Remaining Asset Life: A State of the Art Review

All utilities want to maximize the life of their assets because they must provide satisfactory customer service with limited funds. However, the decision makers and asset managers must understand their assets to determine strategies and tactics that can help them extend asset life. Effective asset management will help utilities meet this challenge. An important element of this is the ability to assess or predict the remaining life of an asset. Asset life and remaining asset life are, however, multifaceted concepts. At a basic level, asset life relates to the repairability of an asset, but is also dependent on a range of other factors. Ultimately, remaining life reduces to a question of economics; the decision to replace or retain an asset should be based on the economic benefit to do so. In practice, maintenance and capital investment modify and extend asset life.

Extending the life of your assets can yield large savings.

This report addresses asset remaining life, especially asset related risk and the linkage to remaining asset life concepts. In the asset management world, risk is defined as the likelihood of failure or other event that causes loss, and the consequence of that failure. Therefore, managing remaining life hinges on reducing or mitigating one or both of these factors. Asset managers are in effect "managing risk" and therefore remaining life. The success of this effort will influence the longevity of their assets. Extending asset life by even a small amount can yield significant savings to a utility.

What is Remaining Asset Life, Really?

To estimate the remaining life it is necessary to determine the end of asset life. At first glance, end of life determinations appear obvious – when an asset fails to function, although many assets can be repaired, so loss of function is not the end of the life. However, an asset could be considered to be at the end of its life before any failures because of the nexus of risk and replacement or rehabilitation costs. The issue of repairability further complicates remaining life determination. Assets can be categorized as non-repairable or repairable. However, just because an asset cannot be repaired, it does not mean that it is acceptable to allow it to fail. The possible consequences may be too great. After examining many definitions of remaining asset life and the end of life, the researchers define these terms as:

> *End of asset life is the time at which a significant (capital as opposed to operational) investment is made. Remaining life is the time left before a significant capital intervention is required.*

Having a holistic definition provides the basis for the discussion of factors that influence remaining life and addresses the needs of the asset manager who is trying to manage that remaining life.

Influences on Asset Life

Numerous factors influence the life of various asset classes. Those relating to physical life are considered in life cycle terms. This is because decisions made in each part of the asset life cycle can influence the useful life obtained. Various other factors influence the

BENEFITS

- Illustrates how risk concepts influence remaining asset life.
- Provides a review of how concepts of remaining asset life relate to asset management.
- Includes case studies to illustrate how some water authorities address remaining life in their asset management strategies and approaches.
- Provides an overview of the state of the art in modeling remaining asset life.

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life of various asset classes. These factors are not related to the asset themselves, but are derived from the economic aspects of the water authority and/or level of service the authority delivers to customers or the community.

Managing Risk is Central to Extending Remaining Asset Life

Asset management is about managing risk and risk is an important determinant of remaining asset life. Risk is defined as the product of the likelihood of failure and the consequence of failure. The likelihood of failure is expressed as the probability of failure (PoF) and can be conceptualized as the relationship between load and capacity. The second part of the risk equation – consequence, completes the estimation of remaining life. The potential consequences of failure define the importance of the asset and the management strategy for the asset. The consequences will drive the degree to which the asset is allowed to deteriorate before intervening. In other words, the end of life and therefore, remaining life, is determined by condition, performance, and risk exposure of the asset.

Asset remaining life concepts can be applied at each of three levels of asset management. For example, in strategic asset management (SAM), capital budgets are partly determined with respect to assets that are approaching the end of their life. Similarly, in tactical asset management (TAM) remaining life concepts are applied in capital improvement program projects validation and prioritization. Finally, inspection and monitoring are part of operations and maintenance (O&M) procedures to assist in understanding remaining life.

The Hard Part: Assessing Remaining Life

An engineer or maintenance practitioner with an appropriate level of knowledge and experience can make a fair assessment of whether an asset is in an acceptable state. It is also possible for the assessor to estimate remaining service life directly from information on asset condition. To provide more consistency, there is a need for standard guidance on what constitutes a significant defect for a range of asset types in a variety of operational contexts and/or standard methods for using expert opinion. Condition and performance grading approaches have been developed as part of the research to facilitate this process.

The researchers reviewed modeling techniques used to predict remaining life. The approaches were divided into deterministic, statistical, physical, and soft computing or artificial intelligence-based models. The report provides a summary of each technique in these categories along with a description of the relevant theoretical background. Included in the report is a guide of the techniques and their practical applications to aid the asset manager in selecting a relevant approach.

The state of the art review provides the asset management team with a good overview of the knowledge that exists to determine remaining life. The researchers recommend standardizing industry terms and definitions and provide areas for further investigations in remaining life determination. A taxonomy gives a detailed discussion of terms found in the report and provides a basis on which members of the asset management team can discuss remaining life strategies and tactics.

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