Theoretical Condition Indices

By Eric Teicholz and Gary Evans

Summary

Research commissioned by the General Services Administration to develop and test a methodology to derive cost-effective, reasonably-accurate condition indices has recently been successfully completed. The result of this research is the "*Theoretical Condition Index*" concept. This article will describe the challenges that needed to be solved, how they were solved and the steps that any organization can follow to predict reasonably-accurate condition indices, for a fraction of the cost of sending trained teams to visually-assess buildings.

Background

For many years, organizations have been performing visual on-site condition assessments with teams of specially-trained, highly-skilled assessors to identify capital repair and replacement projects. The "Condition Index" is generated by comparing the total value of these projects with the replacement value of the facility.

They may either be presented as a decimal, where zero equates to perfect condition; or as a percentage, where 100% equates to perfect condition.

The formulas are: $CI = \frac{\$\text{ Repair Needs}}{\$\text{ Replacement Value}}$ or $1 - \frac{\$\text{ Repair Needs}}{\$\text{ Replacement Value}} \times 100\%$

Challenges

Visual condition assessments are very expensive. While visual condition assessments may be appropriate for large mission-critical facilities, frequent visual assessments of smaller, geographically-diverse facilities is costly and time consuming. Assessments for small remote facilities may cost as much as $1.50 per square foot.

For large organizations, inadequate condition index data is being collected due to high assessment costs and lack of assessment resources.

Research

In conjunction with the Asset Management Division of the Office of Real Property Management of the GSA Office of Government Policy (OGP), alternative methods of calculating condition indices that do not require frequent visual assessments were researched.

Initial research found that various techniques are available, these are:

- **Parametric Estimating Methods**

  Teams of trained assessors perform rapid visual assessments of pre-defined systems of each facility. Conditions are rated using a simple rating system, usually via a PDA, and entered into a parametric estimating model. The Capital Replacement Value (CRV) is apportioned between each of the facility systems.

Parametric estimating methods are designed to be performed annually by field assessors, but rely on photographic evidence, interviews and questionnaires where this is not possible.

While this method reduces costs, and several organizations already follow this technique, many organizations do not have the resources to even perform this level of assessment, so something even simpler is needed. Also, these methods do not identify individual projects at the tactical level, which is often seen as an essential by facility managers.

- **Inventory Lifecycle Analysis Methods**

  These can be performed using standard editable building types or by building up an individual building from its constituent parts.

  A forecast engine is populated with standard preventive maintenance tasks per component and associated unit rates. Individual preventive maintenance tasks are then triggered by pre-programmed frequencies. Repair needs are identified from due dates for pre-programmed repairs or replacements of individual components. These "trigger" dates are then used to derive condition indices. Many expensive repair or replacement projects in a single year can significantly change the condition index results from year to year.

  In order to populate these systems with building-specific data it is necessary to collect data for individual components at a very detailed level. It is also necessary to keep track of which individual repair or replacement projects have been completed at the component level from year-to year to keep up-to date. While this is useful for maintenance planning purposes for individual facilities at the tactical level, it can be time-consuming to gather and maintain this level of information, even during a "traditional" condition assessment.

- **Questionnaire-based Modeling Methods**

  Detailed questionnaires are sent out to facility managers. The answers allow consultants to estimate likely condition indices. While questionnaires are useful for small-to-moderately sized building portfolios, they may become cumbersome for portfolios that consist of thousands of buildings, as not all questionnaires may be completed in a timely manner. Reliance is likely to be placed on untrained personnel to answer the questions, resulting in inconsistencies.

Findings

While existing methodologies meet a need, meaningful condition indices are still missing within the federal government.

In many situations, little information beyond type and age of a building is available. The required method needs to allow condition indices to be calculated using varying levels of available information. We concluded that a new approach was needed that was simple, affordable and reasonably accurate.

In order to meet facility management tactical needs, we concluded that no method should completely remove the need for visual assessments. So, the required concept needs to not only provide condition indices but also be used as a technique to target visual assessment resources.

The solution needs to recognize that there is often more value in performing a visual assessment of an older asset where components are near or at the end of their expected useful lives than a new asset that has just been constructed, as management decisions regarding disposal vs. renovation are likely to center on older assets.

This research concluded with the development of the "*Theoretical Condition Index*".

<u>What is a Theoretical Condition Index?</u>

Building components and systems that make up every type of constructed asset have average life expectancies. Using existing published average life expectancy information, sample building types and a calibrated deterioration curve, it is possible to derive age-based theoretical condition indices.

<u>Overall Concept and Data Requirements</u>

Components that make up every type of constructed asset have average life expectancies and are classified using **Uniformat II**.

In order to derive a theoretical condition index, the following **<u>minimum</u>** information is needed:

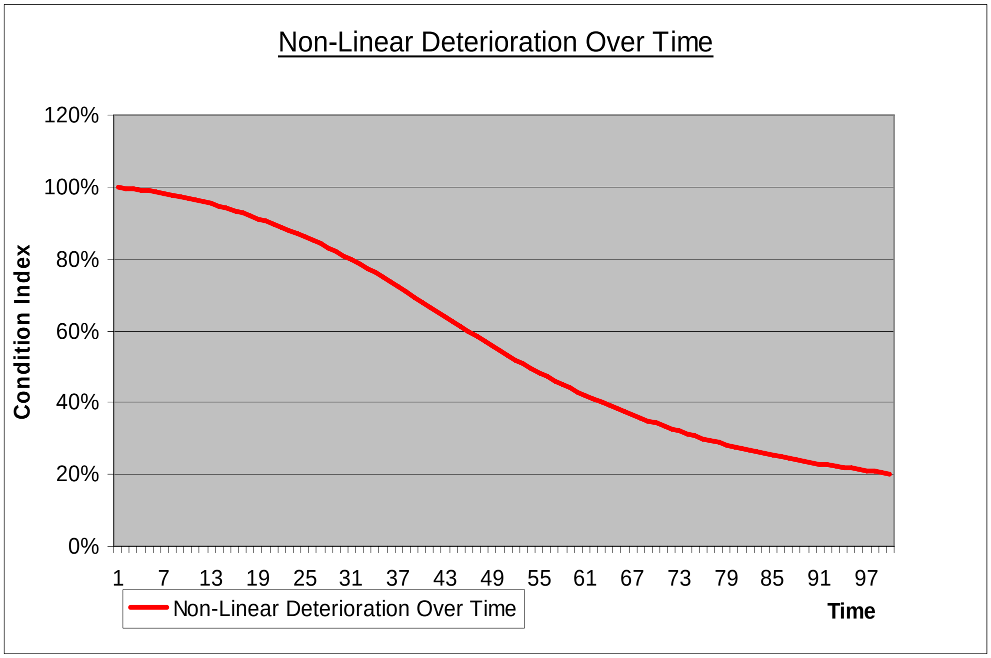
1. Actual or estimated **AGE** of each facility. **AGE** may be determined by the construction date, acquisition date or last major renovation date of the whole building or individual components and may be fine-tuned if more information is known about a building

2. **USE TYPE**; or in the case of the US Federal Government, **PREDOMINANT USE** classification for each constructed asset.

3. **CONSTRUCTION COST BREAKDOWN** for each **USE TYPE**. This is a percentage breakdown for each type of building and can be a pre-defined standard. Some organizations may want to define their own construction cost breakdowns based on their own types of assets, adjust the standard percentage breakdowns or create individual breakdowns for individual facilities. Customization of this information increases accuracy.

4. Estimated Useful Life (**EUL**) of each component for each use type, which can be a pre-defined standard. Industry-standard sources for estimated useful life information can be collated and averaged to create defensible data. EUL information can be adjusted for accuracy for each use type.

The repair-need percentage for each Uniformat II system is calculated using the **AGE** and **EUL** variables and a calibrated S-Curve deterioration rate.



The repair need percentage for the whole facility is calculated by multiplying the system-level percentage repair by the construction cost breakdown percentage. The condition index is 100% minus the repair need percentage for the whole facility. The entire calculations process can be automated.

<u>Testing Procedure</u>

In order to test the calibration of the model, it was necessary to identify and use a method that tests how well the model can predict condition indices. This was achieved by comparing results generated using the model with results generated from visual assessments.

Sample condition assessment data was collected for about 10,500 government buildings. Condition indices were generated using the theoretical condition index method that purely relied on the age of the whole building and standard building type data inputs (the absolute minimum required) and compared the results with actual condition indices obtained from full visual assessments of these buildings.

<u>Results</u>

The original concept developed and tested for calculating condition indices assumed linear deterioration of building systems. However, this was did not accurately predict condition indices. As these results were inaccurate, the “S-curve” deterioration mechanism was tested.

Once calibrated, using the sample set of data, the "S-curve" deterioration model appeared to produce a good level of data correlation as deterioration accelerates as systems approach the end of their expected useful life.

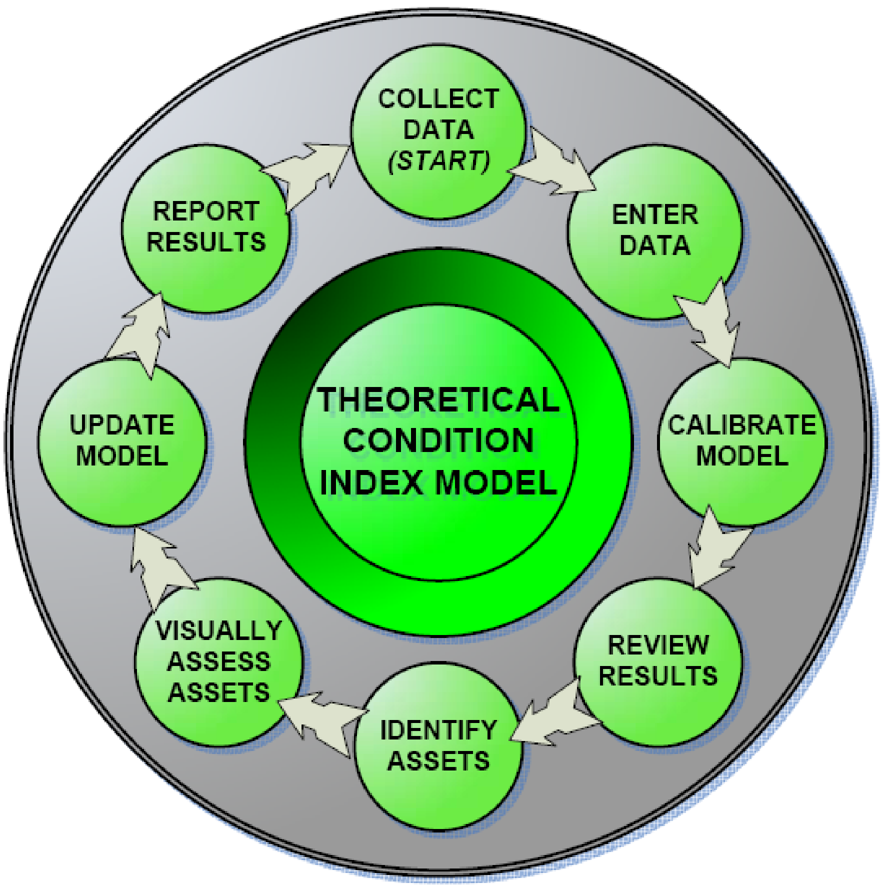
For example, just knowing the date of construction for buildings under 30 years old, **the model can predict condition indices to within 10% accuracy; about 70-80% of the time**. For buildings older than 30 years old, major renovation dates are required to achieve this level of accuracy.

Implementation

In order to use this type of modeling tool, organizations will need to follow a process each year of collecting record information, calibrating the model against existing assessment results, running the model, selecting the buildings at greatest risk of failure (i.e. lowest theoretical condition indices), performing the visual assessment of those selected assets, and updating the results to improve the accuracy of the model for future assessment cycles.

If no useful data exists, condition indices generated using this model would be a good starting point for any organization. Results from visual assessments may be used to "fine-tune" costs, ages and percentage breakdowns based on actual conditions observed at individual assets, improving the reliability and accuracy of repair needs and theoretical condition indices.

Organizations will need to either develop or acquire software that would perform the calculation steps described in this report and the following a set procedure, illustrated as follows:



While the model uses percentage breakdowns and proportions them out, the total value of the building is not required. However, as many people think in dollar values and not in percentages, percentages can be converted into costs to aid estimation.

The following flowchart describes how organizations may wish to structure data gathering and data entry efforts:

Theoretical Condition Index Data Gathering Process

Benefits / Drawbacks

Theoretical Condition Indices should not replace the need for visual assessments, but should be used to target them.

Theoretical condition indices aid strategic decision-making. They help prioritize and target assessment resources to reduce assessment frequencies and make high-level decisions, and should only be recognized and used this way. Detailed, tactical-level decisions relating to repair projects at individual facilities still require visual assessments, as condition indices derived from models do NOT provide detailed project lists.

The potential cost savings using theoretical condition index models are significant. The cost of generating theoretical condition indexes is likely to be less than 2% of the cost of performing "traditional" visual condition assessments and less than 20% of the cost of performing a visual assessment using other modeling techniques.

Data collection and maintenance is manageable as data is only required at the Uniformat II level. There is no need to track detailed component data.

Current industry practices use fixed thresholds for interpreting facility condition indices, such as >95% = Good Condition, 85% to 95% = Fair Condition and below 85% = Poor Condition. The theoretical condition index model improves on these standards and allows direct comparison of the results of a visual assessment with results typically associated with a similar building of the same age.

Significant variances between results obtained from visual assessments and theoretical condition indices may be used to indicate inconsistent maintenance performance or inadequate record keeping. The theoretical condition index model allows these anomalies to be flagged for further investigation.

The model used to calculate theoretical condition indices allows organizations to run "what-if" scenarios and predict theoretical condition indices that would result from replacing systems at Uniformat II level.

Condition assessment models that use standard building types, which are not edited for individual facilities will have errors. Facility Managers need to balance the need for accuracy against the challenges of collecting detailed information. Often, the 80/20 solution is good enough.

Conclusion

While using theoretical condition indices can provide a simple and easy way to predict condition indices, the potential benefits of this tool could revolutionize condition assessment processes.

A web-enabled theoretical condition index application will allow organizations to enter their own data. Existing CAFM providers already want to interface with this type of model.

Visual assessments will evolve from simple defect-finding exercises to encompass simple, cost-effective data gathering tasks that can populate models to provide information that allows effective future strategic planning.