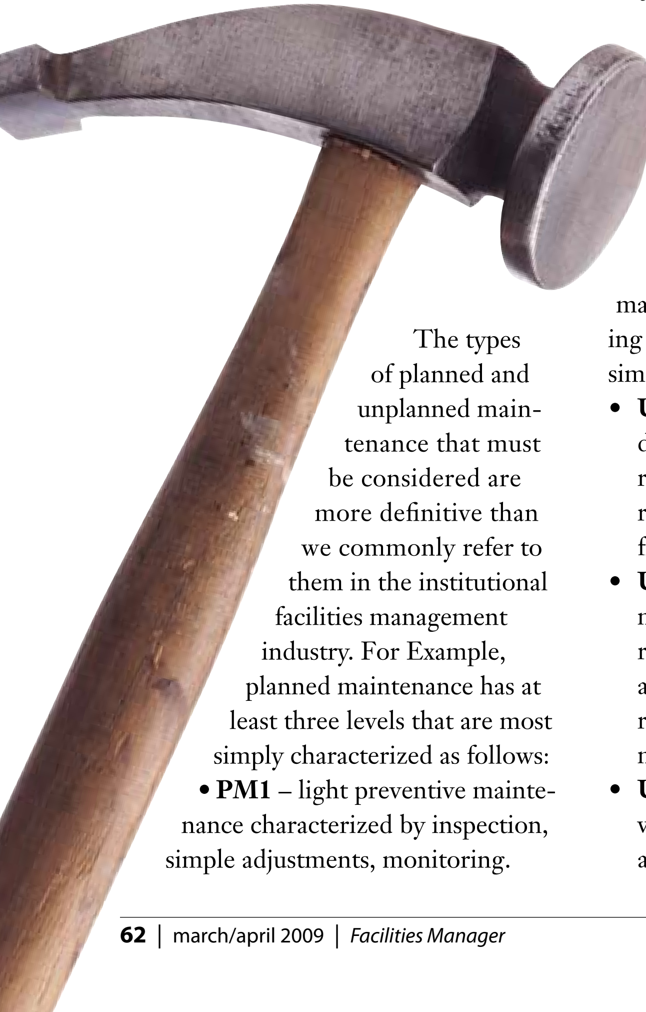
The Predictability of Unplanned Failures

By Matt Adams, P.E.

There is predictability in what is called "unplanned failure" or "unplanned maintenance" (UPM). This concept implies our ability to control and manipulate planned maintenance (PM) and so directly indicates the "expected" amount of UPM a given facility will experience. Thus, UPM is in fact predictable. And, if it has a predicable characteristic we must also be capable of budgeting for it. This might seem intuitive, but in practice it requires some delineation in order to apply it to everyday life within a facility management environment.



The types of planned and unplanned maintenance that must be considered are more definitive than we commonly refer to them in the institutional facilities management industry. For Example, planned maintenance has at least three levels that are most simply characterized as follows:

- **PM1** – light preventive maintenance characterized by inspection, simple adjustments, monitoring. Execution is characterized by high frequency (e.g., monthly) and low cost (e.g., $100 time and materials.)
- **PM2** – more invasive preventive maintenance that involves shutting down a system, opening its chassis, conducting system and component testing as well as lubrication, expendable part replacement, such as belts, and significant adjustment of operating parameters. Execution is characterized by medium frequency (e.g., annually) and medium cost (e.g. $500 time and materials.)
- **PM3** – most invasive planned maintenance characterized by system shutdown for extended periods and primary system overhaul involving significant component replacements. Execution is characterized by low frequency (e.g., every 5 years) and high cost (e.g. over $5000.)

On the other hand, unplanned maintenance has a set of corresponding definitions that are related and most simply characterized as follows;

- **UPM1** – simple system performance difficulties that arise frequently and require system inspection and perhaps resetting or light adjustment (highest frequency, lowest cost.)
- **UPM2** – significant system performance gaps or even shut downs that require diagnostics, performance adjustments, and sub-component replacements, (moderate frequency, moderate cost.)
- **UPM3** – major system failure that involves failure of primary components of a system and requires long down times for material procurement and corrective repairs or rebuilding of the system, (lowest frequency, highest cost.)

Assuming that we can model both PM and UPM in the same context, the actual relationship between the two yields our "predictability." This is because we can reasonably research and compile the recommended planned maintenance costs and frequencies for most building systems. In fact, some system testing data by manufacturers and rating agencies is available that documents statistics for both "run-to-failure" operating modes as well as "optimally maintained" operating modes. From a mathematical standpoint there are two key variables that we must evaluate: cost ($) and frequency (f). The proposed relationships are represented for Cost ($) as:

- PM1$ (UPM cost coefficient 1) = UPM1$
- PM2$ (UPM cost coefficient 2) = UPM2$
- PM3$ (UPM cost coefficient 3) = UPM3$

Considerations for deriving UPM cost coefficients include: overtime pay, expedited parts delivery, collateral damage to systems, etc. Similarly the relationships for Frequency (f) are represented as:

- PM1f (UPM freq. coefficient 1) = UPM1f
- PM2f (UPM freq. coefficient 2) = UPM2f
- PM3f (UPM freq. coefficient 3) = UPM3f

Considerations: PM and UPM frequencies are inversely proportional, optimal relationships might be defined by some manufacturers to allow extrapolation, industry heuristics suggest that 80 percent of manufacturers recommended PM frequencies is optimal and anything more frequent has diminished returns., given a static level of PM(x)f over time the UPM(x)f will increase until system death.

Using manufacturers, RS Means, and other sources for the costs and frequencies of all planned maintenance (PM1, 2, & 3) represents the beginning data set for this predictability model. In effect this becomes a budget model for unplanned maintenance. Given good data for PM (f) and ($) the formulaic relationship between PM and UPM is established by deriving meaningful coefficients for each of the six formula relationships. Research, trial and error, and experience all contribute to the determination of these coefficients, but the effort of creation alone has a positive diagnostic effect for the budgetary process. The basic definitions should look like the following:

- **UPM Cost Coefficient 1 = 1.8x** The cost includes both the time and materials for the activity as well as the labor cost of the PM1 not performed on another similar piece of equipment due to the loss of labor caused by this unplanned event (opportunity cost). It is assumed that labor is 80 percent of the PM1 cost. This assumes that all PM activities are at "least" worth the cost of labor with respect to asset life-extension. In other words, a PM not executed results in UPM(x) that negatively impacts the integrity of a system with a cost at least equal to the labor of the PM(x) not executed. This becomes a rough empiracle measurement of what is commonly referred to as "asset consumption."

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- **UPM Frequency Coefficient 1 = 1.5x** The frequency of UPM1 has a longer cycle than PM1 and that is part of the conundrum. This factor states that if quarterly inspections are required, every 4.5 months, on average, we will experience an unplanned event of level 1. In all cases the assumptions should be conservative until proven otherwise.
- **UPM Cost Coefficient 2 = 1.7x** This cost is derived in a similar fashion to the first cost coefficient but assumes a 30/70 material-to-labor ratio for PM2($).

Using the approach to model UPM for produces budgets that include the negative "knock-on" costs of UPM assuming we are not fully executing our planned maintenance program at the time. In this budget modeling approach, simple depreciation schedules would no longer apply for estimating deferred maintenance. The capitalized cost of the opportunity lost valued by PM labor becomes the new deferred maintenance value.

Matt Adams is president of FM², Atlanta, GA. He can be reached at *matt@adamsfm2.com*.