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Disclaimer: The Publications Committee of the Society of Depreciation Professionals wishes to thank the authors who submitted papers and surveys for the seventh issuance of the Journal. It is our hope that the Journal will become a primary repository and source for innovative ideas and research in the field of depreciation. The opinions expressed by the authors of the papers included in the Journal are their own and do not represent the position of the Society, the Publications Committee, or the authors' employers or affiliates.

Society of Depreciation Professionals Goals and Objectives

Overall Goals

The objectives of the society shall be to recognize the professional field of depreciation and those individuals contributing to this field; to promote the professional development and professional ethics of those practitioners in the field of depreciation; to collect and exchange information about depreciation engineering and analysis; to provide a national forum of programs and publications concerning depreciation.

Activities

·Provide a forum for discussion of issues relating to depreciation policy.
·Recognize professionalism through membership and awards for service and contributions to the art of depreciation.
·Encourage papers on matters of interest to depreciation professionals.
·Sponsor regular conferences.
·Provide members with information and training that will enhance their skills as depreciation professionals.
·Sanction individually, or jointly with other organizations, educational forums on depreciation.
·Publish a regular newsletter.
·Provide electronic data sources such as internet communication or other electronic data services.

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Do Regulatory Prescribed Projection Lives Meet the FCC's Criteria for Use in the TELRIC Proxy Models?
Stephen Barreca

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John S. Ferguson

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David Berquist

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Impact of Investment on the Remaining Life Rate

Jacob Ransom

This paper will address the impact of investment on the remaining life rate. That is, what is the impact on the depreciation rate if the investment used in the development of the reserve percent used in the depreciation rate should have been less than or more than that actually used.

A Combined Index in Simulated Plant Record Analysis

Kimbugwe A. Kateregga, Ph.D.

The simulated plant record analysis (spr) and indexes used for selection among indicated dispersions are reviewed in this paper. It is shown that the index of variation and the retirement experience index, used independently, sometimes fail to provide a dependable selection between competing indications. In such cases, a mathematical combination of the two indexes is offered as a solution.

Economic Depreciation?

NARUC Staff Subcommittee on Distribution

The NARUC Staff Subcommittee on Depreciation presents a discussion paper comparing economic depreciation with traditional regulatory depreciation. There is much discussion today in federal and state decisions, comments from industries, and various academic papers on the use of economic depreciation. Unfortunately, some use the terms "economic life" and "economic depreciation" synonymously. This paper clarifies and discusses the differences between these terms and the more traditional depreciation terms.

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3. Each manuscript should include an abstract of no more than 150 words.

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5. Author(s) should use standard symbols and the English alphabet.

6. Footnotes should be listed at the end of the manuscript.

7. Each table should be titled at the top, each figure should be titled at the bottom, and each table and figure should be provided on a separate sheet.

8. Only references cited in the text should be listed.
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The aims of the Journal of the Society of Depreciation Professionals are:

To serve as a forum for the exchange of information;

To illuminate through theoretical, empirical or professional analysis the effects of depreciation on public policy;

To encourage creative interdisciplinary understanding of depreciation and its impact;

To review and discuss current issues and controversies within the field of depreciation.

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CAPITAL RECOVERY POLICY: THE DECISION-MAKERS

Ronald Kalich

Abstract

This paper will describe factors that affect Capital Recovery Policy-setting based on the views of those setting the policy. Values, risk, and bias significantly affect decision-making of policy-setters. These factors can be manifested through one or more of the following viewpoints: accountancy focus on apportioning expense from capitalized assets; budgeting focus on controlling and monitoring costs; engineering focus on data analysis; and forecasting focus on predictive modeling. How do these decision-making factors affect Capital Recovery Policy?

Introduction

Capital recovery policy and rate-setting for regulated companies is composed by the confluence of views and beliefs held by individuals serving on regulatory commissions and staffs, working for companies, and the interested public. Not surprisingly, stakeholders in these groups have disparate values, have different perceptions of risk, and hold differing biases that directly impact depreciation policy.

Differing perspectives, and not necessarily interests, are the root of many policy controversies past and present. Individuals responsible for setting capital recovery policy are likely to take a role based on at least one the following four perspectives presented here: Accounting View; Budgeting View; Engineering View; Forecasting View. Each viewpoint represents generalized value, risk, and bias that can set policy makers at odds with one another.

Values

The primary decision-making factor is individual values. Values consist of individual beliefs based on background, culture, education, and experience. The set of values that a decision-maker holds provide the motivation for decision-making. The more critical the decision, the more likely the result will reflect the underlying values of the individual making the decision. However, all decisions reflect the value set of the decision-maker.

Risk

A secondary factor in decision-making is risk. Risk can be defined by four factors: probability, time, reversibility, and importance. In terms of decision-making, probability is the likelihood of an event occurring (sometimes referred to as uncertainty). Time represents the time one has to make a decision, the time horizon in which a probable event is likely to occur, and the duration of the impact of a decision. Reversibility is the ability or ease to reverse a course of action taken. Finally, importance defines the relative value an individual places on the decision.

The riskiness of a decision is directly linked to the values held by the decision-maker. Each individual will weight risk factors of a given decision in a unique way, i.e. perceived risk is highly judgmental. The risk continuum from less risky to more risky as defined by the four risk factors can be characterized in a table as presented below:

Less Risky ⟵	RISK CONTINUUM	⟶ More Risky
	Risk Factor	
Unlikely	Probability	Likely
Long time	Time (to make decision)	Short time
Present	Time (decision impact)	Future
Short term	Time (duration)	Long term
Reversible	Reversibility	Irreversible
Unimportant	Importance	Important

The probability that an event will occur determines how a decision-maker will factor risk into their decision-making analysis. It is typically the first determinant of riskiness of a decision. For instance, if a given event is unlikely to occur, the resultant decision would generally be considered less risky as the decision is less likely to have an impact. In contrast, if a given event is highly probable, the resultant decision is generally considered more risky given the greater likelihood of the impact of the decision.

The time period in which the decision-making event is to occur, the time in which the decision is to have a perceived impact, and the duration of the impact define a second factor of risk in decision-making. Time itself is on an irreversible continuum, thus, there is an inherent time-dependent risk in every decision-making event. For example, there is some risk in a postponed decision regardless of the probability of an event.

The reversibility of a decision defines a third risk factor. Generally, the ability to reverse a decision (and potentially the impact of that decision) qualifies as a less risky proposition than a decision that is irreversible. A decision that is otherwise perceived to be quite risky might nonetheless be taken if it is deemed to be reversible.

Finally, the importance or gain/loss potential of decision-making is a fourth determinant of perceived riskiness. For instance, placing a $1 gamble on a lottery is generally considered low risk, despite astronomical odds against winning in that the potential gain is great versus the limited (although highly probable) loss.

It is the perception of risk, based on one's individual values, that is key in decision making. A critical understanding of policy-setting is that risk is never an absolute factor, rather, it is relative to each individual decision-maker. Different individuals will perceive different levels of risk due to their disparate values.

Empirical studies of risk perception have produced several enlightening results applicable to the understanding of policy-setting. For instance, if the expected range and variance of results of a decision is large, or if the expected loss is large, perceived risk is higher. Perceived risk is lower if a positive result is anticipated from all options/courses of action. By extension, the perceived riskiness of policy should be lowered by factoring some level of positive result for all parties (from their viewpoint), and by reducing the expectant range and variability of the results of the decision. This is demonstrable in practice by examining highly effective capital recovery policy seeking to provide similar treatment, while providing incremental (perceived) positive outcomes to all parties.

Bias

Bias is inherent in policy-making based on the values, and risk perceived by those making decisions. Bias is often thought of as being solely a product of experience, however, it is actually a result of the application of individual values (including experiential values) to a given decision and the riskiness of that decision. In other words, bias is a variable based on several conditions, not just one. Although it often carries a negative connotation, bias is vital to decision-making, and the understanding of its impact is vital to the understanding of effective policy-making.

An example of bias is the apparent change in behavior of a customer-client relationship outside of a standard work environment. Often, very important business relationships are fostered in more relaxed environments such as over a meal or on a golf course. Reducing the apparent riskiness of discourse and resulting decisions through informal discussions allows for iterative, interactive testing of probability of outcomes (action/reaction), more accurate estimation of the time factor of risk, reversibility of decisions ("trial balloons"), and thus determination of the importance factor involved with perceived risk.

Another example of bias is the seeming unwillingness to deviate from existing policy, or sticking with the "tried and true". Again, the reduction of perceived risk may be a driver in this case, coupled with decision-makers' values regarding accuracy, stability, fairness, etc.

Capital Recovery Viewpoints

Viewpoints are inherently value-driven and biased. The following viewpoints are judgmental constructs that typify decision-making used to develop capital recovery policy-making: Accounting viewpoint; Budgeting viewpoint; Engineering viewpoint; Forecasting viewpoint.

Accounting Viewpoint

The accounting view of depreciation typically involves both the matching principle and conservatism. The accounting definition of depreciation relates to systematic and rational allocation of the original costs of assets over the period in which those assets produce a benefit. Similarly, the tax accounting viewpoint of depreciation is represented by the reasonable allowance for exhaustion, wear and tear, and obsolescence on certain types of property used in a trade or business or for the production of income. Terms such as rational, systematic, reasonable, and allowance are accounting code-words for matching or apportioning expense to revenue. The conservative bias ascribed to the accounting viewpoint is bolstered by terms such as rational and reasonable.

The most desirable result from the accounting perspective is to fully and ratably recover the initial investment over the period in which the plant is in service. There would be no need for extreme true-ups based on changes to the service lives or net salvage values, rather, there would be gradual changes in depreciation rates that apportion any changes to relevant periods.

Decision-makers with an accounting viewpoint thus are likely to value conservatism and balance. Higher risk is likely to be perceived in situations that require unanticipated accounting journal entries. Conservatism in the accounting sense is equated with "never having to say you're sorry."

Budgeting Viewpoint

The budgeting view sees depreciation as a controllable expense, much like other operating and administrative expenses. However, there is a weak link between the initial capital expenditure creating the long-term stream of depreciation expense and the often shorter-term pressures and concerns of the budgeting process. Depreciation expense is a capital-related expense, dependent upon investment level and depreciation rates. While depreciation expense can be accurately forecasted for a given period, it is not controllable in the traditional budgeting sense of capping or reducing expenditures in various expense categories. Any deviation from forecasted values results in variances.

Decision-makers with a budgeting viewpoint thus are likely to value predictability and control. Higher risk is associated with variance of outcome and deviance from forecast. The rule for budgeting is "no surprises."

Engineering Viewpoint

This engineering view focuses on historical data analysis, coupled with design and performance data and market studies to determine the life and salvage characteristics of plant. It focuses on recorded accounting and statistical data and studies of these to determine net salvage. Some emphasis on predictive value stems from the engineering viewpoint, but it is largely incremental in nature, i.e. modification to historical or statistical results based on additional, specific information. This viewpoint is most frequently encountered by those conducting depreciation studies, and it is largely what is taught in "depreciation school."

Decision-makers with an engineering viewpoint thus are likely to value analysis and causality (cause-effect relationships). Higher risk is associated with improperly factoring data and resulting analysis. The rule for engineering is analysis of detail.

Forecasting Viewpoint

The forecasting viewpoint is typically less concerned with embedded plant investment than the other viewpoints. Often, it deals with technological changes that affect plant investment or predicted market conditions. Forecasting can also involve regulatory and business planning, but for depreciation purposes, it most typically is equated with replacement.

Decision-makers with a forecasting viewpoint are likely to value more recent or developing information, emerging technology, and feedback. The rule for forecasting is discerning and applying patterns to enhance forecasts.

Capital Recovery Policy

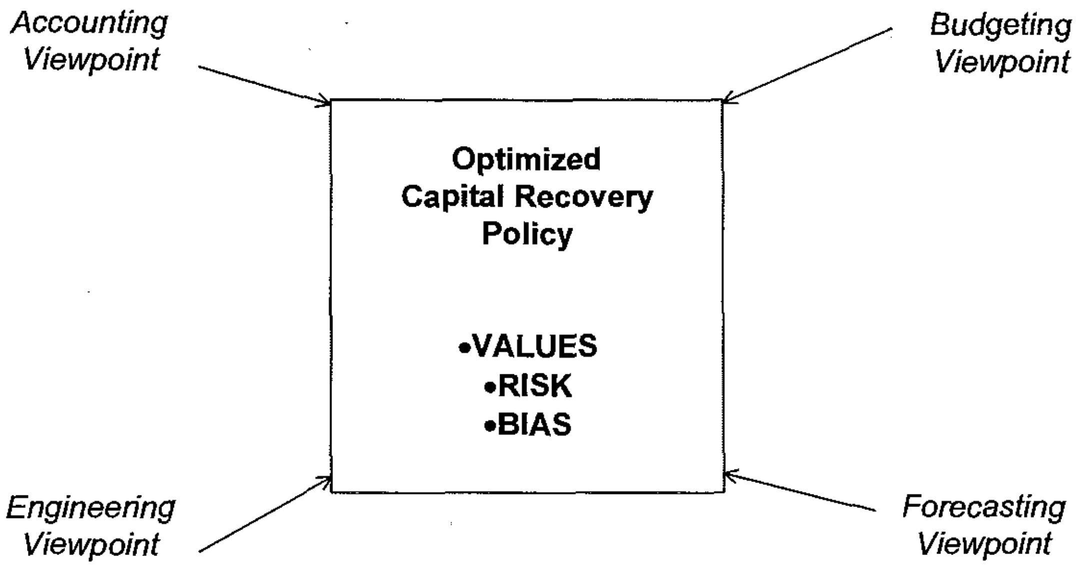
Understanding that values, risk, and bias enter in to decision-making is a step toward effective policy-making. Identifying, understanding, and influencing the differing viewpoints of capital recovery policy-makers is vital to the effectiveness of capital recovery policy. Leveraging the fact that different perspectives can theoretically provide common ground for everyone, one can argue that ideal policy exists for all parties involved in any circumstance.

<u>One Potential Convergence of Capital Recovery Viewpoints</u>

Capital Recovery policy can and does find common ground in the four perspectives. A policy consistent with each viewpoint is the acceptance of the definition of depreciation as representing the loss in service value. Although not commonly associated with accounting viewpoint, periodic adjustment to the depreciation reserve to mimic loss in service value in fact does best represent the matching principle. Tracking loss in service value should also represent fewer "surprises," the budgeting bugaboo. Representing the loss in service value also satisfies the engineering view in that recorded, verifiable, and discernible results can be analyzed. Finally, the forecasting perspective is afforded updated and realistic market information by reflecting actual instead of artificial activity.

<u>Other Potential Convergence of Capital Recovery Viewpoints</u>

Other convergences in capital recovery viewpoints are also possible. Similar cases can be made for stability of recovery, verifiability of underlying data and assumptions, adequacy of recovery, and more.



Summary and Conclusion

The factors that affect policy-makers' decisions include values, risk, and bias of the individuals setting policy. Values and risk help shape bias, which is necessary to setting policy. Four viewpoints typically associated with capital recovery policy are the accounting, budgeting, engineering, and forecasting viewpoints. Effective capital recovery policy can be afforded through the convergence of these overtly divergent viewpoints by finding common ground for all parties.

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1998 U.S. Master Depreciation Guide, CCH Incorporated.

REUSE SALVAGE ADJUSTMENTS IN LIFE AND SALVAGE ESTIMATION

Charles P. Neff

Abstract

This paper illustrates how failure to recognize and adjust for reclaimed salvage in depreciation studies can lead to the misallocation of depreciation charges over the life of an asset. The paper then shows how in depreciation studies the reversal of booked retirements by the amount of reused salvage can help solve the problem.

Materials removed from the field and returned to inventory could affect the proper estimate of life and salvage parameters for overhead lines accounts. These accounts can have a significant amount of reusable equipment which is reconditioned and returned to stores.

Because of pressures for cost reduction, one area receiving increased attention is salvage reclamation of equipment. This equipment would include such items as insulators, brackets, and pole top switches. When these materials are removed in the field, there would be credits to property and credits to the reserve for scrap salvage.

Depreciation analysis would generally track booked retirements, scrap salvage, and removal cost to estimate life and net salvage.

Some of the equipment can be reconditioned and returned to inventory for installation at another location. The problem is that reconditioned equipment would not be expected to have the same life and salvage over its remaining life as would new equipment. Without adjustments to recognize the altered life characteristics of reused materials, life analysis of retirements based only on booked plant accounting data may overstate net salvage and understate life.

It helps to illustrate the problem with a simple three year example.

Assume a \$1000 installation at the beginning of year 1. At the end of one year, \$500 is retired. Of the \$500 retired, assume \$50 is reused and lasts until the end of the third year. At the end of the second year, another \$500 is retired. Of this amount, another \$50 is reused and lasts until the end of the third year. The account dies off at the end of the third year.

Let's further assume removal costs of \$90, \$90, and \$20 over the three year period.

These assumptions are summarized in Table 1.

Using book accounting data without adjustment for reused salvage results in an average life of 1 ½ years for both the \$1000 initial installation and the two \$50 installations and a net salvage ratio of –8% in the first year and –20% in the third year. The survivor curve is shown in Figure 1. The problem in performing the study without some adjustment for reclaimed material is that the resulting depreciation charges could be back loaded toward the later years of the asset's life as shown in Table 2. Even though the plant balance in year 1 of \$1000 is ten times the plant balance in year 3 of \$100, the depreciation expense in year 1 is not ten times the expense in year 3. Depreciation expense in inequitably allocated over the asset's life.

The problem can be corrected in depreciation studies by accounting for the reused material as a reversal of the original retirement.

With adjustments for reused salvage, the average life of the $1000 initial installation is 1.65 years and the net salvage ratio (NSR) is – 20% [NSR = 90/(500-50)] in all three years. The survivor curve is shown in Figure 2. This adjustment results is a level depreciation rate of 72.72% in all three years as shown in Table 3.

This method is not new. It is described on page 25 of the December 1968 edition of the National Association of Regulatory Utility Commissioners *Public Utilities Depreciation Practices.*

One test of the propriety of the adjustment is whether it results in a more equitable allocation of the cost of the asset over its service life. In this example, if it is assumed that the assets having a cost of $1000 have ten times the service value of an assets costing $100 dollars, then the depreciation charges allocated to period 1 should be ten times the depreciation charges allocated to period 3. The adjustment for reuse illustrated in Table 3 accomplishes this.

To the extent that the adjustment results in a better matching of cost and benefits, and thereby contributes to the proper price signals to customers and promotes cost effective behavior within the utility, then adjusting for reused salvage may be a useful tool for estimating life and salvage in depreciation studies.

Table 1—Plant Addition and Retirement Assumptions			
Year	1	2	3
Additions (January 1)	1000	50	50
Beginning Balance	1000	550	100
Retirements (December 31)	500	500	100
Ending Balance	500	50	0
Reused Salvage	50	50	0
Removal Cost	90	90	20

Table 2—Depreciation Expense Not Adjusted for Reuse			
Year	1	2	3
Depreciation Reserve (BOY)	0	180	19.5
Depreciation Expense	720	379.5	100.5
Salvage Reused	50	50	0
Removal Cost	90	90	20
Retirements	500	500	100
Depreciation Reserve (EOY)	180	19.5	0
Remaining Life (BOY)	1.5	1.0909	1
Net Salvage Ratio	-.08	-.08	-0.2
Reserve Ratio (BOY)	0	0.327273	0.195
Depreciation Rate	0.72	0.69	1.005
Average Balance	1000	550	100
Depreciation Expense	720	379.5	100.5

Table 3—Depreciation Expense Adjusted for Reuse			
Year	1	2	3
Depreciation Reserve (BOY)	0	187.27	47.27
Depreciation Expense	727.27	400	72.73
Salvage Reused	50	50	0
Removal Cost	90	90	20
Retirements	500	500	100
Depreciation Reserve (EOY)	187.27	47.27	0
Remaining Life (BOY)	1.65	1.1818	1
Net Salvage Ratio	-.2	-.2	-.2
Reserve Ratio (BOY)	0	.34049	.47273
Depreciation Rate	.72727	.72727	.72727
Average Balance	1000	550	100
Depreciation Expense	727.27	400	72.73

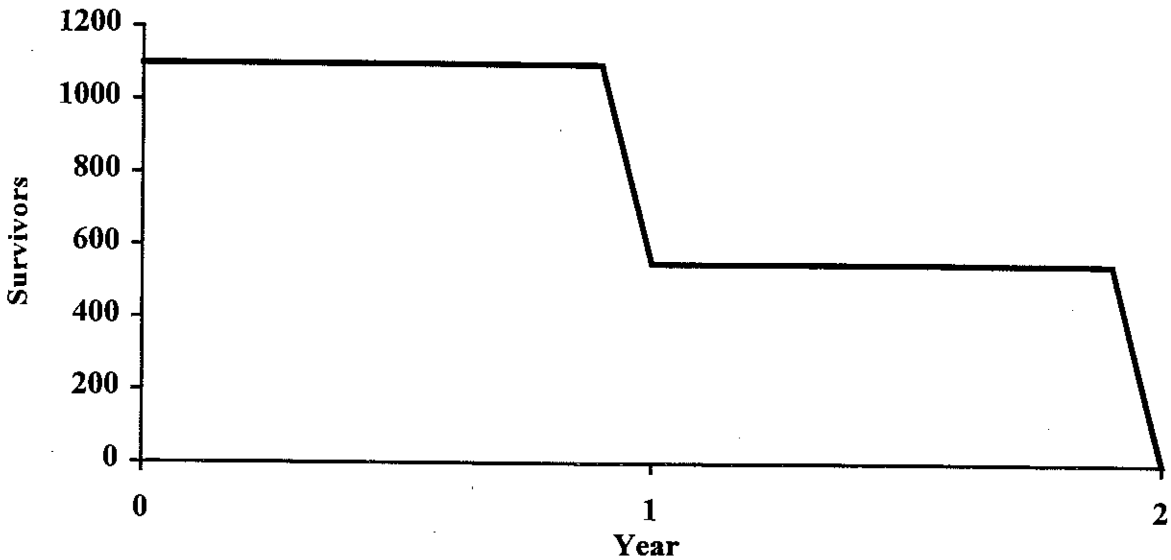


Figure 1--Survivor Curve Not Adjusted for Reuse

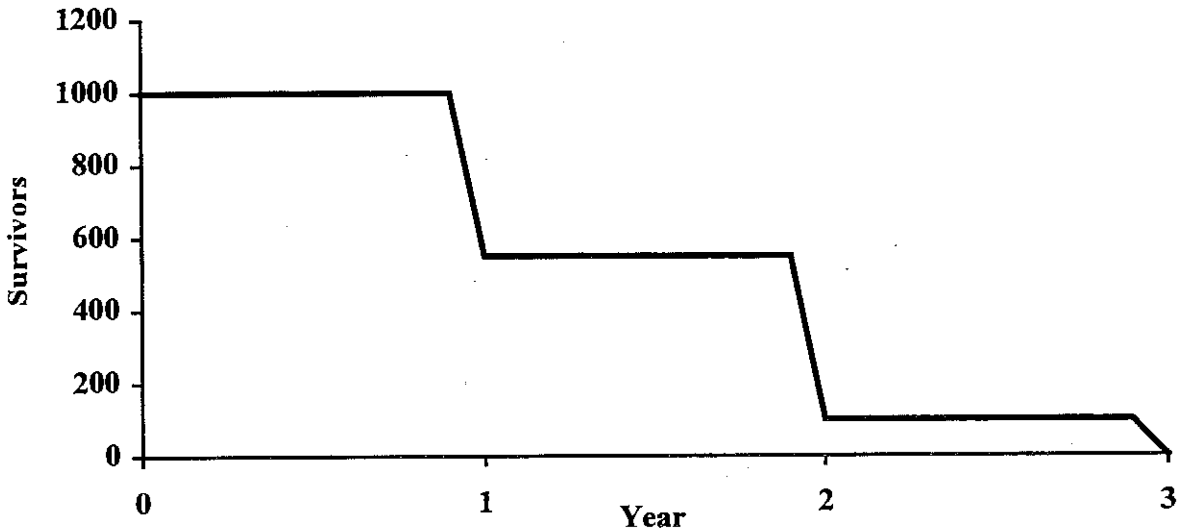


Figure 2--Survivor Curve Adjusted for Reuse

TECHNOLOGICAL OBSOLESCENCE: ASSESSING THE LOSS IN VALUE ON UTILITY PROPERTY

Stephen L. Barreca

Abstract

Traditional mortality studies alone are insufficient to assess the depreciation of utility property that is subject to technological obsolescence. There are two principle reasons for this. First, technological obsolescence is having a more profound impact on the future economic life of utility property today than it had in the past. Second, the current mortality analysis process, i.e., using a single mortality survivor curve for all vintage for all future years, grossly understates the true impact of technological obsolescence. Several writings, published in the early 1980's, document this fact; yet, the current process, developed in the first half of this century, remains unchanged today.

> W.C. Fitch and F.K. Wolf in their paper, titled *Conceptual Framework for Forecasting the Useful Life of Industrial Property*, Iowa State Regulatory Conference, 1984, recognized the need to enhance the Prescribed Projection Life process and conceptualized on how forward-looking impacts such as technological obsolescence could be modeled to give better life estimates.

> K. A. Kateregga, Department of Industrial Engineering, Iowa State University, concluded in his paper *Technological Forecasting Models and Their Applications in Capital Recovery*, that "there is a justifiable need to incorporate technological forecasting in the overall life analysis framework especially in those industries experiencing fast technological changes."

This paper presents a methodology that will allow the influences of technological obsolescence to be reasonably assessed and reflected in the economic life and depreciation of the plant. It proposes that the analyst use *Historical Mortality Analysis* to assess the influence of traditional forces of mortality, and an extension of *Substitution Analysis* to determine the impacts resulting from technological obsolescence. Each of these techniques is common practice and has proven accurate in the context of their use within this paper. The total mortality rate is then computed by statistically combining the influences from both traditional mortality analysis and technology substitution analysis. Finally, the life, value and/or depreciation of the property can be determined using commonly accepted life-cycle techniques.

Background

Depreciation is a measure of the loss in service value incurred in connection with the consumption or prospective retirement of the property[1]. In the context of capital recovery studies, the goal is to book depreciation expense commensurate with the consumption of the asset. To determine depreciation adequately, the influence of <u>all</u> factors that measurably contribute to depreciation must be determined. Failure to adequately account for any significant contributor will understate the magnitude of depreciation, and overstate the true value of the asset.

In practice, separately quantifying the depreciation contribution of all potential influences is not practical and, luckily, not required. Depreciation generally results from two principle classes of loss: traditional mortality forces and technological obsolescence.[2] Most, if not all, significant

[1] *Public Utility Depreciation Practices*, National Association of Regulatory utility Commissioners (NARUC), 1996, page 318.

[2] Different regulatory bodies and corporations may have specific local definitions for depreciation related terms, and may classify the forces contributing to an asset's loss in value differently than presented in this report. The state of

influences on the depreciation of utility property can be captured by assessing the mortality characteristics of just these two classes of forces.

For most of this century, Historical Mortality Analysis (HMA) provided a reasonable estimate of the economic lives and loss in value of utility property. Before the 1970s, the overwhelming drivers of mortality for utility property were traditional mortality forces: wear and tear, deterioration, etc. These forces are typically a constant function of the age of the asset and do not change with the passage of time. For example, 5 years ago, 10 year old assets may have had a 3% retirement rate; today, 10 year old assets would still have a 3% retirement rate; and 30 years from now, 10 year old assets would still have a 3% retirement rate. This concept is fundamental to HMA.

When used to model traditional forces of mortality, HMA, has proven reasonably effective. Some assets, like utility poles, still exhibit characteristics consistent with HMA. With the onslaught of rapid technological obsolescence, however, experience has proven HMA ineffective. The reason for this is simple: when technological obsolescence is present, mortality rates increase with the passage of time. Reliance on past mortality experience as the basis for future mortality patterns understates the true mortality of utility property, understates the depreciation requirement, and overstates the remaining life and value of the assets.

Because of HMA's inability to model mortality forces that change with the passage of time, another technique must be used to assess technological obsolescence. HMA should still be used to assess traditional age-dependent forces of mortality; however, technological obsolescence must be separately addressed using techniques that account for its unique mortality characteristics. The technique presented in this paper to address the unique characteristics of technological obsolescence is an extension of *Substitution Analysis.*

Indiana, for instance, classifies wear and tear from usage as a form of obsolescence, whereas this report classifies wear and tear as a '*traditional*' force of mortality. How one classifies the different forces of mortality is a matter semantics and local custom, and not germane to the results. For the purposes of this analysis, mortality forces are classified in a manner thought to best promote their understanding.

Assessing Traditional Forces of Mortality

Traditional Forces of Mortality, in the context of this paper, refers to those forces of mortality that can be reasonably modeled as a constant function of the age of the asset. That is, the likely mortality of an asset in a given year and for a given age of plant (vintage) is constant. Traditional mortality generally results from usage and exposure to the elements. Specific forces of traditional mortality include wear and tear through usage, deterioration with age, accidental or chance destruction, and most requirements of public authorities.

Provided that the group of assets being studied is homogeneous[3], you can readily model traditional mortality as a constant function of age. For example: Accumulated usage of an asset is nearly a constant function of its age. Wear and tear of an asset resulting from accumulated usage is, therefore, also a constant function of age. Similarly, some forms of deterioration are a direct function of age, while others are a function of accumulated exposure to the elements, which in turn is a constant function of age. Accidental or chance destruction is more a function of the environment surrounding the asset and constant for all age groups. Incidental losses due to public requirements, such as a road move, are also included with traditional mortality forces. Given the incidental and random nature of such mandates, they too are reasonably modeled as a constant function of the age of the plant.

The commonly accepted method of assessing the impact of traditional forces of mortality is *Historical Mortality Analysis* (HMA). The HMA process typically involves developing the mean probability of loss (a.k.a. retirement rate) for each age of plant. Generally, this entails statistical analysis of past retirement

[3] Homogeneous, in this context, indicates that the group of assets has similar life and mortality characteristics.

experience. The resulting mortality patterns are then reflected in a mortality *survivor curve*, which plots the anticipated percentage of initial survivors still surviving as the age of the assets increases. Figure 1 illustrates a typical survivor curve.

Figure 1 – Typical Mortality Survivor Curve

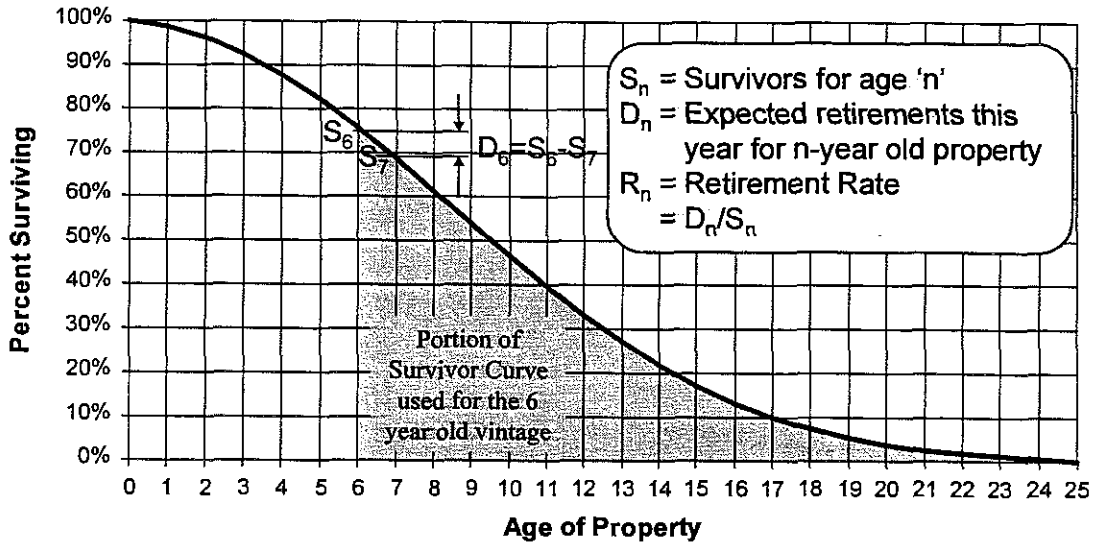


Figure 1 also illustrates how to use survivor curves to project the future mortality for a given vintage. Consider a six-year old vintage that has traditional mortality characteristics consistent with the survivor curve of Figure 1. From the survivor curve, the expected retirements for the current year equals the survivors for age 6 less the survivors for age 7 (S_6-S_7). The retirement rate for the current year, denoted as R_6, equals the retirements divided by the current survivors, or $(S_6-S_7)/S_6$. These calculations can be repeated for all subsequent years. For example, the expected retirement rate for the next year, for this vintage, is $R_7 = (S_7-S_8)/S_7$. Thus, the mortality survivor curve also gives us the future annual probabilities of loss (a.k.a., retirement rates) for each vintage.[4]

Additionally, it is common practice to estimate the remaining life of the vintage as the remaining area under the mortality survivor curve (the shaded area shown in Figure 1) divided by the surviving investment (S_6 in this case). This process can be repeated for each vintage and the average remaining life for all vintages is computed by investment weighting the individual vintage lives. This technique for estimating the remaining life is functionally the same as the *generation arrangement*[5] typically used in depreciation studies. In fact, the generation arrangement is simply a shorthand numerical algorithm for duplicating this more fundamental process.

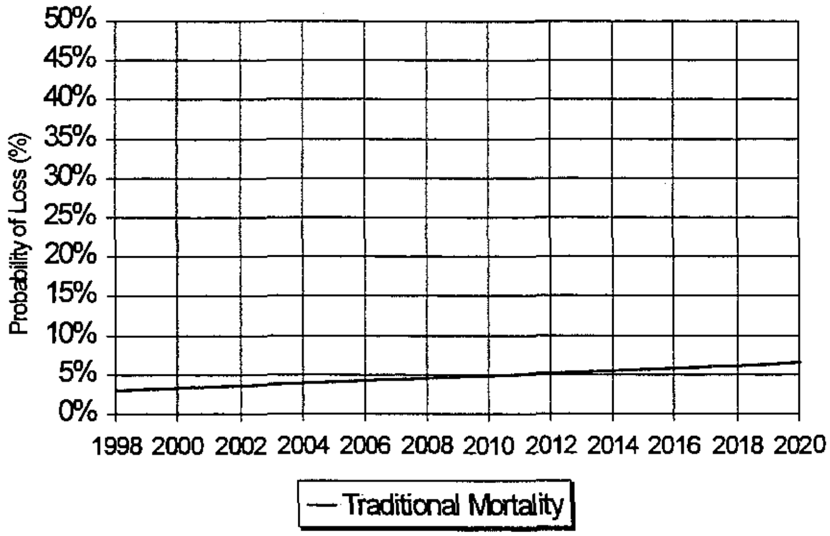
A useful form of the mortality characteristics is category-level retirement rates. These are computed as the investment weighted average of the individual values. Figure 2

[4] To simplify the presentation of this material and to promote its understanding, the mortality computations presented in this paper do not assume the half-year convention. All retirements and losses in value are assumed to occur at the end of the year for numerical computations.

[5] The term *generation arrangement* is commonly used in depreciation/capital recovery studies to reference the numerical algorithm used to estimate the average remaining life.

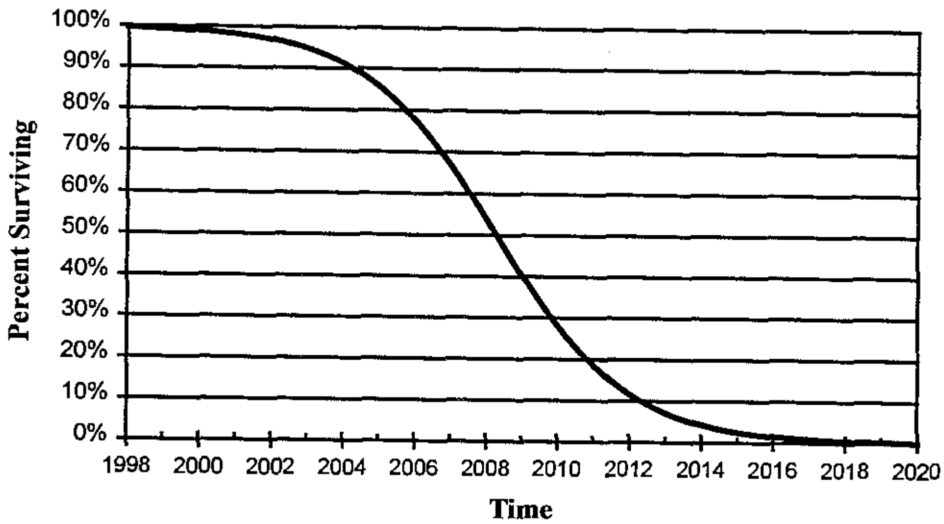
illustrates the resulting retirement rates derived in this fashion. It is important to recognize that these retirement rates represent the statistical *probability of loss* for the category of plant. In other words, the retirement rates are the likelihood (*probability*) that an asset will retire (*loss*) in a given year. These category-level retirement rates can then be used to project future survivors for all vintages combined, which in turn can be used to determine the category average remaining life. This alternate approach is commonly referred to as *Life-Cycle Analysis*, and produces the same resulting life as the two techniques described above.

Figure 2 - Retirement rates due to traditional mortality.



The combined mortality characteristics for all vintages of plant are often illustrated using a *Life-cycle* chart. Figure 3 illustrates a typical life-cycle chart. Here, the combined impact of all mortality forces on the entire category of plant is plotted going forward in time. The initial or starting value is typically reflected as 100% of the plant in service at the start date. As we move forward in time, the plot depicts the percentage of the initial property expected to still in be service. The life-cycle plot gives us a visual representation of the long-term impact that the mortality forces will have on the category of assets under study. The area under this curve is the expected average remaining life of the property.

Figure 3 – Typical Life Cycle Chart



While related, it is important to recognize that the life-cycle curve is very different from the mortality survivor curve. The life-cycle plots the survivors going forward in **time** for all vintages. In contrast, the mortality survivor curve plots the survivors as a function of the **age** for each vintage.

Some depreciation analysts incorrectly consider life-cycle analysis as different from the generation arrangement approach often used in life studies. The likely reason for this misconception is the fact that the generation arrangement does not directly calculate the future survivors; nor does it produce a life-cycle curve. Rather, the generation arrangement uses a shorthand numeric algorithm that, in effect, duplicates life-cycle analysis. The bottom line is that both techniques produce the exact same results when given the same mortality inputs.

The primary benefit of using the life-cycle approach to quantifying the traditional mortality characteristics is that it captures the net annual depreciation loss (retirement rate) as a function of time, rather than as a function of age. In this form, the mortality characteristics of traditional forces of mortality are more readily combined with other mortality influences that are not a function of age, specifically technological obsolescence.

Assessing Technological Obsolescence

Obsolescence is a measure of an asset's loss in value resulting from a reduction in the utility of the asset relative to market expectations. It should be noted that while the absolute usefulness of an asset may remain constant, if market expectations increase, the property may realize a corresponding reduction in value. Such a loss in value is said to be the result of obsolescence. There are two forms of obsolescence, *external* obsolescence and *functional* obsolescence.

Functional Obsolescence

Functional obsolescence results from a *flaw* in the structures, materials, or design that diminishes the function, utility, and value of an asset. The term '*flaw*', in this context, refers to any deficiency in the asset which negatively impact its ability to perform the desired function. Flaws are relative to need; this is, if the need evolves over time and the asset can no longer meet the need, then the asset's value is impaired. Customer expectation is a typical example: New and more powerful generations of personal computers increased customer expectations for personal computing power. While the power of older PCs remain constant, consumer needs increase. Relative to customer expectations (needs) older PCs have a flaw or relative deficiency. The loss in value resulting from this deficiency is a form of functional obsolescence, called Technological Obsolescence.

Technological obsolescence is one form of functional obsolescence. With the rapid pace of technological change, technological obsolescence is the principle cause of functional obsolescence today. In fact, when technological obsolescence is occurring, it generally overshadows all other causes of obsolescence. In this paper, *technological* obsolescence is the principle focus of the obsolescence analysis.

For consumer products, technological obsolescence often has an immediate and drastic impact on the value of older products. Take PCs, for example: the introduction of a new, faster, and more robust model often results in a significant reduction to the purchase price of the previous model. Overnight, the price can drop 20% or more. Such immediate affects of technological obsolescence are not typical of utility property.

Because of the large base of utility assets, typically thousands or tens of thousands of units, and the diverse environments in which they are used, the effect of technological obsolescence does not occur instantaneously. Typically, the property values begin to decline slowly with the introduction of a superior technology. As acceptance of the new technology grows, its costs drop and its usefulness increases further. Consequently, the pace of adoption of the new technology increases; and the pace of obsolescence of the older technology increases proportionally. Eventually, the rate of obsolescence levels off and typically remains relatively constant for the remainder of the life-cycle of the affected assets.

Because the process of obsolescence occurs over time and follows characteristic patterns, its long-term impact can be reasonably modeled from actual experience. The method of determining the impact of technological obsolescence is straightforward. First determine the pace of adoption of the new technology. Assess how rapidly new technology is actually displacing the use of the older technology. Then, equate the technological displacement of the older technology into annual probabilities of loss.

Substitution Analysis

The common method for assessing the adoption of new technology is *substitution analysis.* Substitution analysis is a technique that has proven effective in projecting the adoption of new technology. Substitution refers to the displacement of an established technology by a newer technology because the new technology provides improved capabilities, performance, and/or economies.

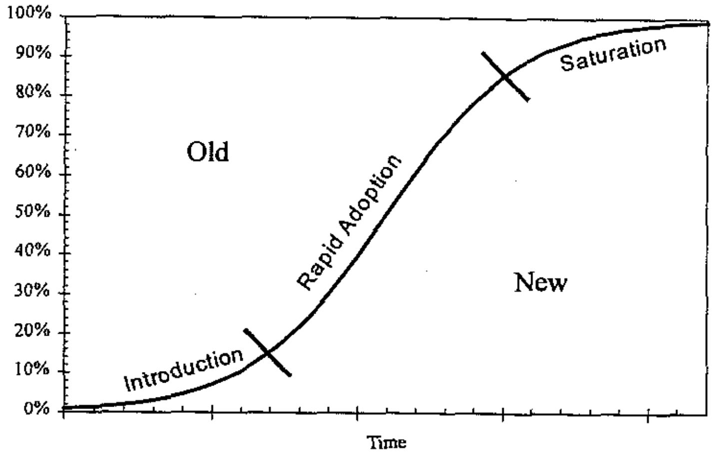
With substitution analysis, we examine patterns of technology substitution. The pattern is remarkably consistent from one substitution to another, and is characterized by an S-shaped curve when the market share of the new technology is plotted over time.

Figure 4 shows the S-shaped curve for the Fisher-Pry model. Of several substitution models available, the Fisher-Pry model and its extensions, notably, multiple substitution models[6], is the most useful in assessing the rate of substitution of telecommunications assets.[7]

[6] Multiple substitution occurs when the substitution of one technology for another is in progress and a third technology enters the market. For example, digital switching was introduced before analog electronic switches had completely replaced electromechanical switches, so both analog and digital switches were substituting for electromechanical.

[7] More information on substitutions and be found in L. K. Vanston and J. H. Vanston, *Introduction to Technology Market Forecasting*, (Austin, TX: Technology Futures, Inc., 1996)

Figure 4 – The Fisher-Pry Model



The adoption of a new technology starts slowly because, when it is first introduced, a new technology is usually expensive, unfamiliar, and imperfect. The old technology, on the other hand, has economies of scale and is well known and mature. As the new technology improves, it finds more and more applications, it achieves economies of scale and other economic efficiencies, and it becomes generally recognized as superior. The old technology, because of its inherent limitations and falling market share, cannot keep pace with the new technology. The result is a period of rapid adoption of the new technology, beginning near the 15% penetration level. This corresponds with a period of rapid abandonment of the old technology. Toward the end of the substitution, adoption of the new technology slows down again as the last strongholds of the old technology are penetrated[8].

Since the pattern of how a new technology replaces an old technology is consistent, we can apply the pattern to a technology substitution in progress, or one just beginning to forecast the remainder of the substitution. We can apply substitution analysis even in cases where the substitution has yet to begin by using appropriate analogies, precursor trends, and evaluation of the driving forces. Although no forecasting method is perfect, the experience with substitution models has been excellent.

The actual obsolescence of an asset occurs roughly proportional to the decline in market share of the old technology. During its introduction phase, new technology is often deployed primarily for new applications and as a replacement vehicle for equipment being replaced due to traditional mortality forces. Thus, technological displacement of the old technology is initially low.

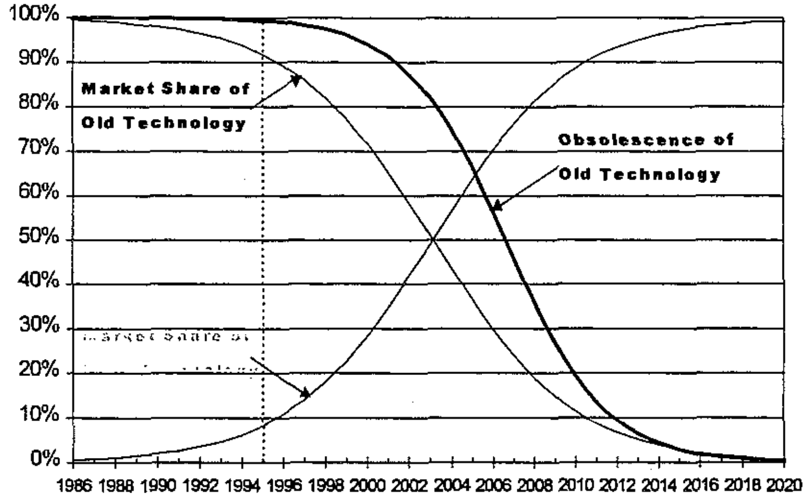
Gradually, the new technology matures and its deployment accelerates. Consequently, it begins to trigger the displacement of older technology that otherwise would have remained in service. This form of displacement is technological obsolescence. As the new technology reaches the rapid adoption stage, technological obsolescence accelerates. Then, as the new technology saturates the market and its deployment slows, the rate of obsolescence of the old technology decreases. Finally, total obsolescence is achieved when the market share of the old technology reaches zero.

Figure 5 shows the relationship between new technology adoption and old technology obsolescence. As can be seen from the figure,

[8] For some technologies, adoption of the new technology may actually accelerate near the very end of the substitution. This is generally due to the increased operational savings associated with the complete removal of the older technology.

the old technology looses very little, if any, value during the introduction phase (1986 to 1995) of the new technology. During this period, obsolescence is virtually non-existent and traditional mortality forces drive the mortality of the property almost entirely.

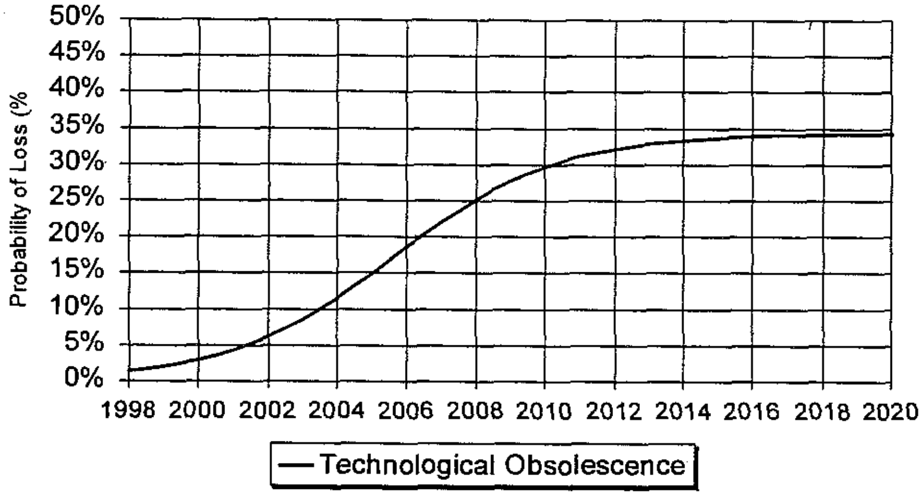
Figure 5 – Typical Obsolescence Chart



As the new technology enters its rapid adoption phase, the obsolescence of the old technology becomes noticeable. This point in time is indicated by the dotted line and occurs near the year 1995, and continues through 2001. During this period, obsolescence gradually increases. As adoption of the new technology continues to increase, the rate of obsolescence tends to stabilize; however, the loss in value due to obsolescence is often dramatic. Then, as we near the end of the substitution, the loss in value due to obsolescence generally slows until the value of the old technology diminishes to zero.

Given the ongoing substitution of an old technology by a newer technology, and given the nature of the initial deployment, the obsolescence of the old technology can be defined in terms of its remaining value, as depicted in Figure 5. In this form, the analyst can readily compute the annual probabilities of loss attributable to technological obsolescence using the same retirement rate formula used for traditional mortality forces (see Figure 1). Figure 6 plots the annual probabilities of loss corresponding with the obsolescence given in Figure 5.

Figure 6 - Annual Loss due to Obsolescence



In this form, obsolescence can be readily combined with the life-cycle plot resulting from traditional mortality. This combined life-cycle then becomes the basis for developing the remaining economic life and remaining value taking into account both traditional mortality and technological obsolescence.

Combining Multiple Forces of Mortality

When forces of mortality are expressed in terms of the probability of loss, they can be readily combined using simple statistical procedures. Typically, forces of mortality are mutually exclusive in that, while all the forces are present simultaneously, only one of them can actually cause the mortality of an asset. For example, each time you leave your house there exist a small probability that you will be killed by lightning and a small probability that you will be run down by a car. While both probabilities of loss are present, you can be killed by only one of them. Such forces are said to be mutually exclusive. The combined probability, P_T, resulting from two mutually exclusive probabilities, P_1 and P_2, is given by the following equation:

$P_T = P_1 + ((1 - P_1) * P_2)$ or alternately $P_T = P_2 + ((1 - P_2) * P_1)$

Thus, if you had a 10% chance of being killed by lightning and a 15% chance of being killed by a car, the combined chance of being killed by either one is 23.5%.[9]

$$0.235 = 0.15 + ((1 - 0.15) * 0.10)$$

When combining forces of mortality, it is imperative that the forces be represented in common terms. A retirement rate expressed as a function of age, for example, can not be combined with one that is expressed as a function of time. All forces of mortality can be equated to annual probabilities of loss over time.

In the case of traditional mortality forces, the age-dependent retirement rates are taken directly from the mortality survivor curve. These vintage values are then applied to the vintage investment, combined, and the resulting annual probabilities of loss over time for the entire category are computed (typical values are illustrated in Figure 2).

In the case of technological obsolescence, the substitution curve is used to first define the loss in market share of the old technology. Growth and usage trends and other factors that may influence the actual technological displacement of the assets are considered, resulting in a projection for the loss in value over time for the category of property (see Figure 5). From this, the annual probabilities of loss, over time, are readily

[9] If such probabilities are applicable to you...Stay Home!

computed using the traditional retirement rate formula. In this form, the mortality characteristics resulting from both traditional mortality forces and technological obsolescence are combined using the formula for mutually exclusive probabilities. Figure 7 illustrates the results of this process.

Figure 7 - Combining Multiple Forces of Mortality

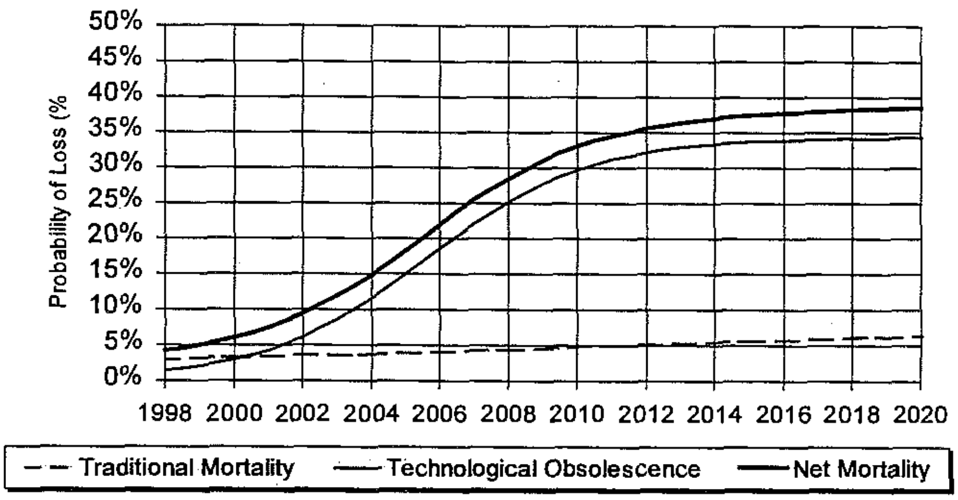


Figure 7 was developed from actual mortality and obsolescence data for telecommunication company (telco) metallic feeder cable from over 40 jurisdictions. Telcos began placing significant quantities of metallic feeder cable with fiber cable around the year 1984. As we can see from the figure, traditional mortality forces are still the dominant driver of mortality, 14 years later. Technological obsolescence does not become the dominant force of mortality until after the year 2000. This figure also illustrates that relying exclusively on either obsolescence or traditional mortality would understate the true mortality of these assets.

When combining the influences of traditional mortality forces and technological obsolescence, it is important to develop the traditional mortality using mortality experience that predates significant influence from technological obsolescence. To do otherwise may distort the results. It is not necessary to used mortality data that predates the introduction of the new technology, as material obsolescence typically lags initial deployment by several years or more. In the example of Figure 7, retirement experience from the early 1980's was used to determine traditional mortality experience. Specifically, a Bell #1.5 mortality survivor curve was used with a life indication of 25.7 years.

Case Study

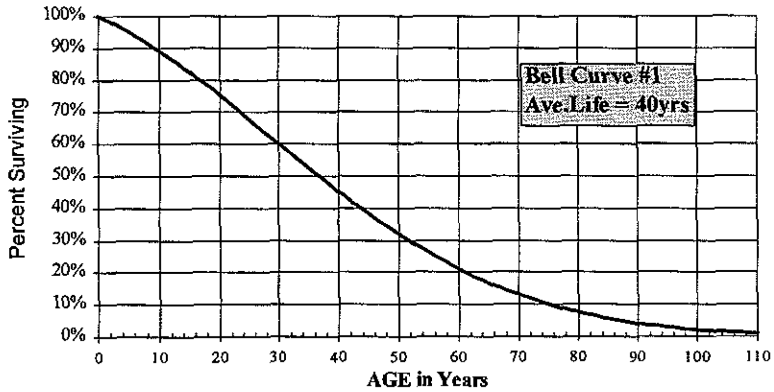
To illustrate the application of the techniques presented in this paper and to demonstrate the reasonableness of the results, the following case study was developed. This study assesses the economic life of metallic underground cable in the Interoffice (IOF) network for a single LEC, and single state jurisdiction. The LEC is referred to as LEC-A.

The case study shows that application of the techniques presented in this paper provides a reasonable and accurate estimate of the economic life. It demonstrates that if one were to rely solely on historical mortality characteristics, they would grossly overstate the life. Conversely, if one were to rely solely on technological obsolescence, they would again overstate the life, but to a much smaller degree.

Traditional Mortality

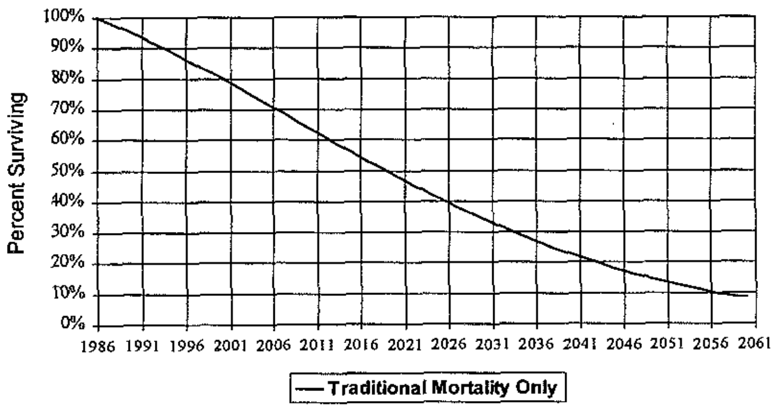
After review of mortality experience for the activity years 1978-1980, predating the deployment of fiber, the standard Bell Curve #1 was chosen as the mortality survivor curve. Life indications were generally high during this period. A projection life of 40 years was chosen, however, life indications tended to be somewhat higher. The resulting mortality survivor curve is shown in Figure 8.

Figure 8 - Mortality Survivor Curve



Applying LEC-A's vintage investment to the selected mortality survivor curve yields the life-cycle chart shown in Figure 9.

Figure 9 - Life-Cycle Resulting From Traditional Mortality Only.



This figure illustrates what the life-cycle of IOF copper would have looked like in 1986 if it were to follow traditional mortality patterns. From the figure we see that absent additional influences on the mortality of IOF copper cable, it would take about 70 years for 90% the copper in service on 1/1/86 to be displaced. Today, we know that it actually took just over 11 years (1986 to 1997) to displace 95% of IOF copper cable. Clearly, forces other than the traditional mortality forces are influencing the mortality of these assets. That missing force is technological obsolescence.

Technological Obsolescence

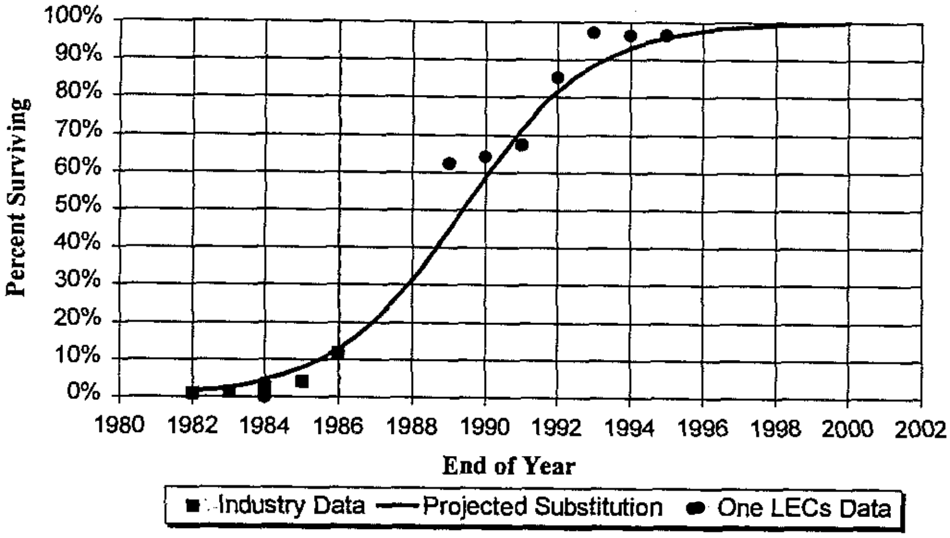
The case study uses industry fiber deployment data, through 1985, as the basis for projecting the substitution for subsequent years.

Prior to 1986, there was very little fiber deployed; and many experts were skeptical about its long-term potential. At that time, there was little empirical data on fiber deployment; nonetheless, there was sufficient industry data to make a reasonable projection of the substitution.

The pre-1986 industry empirical data and the resulting substitution are shown in Figure 10. Also shown, is LEC-A's empirical data. From the graph, we see that a substitution projection made in 1986, while not exact, did provide a rough approximation of fiber's subsequent deployment for LEC-A[10].

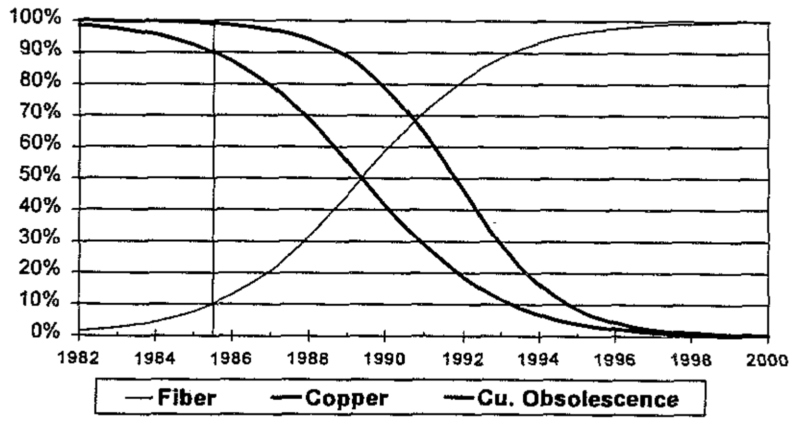
[10] One reason this particular LEC was selected for this study was precisely because the industry substitution trend only roughly approximated the LEC's subsequent fiber deployment. Generally, other LECs and jurisdictions more closely followed the projection. Thus, if the results of this study produce reasonable life estimates, then it further demonstrates the vitality and appropriateness of this process.

Figure 10 - Projected Substitution for LEC-A



From the substitution trend, the percent market share of IOF copper was computed. In the IOF, at that time, new fiber cables were generally placed parallel to copper cables. The trigger for the fiber placements was generally to accommodate future growth. Over time, copper circuits would migrate to the fiber cables as turn-over in the network presented opportunity to do so. To account for this situation, it was assumed that the obsolescence of copper would be negligible until fiber penetrated about 10% of the network. Then as fiber moved into the rapid deployment stage of the substitution, copper obsolescence would track with fiber penetration. The resulting projection for IOF copper obsolescence is provided in Figure 11.

Figure 11 - Obsolescence of IOF Copper



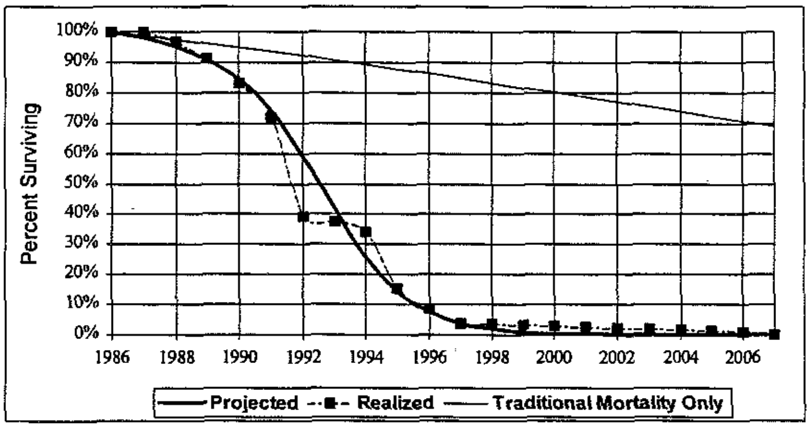
Resulting Economic Life

The remaining life, based solely on <u>traditional mortality forces</u>, was 36.95 years. This life is computed as the area under the life-cycle curve provided in Figure 9. The remaining life, based solely on <u>technological obsolescence</u>, is 6.83 years. This life is computed as the area under the obsolescence curve provided in Figure 11.

To estimate the actual remaining life of IOF copper that was realized (as of January 1, 1986), we must first make an assumption regarding the remaining IOF copper that exists today. For the purpose of these calculations, it was assumed that the remaining IOF copper in LEC-A would be displaced with fiber over the next ten years. While this assumption, by most experts' account, is a very conservative estimate, the volume of remaining copper is so small as to have minimal, if any, impact on these life calculations. The resulting average remaining life realized by LEC-A is 6.49 years.

Figure 12 compares the projected life-cycle to that which was realized, and to what would likely have resulted if only traditional mortality was considered. Clearly, the combined life-cycle, taking into account both traditional mortality and technological obsolescence produced the more accurate estimate of the economic life.

Figure 12 - Resulting Life Cycle



As these plots demonstrate, the industry substitution did not precisely project the life-cycle of LEC-A's IOF copper, however, it did provide a reasonable estimate. The techniques presented in this paper, if applied in 1986, would have accurately projected the life of IOF copper. And done so, at a time when the potential of fiber to displace copper was not fully appreciated; and traditional HMA techniques suggested that the life would be 40 or more years.

Conclusion

Both technological obsolescence and traditional mortality factors affect the useful life, and they do so simultaneously. As such, both should be taken into account. Ignoring technological obsolescence and its unique mortality characteristics will result in a gross overstatement of the life.

The process presented in the paper provides a reasonable and practical method to accurately assess the economic life of property subject to technological obsolescence.

DO REGULATORY PRESCRIBED PROJECTION LIVES MEET THE FCC'S CRITERIA FOR USE IN THE TELRIC PROXY MODELS?

Stephen L Barreca

Background

In a cost-based pricing scheme for fixed assets, depreciation is the dominant driver of the prices. It naturally follows that the period of time over which an asset is depreciated is the dominant driver of depreciation, and hence, the primary determinant of the price of fixed assets. Traditionally, for regulated industries the period of time over which a company depreciates a group of asset is referred to as the useful service life. The useful service life represents the average physical life span that the group of assets is in-service. Useful service lives reflect the expected physical mortality of the assets. That is, they account for physical mortality impacts such as wear and tear through usage, deterioration with age, and accidental or chance destruction or removal.

The purpose of depreciation is to match the consumption of an asset (i.e., the ongoing decline in value of the asset) with the recovery of the asset (i.e., depreciation). Often, the value of an asset declines at a pace different from the decline in value attributable to just physical mortality impacts. Factors such as increased competition or less expensive newer technologies can accelerate the decline in value above physical mortality levels. Depreciation which reflects not only physical mortality but also the economic loss in value is called economic depreciation; and similarly, an asset life that reflects the true economic loss in value of an asset is generally called an economic life.

In establishing the rules for determining the prices for Unbundled Network Elements (UNE), generally referred to as Telecommunications Long Run Incremental Cost (TELRIC), the FCC has established that the prices will be cost-based. The FCC further established that depreciation must reflect the true declines in the economic value of the assets. The asset lives used for depreciation in TELRIC, therefore, must be economic lives.

Some have proposed that the asset lives currently prescribed by the FCC for the depreciation of Incumbent Local Exchange Carrier's (ILEC's) embedded assets, called "Prescribed Projection Lives", meet the FCC's criteria for economic lives. Others claim that Prescribed Projection Lives are inappropriate for this usage. The purpose of this paper is to examine the nature and scope of Prescribed Projection Lives relative to the FCC's established criteria for use in TELRIC.

The debate over what constitutes an economic life is not new. Many different types of asset lives are floating around that purport to be economic lives. A very short list includes Financial Life, Projection Life, Depreciation Life, Average Remaining Life, Average Service Life and others. In the proper context, one would have no trouble finding intelligent people who would argue strenuously that their life is the correct economic life. The fact of the matter is that each of these lives, in the proper context, is a valid, but different, form of an economic life. Used out of context, however, each of these lives, as well as any others, may not be valid.

Consider, for example, the asset life that many property tax appraisers use. Property tax appraisers are interested in assessing the average life of embedded assets. That is, they want to know how long a group of assets has lived and how much longer these assets will live going forward. The combined total is an estimate of the average life. Property tax appraisers routinely refer to this life as the economic life. The economic life to a tax appraiser is not necessarily appropriate for use by Financial Annalists. Tax appraisers have defined the criteria necessary to meet their objectives, and any life that meets these criteria is appropriate for their use.

The long-standing debate over what constitutes an economic life is not going to be resolved any time soon. In the context of TELRIC, this debate is irrelevant -- like the tax appraisers, the FCC has defined the criteria for economic lives that can be used in TELRIC. If a life does not meet these criteria, that life is not valid for use in TELRIC.

The TELRIC Construct

The FCC has established criteria that define, in part, how to develop UNE prices. These criteria constitute a construct, referred to as the TELRIC construct in this paper. The TELRIC construct defines a hypothetical network that price calculations must reflect. Because the economic life is the dominant driver of the price for fixed assets, it is imperative that the economic lives used in TELRIC are consistent with the TELRIC construct. Otherwise, consumers will not realize the FCC's objectives for TELRIC.

In its description of the nature and scope of the TELRIC proxy model, the FCC clearly defines the nature and scope of what constitutes an economic life. In evaluating the validity of an asset life for use in TELRIC, one must be careful not to confuse traditional or personal understandings of life terminology with the FCC's intended usage of the term 'economic life'. In summary, the FCC requires UNE pricing to reflect forward-looking costing principles that reflect the least cost; most efficient telecommunications technology and network configuration available to the industry; and that the lives not be physical lives. The remainder of this section examines in more detail the TELRIC construct established by the FCC.

Least Cost and Most Efficient Technology

The FCC requires that the proxy models use only the least cost and most efficient technology available to the industry. This generally requires the use of the latest, most advanced technology currently being deployed or commercially available. All ILECs, for example, are currently deploying SONET multiplexer technology in their Interoffice and Feeder networks. The majority of the ILEC's embedded base, however, consists of older, more costly and less efficient non-SONET technology. While it is 100% probable that some UNEs would use these less efficient technologies, the TELRIC construct requires ILECs to assume that SONET, the most efficient and least costly technology going forward, is used. [1] Thus, the life used in the proxy models must reflect the economic life of the most efficient and least cost technologies (i.e., SONET in the above example).

Newly Placed Assets

The TELRIC proxy model assumes a hypothetical network where the least-cost provider deploys a <u>new</u> network using the most efficient technology and network configuration. It naturally follows that the economic life used in the proxy models must reflect the life of newly placed assets. This construct precludes the use of lives that reflect the economic life of embedded assets.

Forward-Looking

The FCC requires that prices of UNEs reflect a forward-looking assessment of the long-run incremental cost. They state that properly designed depreciation lives must account for expected declines in the value of capital assets. The economic lives used in

1 There are times when the latest most advanced technology is not the 'most efficient' technology available for the specific application at hand. Such applications are generally rare, and the proxy models in use can adequately account for the low probability that these applications enjoy.

TELRIC, therefore, must capture the future changes in the economic value of the assets. This requires that the lives reflect not only the historical impacts expected to continue in the future, but also any anticipated future economic impacts.

Future impacts mentioned by the FCC included technological obsolescence, lower prices resulting from increased competition, competitive losses and lower replacement costs of newer technologies. The lives used in the proxy models must reflect these forward-looking influences, as well as any other economic influences. Lives based on historical experience, which do not reflect the economic realities of the future, would not meet the TELRIC construct.

Not Physical Plant Lives

The FCC specifically states that the lives used in the proxy models should reflect projected economic lives of investments rather than *physical lives*. *Physical lives,* also called useful service lives, reflect the physical life characteristics of an asset. For example, if an asset was placed in-service and retired 10 years later, its physical life is 10 years. Depending on the circumstances, however, the asset's economic life could be less than 10 years. A reduction in replacement cost is one example of an economic reality that would lesson the value of the asset and, hence, lesson its economic life. Technological obsolescence and competition are additional examples of future impacts that affect the economic life.

Additionally, many assets never achieve their *potential* physical life. New technology, competition and other factors often render assets worthless long before they reach their potential physical life. Replacement of an asset before it reaches its potential physical life, is sometimes called a *premature retirement.* For example, there is no physical reason why electronic personal computers (PC) could not live for twenty years (a 20 year physical life); however, rapid technological change and competition render PC equipment essentially worthless in less than ten years. If, for instance, a corporation replaces a functioning PC with a higher performance PC, after 5 years, some call that a *premature* retirement. Such a replacement is a natural occurrence. The increased advantages of the higher performance PC economically justify the replacement of the older PC, although the older PC could remain functional for many more years. This replacement is *premature* only in the sense that the older PC did not live as long as it was physically capable.

The FCC, in drawing a distinction between economic and physical lives, recognizes that there is a difference, and that physical lives are inappropriate for TELRIC. Thus, the lives used in the proxy models must not be physical lives; rather they must be economic lives that reflect the true changes in economic value.

Summary of the TELRIC Construct

The FCC established rules and guidelines that define and govern the nature and scope of the TELRIC proxy models. These criteria establish a construct that defines the nature and scope of the economic lives that the proxy models must use. This TELRIC construct establishes that the economic lives must meet certain conditions. A summary list of these conditions is as follows:

- The economic lives must reflect the least-cost and most efficient technology and network configuration available to the industry;
- The economic lives must reflect newly placed assets;
- The economic lives must be forward-looking and reflect true changes in economic value;
- The economic lives must not be physical lives.

For a life to be valid for use in the TELRIC proxy models, it must reasonably satisfy <u>all</u> of these constructs. If the life does not meet these criteria then it can not be used in TELRIC. To do otherwise, would undermine the objectives of the FCC and further jeopardize the validity of the entire TELRIC process. The following section examines the validity of using Prescribed Projection Lives in TELRIC.

Regulator Prescribed Projection Lives

Are regulator Prescribed Projection Lives acceptable for use in TELRIC? To be valid for use in TELRIC, a life must reasonably satisfy all of the constructs established by the FCC. If the life does not meet the FCC's criteria for TELRIC, than it is invalid for use in the proxy models. To do so would undermine the intended objectives, introduce unnecessary risk, discourage competition and possibly constitute a taking by the state. To determine if Prescribed Projection Lives are acceptable, we must simply evaluate the nature and scope of the Prescribed Projection Lives relative to the FCC's TELRIC construct, as outlined in the preceding section. The remainder of this section does just that.

Most Efficient and Economic Technology Available

The FCC establishes Prescribed Projection Lives for a specific prescribed category of plant. The FCC's Uniform System of Accounts (USOA) – Part 32 establishes the prescribed categories and defines the type of equipment contained in them. Generally, these categories are broad in scope and do not separately account for the latest, least cost and most efficient technologies. The latest technologies are included in the same categories with the older more costly technologies. The Prescribed Projection Life represents an investment-weighted average life of all of the technologies within the category. Prescribed Projection Lives, therefore, do not reflect the life of the most efficient and least costly technologies available as required by the FCC for use in TELRIC.

Prescribed Projection Lives are more representative of the older, less efficient technologies than they are of the newer, more efficient technologies. This is due to the fact the relative investment in the prescribed categories is greater for the older technologies: the newer technologies have not been around as long and their per unit cost are typically lower.

Are Prescribed Projection Lives Forward Looking?

While some have argued that *by definition* Prescribed Projection Lives are forward-looking economic lives, the fact of the matter is that they do not meet the FCC forward-looking construct and are therefore not appropriate for use in TELRIC.

First, the argument, that *by definition* Prescribed Projection Lives are economic lives, is irrelevant in considering their appropriateness in TELRIC. Quite simply, if Prescribed Projection Lives meet the TELRIC construct, they can be used, if they do not meet the TELRIC construct, then they can not be used; the traditional interpretation of Prescribed Projection Lives is irrelevant.

Nonetheless, the traditional definition of Prescribed Projection Lives was established over 100 years ago and is not applicable in today's TELRIC environment. Traditionally, in the context of Prescribed Projection Lives, we assumed that the projection life of embedded assets equals the life of new assets, and we further assumed it equals the economic life. These assumptions do not hold true today.

In the stable monopolistic environment of the first half of this century, economic impacts other then physical mortality were small and generally had a negligible impact on the economic life of regulated utility equipment. With only physical mortality impacts, the projection life of newly placed assets, in this era, approximately equaled that of older generations of the same equipment. For some technologies, like poles, these traditional assumptions still hold true. Today, however, the environment has drastically changed for the vast majority if telecommunications infrastructure; and the traditional assumptions are invalid.

In today's environment, the average life of embedded older technologies does not equal the life of the newly placed technologies. Technological obsolescence, for example, shortens the projection life of newly placed older technologies relative to the life of the embedded assets. For example, the life of newly placed copper cable is shorter then the life of copper cable placed 10 years ago. Additionally, rapid technological advancement, for some technologies such as Switching technology, has shortened the projection life of newer technologies relative to the life of older technologies. Digital Switching equipment, for example, has a shorter life than Analog Switching equipment, and Analog Switching equipment had a shorter life then Electromechanical switching. In today's environment, the projection life is changing over time: the projection life of embedded assets is different from the projection life of new assets. The traditional definition of projection lives incorrectly assumes that the life does not change over time.

The future will entail continued rapid technological advancement and obsolescence; government is eliminating the last remaining remnants of the Bell System monopolies. Prescribed Projection Lives are rooted in antiquated traditions and based on the flawed assumption that the physical mortality impacts of the past will be the dominant drivers of the value of the assets in the future. Prescribed Projection Lives do not reflect the realities of today's environment, and are grossly inconsistent with the objectives of TELRIC. A forward-looking economic life must reflect the realities of the future; we must not rely on flawed traditional interpretations of irrelevant and obsolete assumptions. The argument that *by definition* Prescribed Projection Lives are forward-looking economic lives does not standup and is inconsistent with the FCC's TELRIC construct.

Second, we have established in the previous section that Prescribed Projection Lives represent an average of the various generations of technologies that are currently in-service. The TELRIC construct requires that the proxy models include only the latest, most efficient and less costly technology. Just as it is unacceptable to use the cost of embedded, older and less efficient technologies in TELRIC, it is unacceptable to use the lives of embedded, older and less efficient technologies in TELRIC. The FCC specifically establishes Prescribed Projection Lives to recover the cost of all embedded technologies that are in-service. This violates TELRIC's forward-looking construct.

Third, the TELRIC construct requires the proxy models to use the most efficient technology commercially available. This is applicable even if the ILEC has not yet deployed this technology. As noted above, the FCC specifically establishes Prescribed Projection Lives for assets in-service. When the ILECs first deployed SONET technology, for example, the FCC did not establish a life for SONET until a couple of years after the fact. The reason the FCC did not establish a life for SONET at that time was that SONET's investment was too small to affect the Prescribed Projection Life of the category. In this case, the Prescribed Projection Life initially ignored the life of the most efficient and least cost technology, SONET. Clearly, Prescribed Projection Lives, which reflect investment-weighted average lives of all embedded technologies, do not reflect the life of technologies not currently deployed.

Fourth, Prescribed Projection Lives are not forward-looking in that they do not reflect true changes in economic value. Future loss in value, for example, is likely to result from increased competition and less expensive new technology. The process used to determine Prescribed Projection Lives does not accommodate the modeling of such impacts.

The process used to determine Prescribed Projection Lives assumes that ongoing (future) losses in value follow a physical mortality pattern that is 100% compatible with ware and tear through usage, deterioration with age, and accidental or change destruction or removal. The Prescribed Projection Life process assumes that historical retirement levels and physical mortality patterns will continue unchanged into the future. The process ignores, for example, the progressive nature that technological obsolescence has on mortality patterns. The process used to determine Prescribed Projection Lives is, therefore, incompatible with the types of forward-looking changes in economic value cited by the FCC.

It is not possible for the current Prescribed Projection Life process to account for true changes in economic value. Several writings, published in the early 1980's, document this fact; yet, the current process, developed in the first half of this century, remains unchanged today.

> W.C. Fitch and F.K. Wolf in their paper, titled *Conceptual Framework for Forecasting the Useful Life of Industrial Property,* Iowa State Regulatory Conference, 1984, recognized the need to enhance the Prescribed Projection Life process and conceptualized on how forward-looking impacts such as technological obsolescence could be modeled to give better life estimates.

> K. A. Kateregga, Department of Industrial Engineering, Iowa State University, concluded in his paper *Technological Forecasting Models and Their Applications in Capital Recovery,* that "there is a justifiable need to incorporate technological forecasting in the overall life analysis framework especially in those industries experiencing fast technological changes."

In summary, Prescribed Projection Lives are inconsistent with the FCC's criteria that the lives reflect the true forward-looking changes in economic value. The traditional definition of Prescribed Projection Lives is not applicable in today's environment and inconsistent with the TELRIC definition for economic lives. Prescribed Projection Lives are heavily influenced by the relative investment of older and less efficient technologies; with little weight given to newly introduced technologies; and no weight given to commercially available technologies that have not yet been deployed. Finally, the Prescribed Projection Life process models physical mortality patterns and is incapable of modeling the true forward-looking changes in economic value. Clearly, Prescribed Projection Lives do not meet the FCC's forward-looking TELRIC construct.

Do Prescribed Projection Lives Reflect the Economic Life of Newly Placed Assets

Prescribed Projection Lives reflect the investment weighted average life of <u>all</u> technologies contained within the prescribed category they represent. These categories, as noted earlier, consist of investment for <u>all</u> technologies currently <u>in-service</u>. This generally includes several older, less efficient, and more costly technologies. Prescribed Projection Lives, clearly, do not reflect the life of just newly placed equipment.

Additionally, for prescribed categories experiencing rapid technological change, the FCC has acknowledged that the Prescribed Projection Life process is insufficient. Under these conditions, the FCC generally accepts, at least in part, the ILEC's assessment of the Average Remaining Life (ARL) for depreciation rate making purposes. As a matter of formality, the Prescribed Projection Life is determined, using a physical mortality survivor curve, as the best-fit life which yields the mutually agreed to ARL. This inverse process of backing into the Prescribed Projection Life is, in essence, the same as developing a projection life for each vintage of investment and calculating an investment-weighted average life for all embedded vintages in the category. This in and of itself is recognition that the life of newly placed assets is different from the Prescribed Projection Life. The following example further documents this fact.

Consider the following example: An ILEC plans to replace an analog switch with a digital switch in exactly three years. The new digital switch is replacing the entire analog switch along with any new additions made to the analog switch. The projection life of the switch and any new additions to this switch is three years. The projection life of additions made one year ago is four years (the one year already realized and the three more years until the switch is replaced). Similarly, the projection life of additions made 17 years ago is 20 years (the 17 years already realized plus the three more years until the switch is replaced). If one were to calculate the projection life for the entire switch, clearly the calculated life would be significantly greater than the three year projection life of newly placed equipment. For a typical ILEC, a projection life of about 12 to 14 years is likely for the entire Analog Switching account. Clearly, a Prescribed Projection Life does not equal the projection life of newly placed plant.

The situation described above for Analog Switching is identical to that of any account experiencing technological change or loss in economic value over and above physical mortality. Such forward-looking impacts lower the life of newly placed technology relative to that of previously placed assets. Analog Switching was chosen for this example because the makeup of a single switch is analogous to an entire account; and the life implications described are equally analogous to other assets including Digital Switching, Circuit Equipment and Copper Cable.

The FCC's Depreciation Study Guide for 1995 states that "The estimation of the future remaining life for existing assets is the foundation of the current depreciation process." It naturally follows the Prescribed Projection Lives also reflect a life for existing assets. Prescribed Projection Lives do not meet the TELRIC construct that economic lives reflect the life of newly placed equipment.

Are Prescribed Projection Lives Economic Lives Rather Than Physical Lives

The FCC's TELRIC construct for economic lives specifically states that economic lives must reflect the true forward-looking changes in economic value and must not be physical lives. Prescribed Projection Lives are heavily based on physical retirement patterns; and therefore do not meet this condition.

First, the Prescribed Projection Life process is rooted in physical retirement patterns. The FCC's depreciation review process requires the ILECs to file numerous exhibits specifically designed to capture and quantify past physical retirement levels and patterns. These include, but are not limited to, the Curve Shape Analysis Plot (plots the historical physical retirement pattern in terms of percentage of embedded investment surviving by age of plant); Average Life Indications (plots the projection life necessary to achieve the historical physical retirements realized in a period, assuming that future retirement patterns will follow the historical physical retirement patterns established by the mortality survivor curve); Summary of Graduation Data (table of statistical data used to select the mortality survivor curve which best fits the historical physical retirement experience); Annual Retirements (table of past retirement levels); and Planned Retirements (table of retirements forecasted for three years). In contrast to these required exhibits, the company may provide exhibits that quantify a technological substitution that is taking place, for instance, but such exhibits are not required. Clearly, past physical retirements are the foundation of Prescribed Projection Lives. The resulting life is more a physical life than a forward-looking economic life as required for TELRIC.

Second, The FCC uses "Life Indications", in part, as a basis for determining Prescribed Projection Lives. Pure statistical analysis of physical retirement history determines Life Indications. Consequently, they naturally give an indication of the average physical life of the embedded assets. The Life Indication is determined as the best-fit projection life that yields the historical physical retirement levels experienced over a period of time (usually the past 5 years). The FCC requires ILECs to develop Life Indications and supporting exhibits as part of their depreciation review process. The use of Life Indications in the determination of Prescribed Projection Lives is further evidence that Prescribed Projection Lives are physical lives and not applicable for use in TELRIC.

Third, the process used to determine Prescribed Projection Lives relies heavily on the use of mortality survivor curves. Mortality survivor curves were developed over a hundred years ago; and are based on human mortality experience. The fundamental assumption made in the application of human mortality experience to telecommunications is that for any given age of an asset, the asset will have a fixed probability of surviving the next year, just as human beings do. In terms of human beings, this means that a person 80 years old 10 years ago had the same probability of dying in the subsequent year as a person 80 years old today has. In other words, a fixed probability of mortality is associated with each age; and that probability of mortality remains constant for all time. In terms of telecommunications, mortality survivor curves assume a fixed probability of retirement (retirement rate) for each age of plant; and they further assume that the retirement rate remains constant for all time.

The ILECs and the FCC determine the mortality survivor curve by statistically fitting a curve to the historical retirement experience. This complex process is called a Graduation. The curve-selection process combines historical mortality experience by age of plant then uses a least-squares criteria to select the mortality survivor curve. Mortality survivor curves provide an indication of <u>past</u> <u>physical</u> mortality patterns (physical retirement rates). The application of mortality survivor curves in the development of Prescribed Projection Lives assumes that the physical mortality patterns experienced in the past will continue into the future. Prescribed Projection Lives are, therefore, physical lives reflecting past retirement experience, which makes them inappropriate for use in TELRIC.

Moreover, mortality survivor curves do not do a good job of projecting even the physical characteristics of most telecommunications equipment. For instance, mortality survivor curves completely ignore the fact that technological obsolescence progressively increases the retirement rates for each age group over time. It is a mathematical reality that retirement rates for each age must increase for a group of assets that are being replaced by a newer technology. Mortality survivor curves can not model this situation: they assume that the retirement rates for each age will remain constant. Consider the Analog Switching example given earlier. The year before the digital switch replaces the analog switch; each vintage of plant has a 100% retirement rate (ignoring common equipment). A mortality survivor curve has no mechanism for accounting for this situation; it ignores the fact that the digital switch is replacing the analog switch in one year. A best-fit mortality survivor curve will still result in a Prescribed Projection Life of roughly 12-14 years.

Not only are Prescribed Projection Lives physical lives, their dependence on the flawed assumption that the future decline in economic value will follow human mortality patterns totally ignores the realities of technological obsolescence, deregulation and competition. Prescribed Projection Lives do not meet the FCC's TELRIC construct that the lives must not be physical lives.

Summary

The FCC established a criterion that defines and governs the nature and scope of the economic lives used in TELRIC. This criteria establishes that:

- The economic lives must reflect the least-cost and most efficient technology and network configuration available to the industry;
- The economic lives must reflect newly placed assets;
- The economic lives must be forward-looking and reflect true changes in economic value;
- The economic lives must not be physical lives.

For a life to be valid for use in TELRIC, it must reasonably satisfy <u>all</u> of these criteria. If the life does not meet each of these criteria then it must not be used in TELRIC. To do otherwise, would undermine the objectives of the FCC and further jeopardize the validity of the entire TELRIC process. Prescribed Projection Lives satisfy <u>none</u> of these criteria.

Prescribed Projection Lives do not reflect the life of the most efficient and least costly technologies available to the industry. A

Prescribed Projection Life is an investment-weighted average life of all of the technologies within a prescribed category. The majority of the investment in these categories is for older, less efficient and more costly technologies. Therefore, the Prescribed Projection Lives are more a life of older, less efficient technologies than a life of the newer, more efficient and less costly technologies. Additionally, Prescribed Projections Lives reflect only the life of in-service assets and do not account for new technologies, commercially available, but not deployed.

Prescribed Projection Lives are inconsistent with the criteria that the lives reflect true forward-looking changes in economic value. The argument, that *by definition* Prescribed Projection Lives are forward-looking economic lives, is irrelevant in considering their appropriateness in TELRIC. Quite simply, if Prescribed Projection Lives meet the TELRIC construct, they can be used. If they do not meet the TELRIC construct, then they can not be used. The traditional interpretation of Prescribed Projection Lives is irrelevant. Additionally, the TELRIC construct requires that only the latest, most efficient and less costly technology be modeled in TELRIC; including technologies commercially available but not deployed. Prescribed Projection Lives reflect the life of only assets that are currently in-service. Finally, the Prescribed Projection Life process models physical mortality patterns. This process is incapable of modeling the true forward-looking changes in economic value attributable to such factors as increasing competition, technological obsolescence, and lower priced future technologies.

Prescribed Projection Lives do not reflect the life of newly placed equipment. Prescribed Projection Lives reflect the physical life of <u>embedded</u> asset. In today's environment of rapid technological change and increasing competition, the life of new equipment is significantly lower than the life of the embedded equipment.

Prescribed Projection Lives are physical lives. The process used to determine Prescribed Projection Lives depends heavily on the statistical analysis of physical retirement patterns. This process is specifically designed to reflect physical life characteristics. There is no mechanism in this process to account for other types of declines in economic value. Prescribed Projection Lives are clearly physical lives.

Prescribed Projection Lives do not satisfy any of the criteria established by the FCC for the use of economic lives in TELRIC. To Use Prescribed Projection Lives in TELRIC would undermine the FCC's objectives, introduce unnecessary risk, discourage competition and possibly constitute a taking by the state. Prescribed Projection Lives must not be used in TELRIC.

PUBLIC UTILITY DEPRECIATION PRACTICES - 1996 EDITION

John S. Ferguson

The project of the National Association of Regulatory Utility Commissioners (NARUC) Staff Subcommittee on Depreciation to rewrite the 1968 edition of Public Utility Depreciation Practices has culminated with the publication of the 1996 edition. The new edition retains the original title, but is a complete rewrite, and, unfortunately, also retains significant shortcomings of the 1968 edition.

The 1968 edition is said to have had significant input from the Bell System, which has been faulted by some. An electric and gas industry offer to perform a review function for the rewrite was turned down. The same offer by the Society of Depreciation Professionals (SDP) was accepted. I was a member of the SDP committee organized to perform the review, and provided comments on the initial draft of each chapter and a later draft of two chapters.

I had hoped that my comments would stimulate the authors of the rewrite to correct what I believe to be serious shortcomings of the 1968 edition. As is evident from this discussion, it is my opinion that this has not happened.

Comparison Of The 1968 And 1996 Editions

The Attachment lists the contents of the 1996 edition and discusses the contents when not obvious from the item titles. The first two chapters of the 1968 and 1996 editions are quite similar, but the remaining portions are organized differently. Accounting for plant assets and theoretical reserve calculations now have their own chapters and tax depreciation no longer has its own chapter. Life analyses methods are now covered by three chapters (Turnover, Actuarial and Life Span). However, the Life Span chapter is more on calculations than analyses. The generation arrangement and equal life group calculations now have separate chapters.

There are positive aspects to the reorganization, such as the reduced emphasis of tax depreciation and the increased emphasis on the equal life group rate calculation. However, as will be discussed later, poor organization limits the value of the 1996 edition. Rewriting rather than editing the 1968 edition has caused some good discussions to change significantly, which is unfortunate. For example, the discussion of the importance of recognizing that mere measurement of the past is not a prediction of the future is much better in the 1968 edition than in the 1996 edition. As a result, the 1968 edition continues to be of value as a reference and not be replaced by the 1996 edition.

General Comments

The 1996 edition is written for experienced depreciation analysts, but does not say so, and will be utilized by inexperienced observers who will not realize this. As a result, meanings that will be clear to experienced analysts, but are not obvious, may not be correctly interpreted. This is unfortunate, because inexperienced observers may be led astray, and because some participants in regulatory proceedings intentionally mislead.

The discussion of the purpose of depreciation accounting in the 1968 edition is quite limited and does not link this purpose to the depreciation rate development process. In my opinion, this lack is a major factor in the all too common regulatory requirement for use of depreciation rates that produce a mismatch between the usage of assets and the recording of that usage. The mismatch has been evident for telecommunication assets for many years and has led to massive write-offs for asset impairment in recent years. While not as clearly evident for energy utilities, their mismatch is known. The 1996 edition retains this significant shortcoming, which, in my view, limits its usefulness as an authoritative source.

The rewrite involved multiple authors, and the National Regulatory Research Institute (NRRI) provided editorial assistance to obtain presentation consistency. However, the NRRI does not have the expertise to address technical consistency. One consequence of this limitation is that each author utilized unique data sets for examples. Use of the same data for the examples throughout the book would have made clear the differences between methods of analyses and weighting, the differences between methods, procedures and techniques for calculating rates, and how well rates comply with the purpose of depreciation accounting, which would have been helpful for inexperienced observers.

Depreciation accounting policies of both the regulator and the regulated entity are of significance to depreciation rates, because policies determine the magnitude of the rates and the rate base. However, neither edition discusses this situation. Among the policy elements of significance are:

- Method of depreciation;
- Procedure and technique for calculating depreciation rates;
- Basis for defining depreciable property groups;
- Basis for determining property mortality characteristics;
- Extent to which salvage and cost of removal are to be recognized in depreciation rates;
- Accounting practices, such as capitalization rules, recording reused materials, overheads and construction reimbursements, and segregating construction and removal labor; and,
- Extent to which the recording of depreciation is to be deferred.

Deferral can be utilized for financial reporting by entities that qualify for the special accounting practices allowed by Statement of Financial Accounting Standards No. 71, *Accounting for the Effects of Certain Types of Regulation* (SFAS 71), yet there is no mention of this accounting standard or its significance in the 1996 edition.

The development of depreciation rates involves four basic sequential steps, (1) data collection, (2) analysis of the past, (3) evaluation of whether the past is a reasonable prediction of the future and determination of the mortality characteristics applicable to surviving property, and (4) calculations based on the mortality characteristics. The book would have been more useful if the rate development portion had been organized in this sequence. Examples of lack of clarity due to organization are data collection being discussed in several chapters without any link between the life analysis and the salvage and cost of removal analysis needs, lack of distinction between analyses and calculations, and inconsistent discussions of the same subject in different chapters.

The distinction between analyses and calculations is of particular significance to a depreciation accounting text, because the intervening step (evaluation of the past) is the most important aspect of a depreciation study. It is also the only aspect of a study that requires special expertise. The other three steps are essentially clerical. Neither the 1968 nor the 1996 editions go much beyond stating the need to evaluate the significance of the past. However, the 1968 edition discusses the need for this aspect of a depreciation study more extensively than does the 1996 edition. While I consider this limited discussion to be a significant defect, it is not surprising, because depreciation accounting texts rarely discuss how to conduct evaluations of the past. Authors seem to know of the need, but not how to accomplish it.

The heavy emphasis on life analysis (79 pages verses eight pages for salvage and cost of removal) is inconsistent with the relative influences of life and net salvage on depreciation rates. For energy utilities, if life is accurate to within one year, consistency dictates that net salvage factors be accurate within about three percentage points. The salvage and cost of removal aspects of the determination of depreciation rates are at least as important as the life aspects, and in some ways are more important. The need for balance is important to a depreciation study, and is no less important to a depreciation accounting text.

Specific Comments

The remainder of this discussion is sequential and covers specific aspects of the book.

Page 6 states that Appendix E is the result of a survey that included the current depreciation procedures and techniques authorized by each regulatory body. However, the Appendix does not contain this information, and the wording of some of the column headings suggests the headings are not complete. The incomplete headings are errors, but the authorized depreciation procedures and techniques were left out on purpose. The original survey requested information on procedures and techniques, but this was excluded from a later survey that is summarized in Appendix E. Therefore, it is the reference on page 6 that is in error.

The discussions of reimbursements on pages 31 and 157 do nothing to alleviate the common misunderstanding that exists concerning how reimbursements should be recorded and how they should be treated when developing depreciation rates. Reimbursements are from customers, from insurance recoveries for damages, and from government entities for relocations necessitated by such things as road widening and urban renewal. Customer reimbursements for construction are nearly always credited to construction work orders to reduce the installed cost of the new facilities. Insurance and relocation (third-party) reimbursements for construction are sometimes credited to retirement work orders and recorded in the accumulated provision for depreciation. The discussions assume that third-party reimbursements apply to the retired property, which is not usually the case. Correct treatment of third-party reimbursements that are unrelated to retired property is of particular significance to the salvage analysis portion of a depreciation study, because the cause and effect relationship is to the additions - not to the retirements. Relating reimbursements for construction to retirement amounts incorrectly treats them as salvage, thereby severely overstating the salvage factors that can be expected from the eventual retirement of surviving property.

The discussion on page 41 of betterments is not consistent with betterment accounting, which capitalizes only the "betterment." For example, if replacement of a 100 horsepower motor with a 150 horsepower motor is considered to be a betterment, the equivalent cost of a new 100 horsepower motor is expensed, and the remainder is capitalized. One of the reasons I do not like betterment accounting is the confusion that can result when a single item has investment in more than one vintage. While Uniform Systems of Accounts (USofA) allow certain additions to be treated as betterments, some utilities preclude it.

Some authors use "salvage" to mean gross salvage, net salvage or cost of removal. This causes confusion, and sometimes leads to inappropriate decisions in regulatory proceedings. Salvage seems to be used to mean net salvage on pages 43, 44 and 139.

The description of Unit Depreciation on page 49 is not complete, because it does not mention the ceasing of depreciation when the item reaches an age equal to its depreciable life. Not mentioned is the common adoption by entities practicing unit or item depreciation of depreciable lives that are shortened in order to reduce or eliminate differences between book and tax depreciation and the existence of under-depreciated assets requiring recording of losses. Also not mentioned is that for recording of depreciation ceases under the item concept when the property reaches an age equal to the depreciable life, but does not cease under the group concept Non-regulated entities nearly always utilize item depreciation. Regulated entities shifting to item depreciation would undoubtedly increase their depreciation provisions and operation and maintenance expenses.

The reference on pages 59 and 60 to the annual revenue requirement levelizing annuity rate for the sinking fund procedure is likely to be misinterpreted. Inexperienced observers will think the reference is to the conventional rate of return that has the debt component on a pre-tax basis and the equity component on an after-tax basis. When dealing with investment, level annual revenue requirements occur when both rate of return components are pre-tax. When dealing with salvage or cost of removal, level annual revenue requirements occur when both components are after-tax.

Page 61 states that the group plan "is particularly adaptable to utility property." While that is true, it is not the reason the group plan is used by utilities. Group depreciation accounting is inherent in USofA accounting rules for energy utilities, so utilities have no choice in the matter. The 1996 edition should have had more to say about USofA rules and their influence on depreciation accounting and the determination of depreciation rates.

The statement on page 63 that Broad Group does not require the dispersion pattern is not correct, as the pattern is required to calculate Broad Group remaining life rates. It is also required for Broad Group whole life rates, if a theoretical reserve test is made using the prospective method. It is not possible to determine an average service life without also determining the dispersion pattern, so even though not utilized directly in the Broad Group whole life rate calculation, retirement dispersion is inherent in the average service life that is utilized.

Inherent in the page 65 description of units-of-production (UOP) as a depreciation method is the assumption that life is measurable only by time. This limitation is not appropriate and is inconsistent with the discussion in the first paragraph of page 18. Therefore, UOP is really a straight-line procedure, not a depreciation method.

The two fitted curves on Figure 8-1 (page 121) are much different from the observed survivor curve on the Figure, yet the text refers to them as "best fits" and discusses differences not visually apparent between the two "best fits" that are stated to result from different T-cuts. While the Figure seems to illustrate the importance of <u>never</u> accepting a machine curve fit without visual observation, I doubt that this is the intent.

Page 131 states "the generation arrangement allows some vintages in a category to be studied under the ELG procedures, and some vintages in a category may also be studied under other procedures using either the whole life or remaining life techniques." The use of "studied" is unfortunate, as it may lead inexperienced observers to think that Generation Arrangement and ELG are something other than calculation processes that have nothing to do with studies or analyses.

The weighting example on page 137 includes a proof that the items are fully depreciated, but the examples on pages 138 and 139 do not include such proofs. Proofs for all the weighting examples and discussions of reasons for over- or under-depreciation would have been helpful.

Page 142 states "a general characteristic of property studied using the life span method is the gradual increase in the depreciation rate as the property ages." The implication likely to be drawn is that interim addition amounts should be excluded from rate calculations, but that the future life span these additions will cause is to be utilized. This would create an inconsistency, because one aspect of an event would be excluded and another aspect of the same event would be included, which violates the matching principle of accounting. My experience is that this inconsistency would cause depreciation rates for power plants to more than double over their lifetimes, thereby creating a significant mismatch between the usage of the facilities and the recording of the depreciation costs of the facilities. Such a mismatch is inconsistent with the American Institute of Certified Public Accountants depreciation accounting definition quoted on page 14 that states the distribution of asset cost is to be "in a systematic and rational manner," and creates an intergenerational customer inequity by shifting to future customers costs that are incurred to serve current customers. However, entities that qualify for SFAS 71 are allowed to record depreciation on a deferred or backloaded basis. Of course, such a mismatch creates the potential for stranded costs, and causes the utility to be less competitive. This support for developing depreciation rates in a manner that backloads the recording of depreciation is a significant defect.

I am particularly disappointed in Chapter XI, Estimating Salvage and Cost of Removal. I consider the lack of a discussion of the influence of the age of retired property on cost of removal factors to be a significant flaw. This lack is inconsistent with the statement on page 19 that cost of removal "must be given careful thought and attention." The age influence on salvage is discussed extensively. My experience is that the influence of age on cost of removal is easier to understand and estimate, and is much more significant to depreciation rates than is the age influence on salvage.

The discussion on page 157 of some commissions changing from an accrual basis for net salvage to a cash basis, combined with the lack of discussion of the influence of USofA rules on depreciation accounting, could lead inexperienced observers to inappropriate conclusions. Most energy utilities follow the Federal Energy Regulatory Commission (FERC) USofA that states accrual accounting is required. The NARUC USofA contains no such requirement, but has not been kept current, so is not really useful anymore. I am aware of several instances when a cash basis was proposed for net salvage without disclosing that the proposal violated the USofA rules, and am aware of a few instances when the proposal was accepted by the regulator without realizing it violated the USofA.

The example of weighting on page 162, when combined with the discussion on page 159 of salvage and cost of removal amounts relative to age of retired property, may lead inexperienced observers to incorrect conclusions concerning long-lived property, This is partly due to the discussion being for amounts, not the relationship to retirements, without so stating. For energy utilities, the gross salvage and cost of removal factors on the unnumbered table on page 162 for Future Final Retirements are the reverse of realistic factors, because salvage ratios decrease with age and cost of removal ratios increase. The relationships depicted on page 164 are more realistic.

Page 165 states that aged data are required for ELG rates. This is one of the many myths that have been created to convince regulators to preclude the use of ELG rates. If true, which it is not, any rate calculation procedure or technique that makes direct use of dispersion would require aged data. This would mean that only Broad Group whole life rates could be used for property for which aged data are not available or are not collected. The book is inconsistent, as well as wrong, since it makes no mention of this limitation for Broad Group remaining life, Vintage Group or Generation Arrangement rates.

Experienced observers will recognize that the discussion on page 172 of the history of ELG covers its use when dispersion curves define the equal life groups, and that this unstated limitation makes the discussion incomplete. ELG rates are commonly used for power plants, with the generating units defining the equal life groups. The claim that the FERC has not approved the use of ELG rates is not correct. I am aware of two electric utilities authorized by their state regulators to utilize ELG rates that have also received FERC authorization to use ELG rates for property for which the equal life groups are defined by retirement dispersion patterns.

Page 192 states that the retrospective theoretical reserve calculation must be used when aged data are not available. As with the similar claim for ELG rates, this claim is not correct.

The example starting on page 200 may mislead inexperienced observers, because it is inaccurate and is inconsistent with the statement on page 197 that increased depreciation reduces cost of capital. The calculation of the 12.34% cost of capital from a $100 (20%) increase in depreciation assumes that debt capital is instantaneously increased, which would not actually happen. Further, the extra depreciation would have to decrease the cost of equity capital by only 0.09 percentage points to not change cost of capital, which is probably less than the decrease that can be expected for a 20% increase in depreciation. While short-term revenue requirements do increase as a result of depreciation increases, the increase is less than indicated. Of course, rate base regulation causes the short-term revenue requirement impact of any depreciation expense change to reverse in a few years. The reference to present value of revenue requirements on page 203 is unfortunate, because (1) regulators base revenue requirements on nominal amounts, and (2) present value comparisons are sensitive to magnitude of the discount rate and discount rates used to "prove a point" in regulatory settings often seem to be selected more for effect than for validity.

The Bibliography is extensive, but excludes the following references that are important to depreciation accounting:

> Accounting for Public Utilities, Hahne and Aliff, Matthew Bender
>
> An Introduction to Net Salvage of Public Utility Plant, American Gas Association/Edison Electric institute
>
> Professional Standards, Volume 3, Accounting, American Institute of Certified Public Accountants

The definition of Accelerated Depreciation in the Glossary is incomplete, because it does not state the relationship to asset use that is necessary to determine if depreciation is accelerated, straight-line or deferred. This is also missing from the definition of the Straight-Line Method, and there is no definition for Deferred Depreciation. This situation is further evidence of the lack of any link between the purpose of depreciation accounting and the development of depreciation rates, which I consider to be a significant failure of both the 1968 and 1996 editions.

CONCLUSION

The Staff Subcommittee had an opportunity to prepare a depreciation accounting text that could serve as an authoritative source. As is evident from this discussion, I believe the 1996 version has several serious flaws that severely limit its usefulness. Flaws in the 1968 version are a factor in the typical deferral reflected in the depreciation of regulated entities, and the 1996 version does little to alleviate this situation.

CONTENTS OF 1996 NARUC BOOK

Following are the item titles and number of pages, and the contents of each are briefly stated when not obvious from the title.

Foreword (3 pages)

The history leading to the organization of the Staff Subcommittee on Depreciaton and to the text are discussed. The basis for the 1968 edition is stated to be the 1943-1944 Report of the NARUC Committee on Depreciation, and the preparation process of the 1996 edition and the participants are stated.

Table of Contents (6 pages)

Preface (1 page)

The stated purpose is to present current practices and methods of determining depreciation and to update the 1968 version. The book is the work of a committee and the opinions expressed reflect "some give-and-take."

Chapter I, Brief History of Utility Depreciation (9 pages)

Chapter II, Current Concepts of Depreciation (14 pages)

Discussed are value and cost allocation concepts,regulatory and accounting definitions of depreciation, forces of retirement, methods of allocation, salvageand cost of removal considerations, the group concept, tax depreciation, impact of cost inflation and deflation, and regulatory considerations.

Chapter III, Accounting for Plant Assets (18 pages)

Included are discussions of depreciation study data, transactions that influence such data, and how certain of these transactions should be treated for depreciation study purposes.

Chapter IV, Depreciation Accounting (8 pages)

Discussed are the distinctions between depreciation, depletion and amortization and between the group and item concepts, how depreciation is recorded, and clearing accounts.

Chapter V, Computing Depreciation (15 pages)

Discussed are depreciation methods, procedures and techniques.

Chapter VI, Mortality Concepts (13 pages)

Discussed are retirement dispersion patterns and how to utilize them to calculate curves and lives.

Chapter VII, Turnover and Simulation Analyses (29 pages)

Included is a discussion of statistical aging

Chapter VIII, Actuarial Life Analyses (19 pages)

Included are discussions of mechanical and visual curve fitting and interpretation of results.

Chapter IX, The Generation Arrangement (10 pages)

Chapter X, Life Span Method (15 pages)

Chapter XI, Estimating Salvage and Cost of Removal (8 pages)

Chapter XII, Equal Life Group Depreciation Rates (22 pages)

Chapter XIII, Theoretical Reserve Studies (8 pages)

Chapter XIV,Depreciation Expense and Its Effect On The Utility's Financial Performance (11 pages)

Appendix A

This Appendix is untitled and discusses survivor curve formulas, the Gompertz-Makeham, Iowa and h type dispersion patterns, and smoothing and extending retirement ratios.

Appendix B, Federal Court Decisions Relative to Depreciation

Appendix C, Curves Comparing Alternative Methods of Depreciation

The comparisons are for the straight-line method, the sinking fund deferred method, and the declining balance and sum-of-the-years digits accelerated methods.

Appendix D, Bibliography

Appendix E, Current Regulatory Commission Practices

Appendix F, Nuclear Decommissioning

Appendix G, Alternative Capital Recovery Models

The models discussed are quantifying added uncertainty, economic value depreciation, Fisher-Pry substitution analysis, and competitive value.

Glossary (15 pages)

Index (4 pages)

UNIT COST METHODS FOR DETERMINING NET SALVAGE FOR MASS ACCOUNTS

Dave Berquist

Abstract

There are mass plant accounts that may have no or few recent retirements. A method is presented for determining the cost of removal and salvage. For accounts where the cost of interim retirements may not be a good indicator of the cost of final retirements, a method is given for determining the net salvage. For accounts with essentially one type of retirement unit, a method is presented for determining the net salvage. A way to adjust for age differences between plant retired and plant surviving in the net salvage calculation is described.

The equation for determining the depreciation rate includes the net salvage expected for the equipment in the account. The equation for determining the net salvage percentage number is:

$$\text{Net Salvage in Per Cent} = \frac{\text{Gross Salvage Dollars - Cost of Removal Dollars}}{\text{Original Cost Dollars of Plant Retired}} \times 100\%$$

Some of the mass accounts may have infrequent retirement or even no retirement activity. This may be because of the long design life of the equipment compared to its age. The nature of the equipment may be such that the unit of retirement is large and not readily divisible into smaller units. Also, the cost of the initial installation and its replacement may be so large that the condition of the equipment is closely watched and maintenance is timely performed, thus causing the retirement unit to be long lived. These circumstances do not permit the direct use of calculations of net salvage percentage numbers based on the familiar equation above.

This is because a few retirements may not be representative of what is expected to happen to the entire account. The retirements that have happened may have been as a result of emergencies or third party accidents, such as storm damage or dig ins, respectively. The equipment had to be replaced during adverse conditions and as quickly as possible to restore service. Care may have had to be taken to protect adjacent equipment. Such care may not be necessary when planned mass retirements occur. The retirement and replacement of the equipment may have required that the work be done using special tools or protective clothing because of energized wires, gas pressure in pipe, or severe weather. As a result, the net salvage percentage indicated by historical data may be judged by the depreciation analyst as not being typical for the account in the long run. In these cases the net salvage parameter proposed to be used in the depreciation rate calculation may be based on judgment or what has been approved by other regulatory commissions for use by other utilities.

Here are some suggested analyses which may be used to give indications of what net salvage may be expected for the equipment in the situations described above, instead of relying on solely on judgment or precedents in other jurisdictions.

1. No Recent Retirements

Some accounts are composed almost entirely of one type of property unit. This unit is physically separate from other units in the account. Usually, the retirement of one unit is independent of the retirements of other units. The costs to retire are largely independent of the physical size, material, or age of the unit. The materials and equipment that make up the unit are similar from unit to unit and the nature of the equipment does not change with new installations over time. There are no economies of scale by removing large numbers of the equipment as compared to removing one unit because of the geographic separation of the units and the necessity of doing the same work for each individual unit. An example of this is Account 352, Well Equipment. The retirement property unit is the well. The equipment is the several concentric steel pipes surrounded by concrete extending from the surface downward to seal the space around the casing, and the valves at the surface. The activities to decommission the well equipment are to seal off the flow at the well and disconnect the well piping from the gathering line. Then the flow can be sealed off down in the hole. The casing may be cut with explosives and pulled out. Then concrete is poured down the casing to seal the hole.

A retirement that occurred some time in the past can be used to identify the activities necessary to shut in and decommission a well. The types of equipment, hours of use, manpower, and volumes of materials used in the plugging or decommissioning will be available from the retirement work order. The labor rates and costs of power operated equipment can be updated to the present to get an estimate in current dollars of the cost to decommission a well. An example of the components of the cost of plugging a well are:

Rig time	$10000
Blowout Preventer	500
Power Tongs	400
Trucking and Tank Rentals	500
Water Hauling	500
Cement Truck and Cement	9000
Mud	1000
Welder and Operator	200
Backhoe	300
Kill Well	2000
Cement Retainer	2000
Setting Retainer	2000
Free Point and Shoot Pipe	2000
Miscellaneous Tool Rental	1000
Total	$ 31,400

1. Rig time-The time that is used to perform an operation where a work over rig is used.

2. Blowout preventer-A piece of safety equipment that is required by law to thwart a well from blowing out of control.

3. Mud-A mixture of clay, water, and other additives that is circulated down the well bore.

4. Kill well-When water, brine, or mud is pumped down the well bore to prevent the well from flowing gas or oil up to the surface.

5. Cement retainer-A collar used to hold concrete in place in a well bore.

6. Free point and shoot pipe-Using strain rosettes to determine the stretch in a pipe when the rig is pulling on it. This allows the free point to be established. Then the crew can sever the pipe (shoot it) with an explosive or by cutting. The pipe is then pulled out of the well.

Revenue that is expected to be realized from the recovery of pipe or valves, for example, would be gross salvage. The cost of removal dollars would be subtracted from the gross salvage dollars to give the net salvage dollars.

The net salvage dollars are the net unit cost to decommission one of the account's retirement units, a well. This unit's cost times the number of wells in plant in service gives the total dollars to decommission the account. This can be converted to a net salvage percentage of plant in service in the account by dividing by the dollars of plant in service.

2. Interim Retirements are Occurring, But No Final Retirements

For some accounts there are likely to be different tasks involving interim or individual retirements as compared to retirements of large numbers of the equipment. An example of this may be transmission towers for electric plant. The removal of an individual tower may be unlikely and the result of having to replace a tower in order to return the line to service after storm damage, third party damage, or road construction. The costs of removing all the towers when the line is no longer used may be considerably different because of more flexibility in scheduling the work, more lead time to permit bids to be sought, and the cost of bringing power operated equipment to the towers can be spread over many towers.

The cost to remove a tower may be estimated as:

Skilled crew for two days	$2000
Labor crew for one day	1000
Indirect crew costs at 25%	750
Crane rental	2000
Total	$5750

An estimate of gross salvage could be based on the weight of the metal and the current price for it as scrap. The gross salvage minus the final removal cost represents the net salvage dollars. This amount of net salvage for one tower can be multiplied times the number of similar towers in the account to estimate the net salvage for that type of tower.

A review of the debits to the accumulated provision for depreciation account would indicate the monies spent on removal work for the towers plant account for one or several recent years. Amounts received for gross salvage could be added if those monies are identifiable from the removal contracts or are separately accounted for. The average net annual dollars spent for recent interim retirements can be determined by dividing the cost of removal dollars for the selected years by the corresponding number of years. This amount for interim retirements would be added to that for final retirements. The sum would be divided by the original cost of the plant to give the net salvage ratio for the account.

Another example is the removal of gas transmission pipe lines. The cost to remove a short length of pipe damaged by third party damages such as a dig in, or a break caused by the uprooting of a tree by a storm, would likely be relatively high because of the need to perform the repair work on an emergency basis. The removed portion is replaced with new pipe and is connected to the adjoining pipe that is in place. Care must be taken to protect the adjoining pipe. In these situations costs may be high because of the need to protect the adjacent pipe and reconnect it to maintain the integrity of the system.

The historical retirements may be infrequent and for relatively small dollar amounts of plant, not for the removal of long lengths of pipe without replacement when there is no need for a pipe line on that route.

The retirements described above may be considered interim retirements: the retirement of relatively small portions of a natural gas transmission main or electric line towers with replacement by similar equipment that is large enough to be capitalized rather than expensed.

There can be a calculation to determine the average dollars spent annually for interim removals. This could be done by adding the dollars of net salvage experienced for several recent years and dividing the sum by the number of corresponding years. The assumption is that this should be provided for every year of the unrealized (or future) service life.

When the line is no longer needed, the cost of removal may be much lower on a per unit length of pipe basis because the line may be abandoned in place. Then the retirement work would consist of isolating the line from the transmission system. The line would be removed from the upstream source of gas by closing a valve. Downstream at a city gate or regulator station another valve would be closed, permitting disconnection from the lines or customers connected to the line. These steps allow the isolated gas to be released safely into the atmosphere, purging of the line, and plugging the ends. Or the line may be removed for reuse as a material for light construction or sold for scrap value.

The final net salvage would be estimated in current dollars by applying the logic in the first method, above. The sum of the interim and final net salvage dollars would be determined. Dividing the sum by the *total* dollars in the account would give the annual net salvage as a decimal fraction.

3. The Field Work for Interim Retirements is the Same as for Final Retirements

There may be an account that contains the same type of equipment, but is divided into subaccounts based on the material used in the equipment. An example of this is natural gas distribution services. The primary account may be divided into wrought iron, bare steel, copper, coated and wrapped steel, and plastic. The activities to remove the equipment from service are the same regardless of whether one or several units are to be removed. The available history may consist only of few retirements of the older subaccounts. Because of the age of the plant dollars retired, the ratio of current labor and equipment costs to the plant retired may result in net salvage percentages in the hundreds of per cent for the older subaccounts. These may not be appropriate to apply to other subaccounts or the entire primary account because of unique circumstances such as the extreme age of the retired plant, interference from other buried plant, and multiple layers of pavement in downtown areas. On the other hand, a subaccount that has more recently been established, such as plastic services, may have few retirements to base the net salvage on.

An approach is to determine the annual net salvage dollars for subaccounts with more activity, such as coated and wrapped services, for recent years. The number of services retired also needs to be determined for the corresponding years. Dividing the annual net salvage dollars by the number of services retired gives the unit cost in recent dollars to retire a service. This method was used because the work required is largely independent of the type of material the pipe is composed of, the length of pipe, and its age. Service pipe is generally left in the ground. This approach is conservative because it assumes that there will be no mass retirements of all the services in a neighborhood by merely shutting off the gas to the distribution main and abandonment. The local gas safety code regulations should be reviewed to determine what the requirements are for the removal of gas utility equipment.

If the field work required for removal can reasonably be determined to be independent of the age or type of pipe, then the net salvage dollars required to decommission a single coated and wrapped distribution service can be used as an estimate of the dollars to decommission a single service in the dying subaccounts. The number for coated and wrapped services may also be a starting point for the subaccounts that are too young to have significant numbers of retirements, such as plastic services. Multiplication by the total number of services in each subaccount gives the total net salvage dollars required to retire each subaccount. Dividing this by the plant dollars in the subaccount gives the net salvage percentage number for use in the depreciation rate calculation.

For example, suppose the services account has 100,000 services in it. The original cost is $25 million. The records show that it cost $10,000 to retire 200 services last year. The average cost to retire a service is then $50. The pipe is not reused. Then the net salvage, or cost to retire the entire account is 100,000 services times -$50 per service, or -$5 million. The net salvage is then:

$$\frac{-\$5 \text{ million}}{\$25 \text{ million}} \text{ times } 100\% = -20\%$$

4. Retirements are Occurring in an Account with Several Kinds of Retirement Units

The average age of retirements during a recent period of years may be compared to the average age of the surviving assets in the account. It may be that the average age of plant retired in recent years is not the same as the average age of the surviving plant. For example, an account had plant that was retired in 1991 through 1995. The average age of plant retired was 30 years. The ratio of the net salvage to the original cost of plant retired is -90%. However, this is the ratio of 1991 through 1995 cost of removal dollars to plant retired dollars of 1966 vintage on the average (1995-30 = 1966, counting 1966 as the first year). An inflation adjustment to match the age of property retired to the age of the surviving plant can be made. Suppose the surviving balance's average age is 22 years. The Handy-Whitman Index is available commercially as an indicator of the relative changes in cost of construction of various utility plant accounts for regions of the United States. Using the Index numbers an adjustment may be calculated as follows:

$$-90\% \text{ from } \frac{\text{NS \$ 91-95}}{\text{Plant \$ of 1966}} \ \mathrm{X}\ \frac{\text{HW index of 1966}}{\text{HW index of 1974}} = \text{Net Salvage}$$

Assuming from published tables that the HW index is 70 for the account in 1966 and 140 for the account in 1974, substitution gives:

$$-90\% \ \mathrm{X}\ \frac{70}{140} = -45\%$$

The Handy-Whitman Index numbers are only used to adjust the historical plant in service dollars that were retired during the recent study period. They are not being used to adjust the realized net salvage dollars.

The nature of the equipment, circumstances of retirements, and the field work involved with retirements in each mass account should be determined before the above methods are used.

IMPACT OF INVESTMENT ON THE REMAINING LIFE RATE

Jacob Ransom

Abstract

This paper will address the impact of investment on the remaining life rate. That is, what is the impact on the depreciation rate if the investment used in the development of the reserve percent used in the depreciation rate should have been less than or more than that actually used.

Example 1

Let us assume a hypothetical account with the following:

Hypothetical Account

Investment	$1,000
Accumulated Reserve	$200
Remaining Life	10 years
Future Net Salvage	0%
Reserve Percent	20%

Table 1

The remaining life rate formula is used to calculate a rate based on the information from Table 1 as shown below.

$$RL\ Rate = \frac{100\% - \mathrm{Re}\,serve\% - Future\ Net\ Salvave\%}{\mathrm{Re}\,maining\ Life}$$

$$RL\ Rate = \frac{100\% - 20\% - 0\%}{10\,yrs} = 8.0\%$$

Let us now assume that this depreciation rate is used for five years, with no plant added or retired. Table 2 shows the depreciation over this time period.

Year	BOY Inv.	EOY Inv.	Avg. Inv.	Depr. Rate	Depr. Expense	BOY Reserve	EOY Reserve
a	b	c	d=(b+c)/2	e	f = e*d	g	h = f+g
19X1	$1,000	$1,000	$1,000	8.0%	$80	$200	$280
19X2	$1,000	$1,000	$1,000	8.0%	$80	$280	$360
19X3	$1,000	$1,000	$1,000	8.0%	$80	$360	$440
19X4	$1,000	$1,000	$1,000	8.0%	$80	$440	$520
19X5	$1,000	$1,000	$1,000	8.0%	$80	$520	$600

Table 2

Example 2

Now let's assume that there was only $900 of actual investment in the hypothetical account when the depreciation rate was developed. What would have been the impact on depreciation?
A retirement of $100 would result and the investment and reserve in Table 1 would be reduced by this amount, yielding the information shown in Table 3.

Hypothetical Account

Investment	$900
Accumulated Reserve	$100
Remaining Life	10 years
Future Net Salvage	0%
Reserve Percent	11.1%

Table 3

The remaining life rate that results from using information from Table 3 is shown below.

$$RL\ Rate = \frac{100\% - 11.1\% - 0\%}{10yrs} = 8.9\%$$

The $100 investment retirement caused the reserve percent to be smaller than in the first example. Thus, the depreciation rate is greater than in Example 1.

Depreciation over a similar period as the first example results in depreciation shown in Table 4.

Year	BOY Inv.	EOY Inv.	Avg. Inv.	Depr. Rate	Depr. Expense	BOY Reserve	EOY Reserve
a	b	c	d=(b+c)/2	e	f = e*d	g	h = f+g
19X1	$900	$900	$900	8.9%	$80	$200	$280
19X2	$900	$900	$900	8.9%	$80	$280	$360
19X3	$900	$900	$900	8.9%	$80	$360	$440
19X4	$900	$900	$900	8.9%	$80	$440	$520
19X5	$900	$900	$900	8.9%	$80	$520	$600

Table 4

There is no difference in the depreciation expense in this example as compared to Example 1. The smaller investment because of the retirement has been compensated by a higher depreciation rate.

Example 3

Now let's assume that there should have been $1,100 of investment in the hypothetical account when the depreciation rate was developed. A $100 that was previously retired is added to the investment and reserve shown in Example 1, yielding the information shown in Table 5.

Hypothetical Account

Investment	$1,100
Accumulated Reserve	$300
Remaining Life	10 years
Future Net Salvage	0%
Reserve Percent	27.3%

Table 5

The remaining life rate that results from using information from Table 5 is shown below.

$$RL\ Rate = \frac{100\% - 27.3\% - 0\%}{10yrs} = 7.27\%$$

While more investment caused the reserve percent to be smaller than in the first example, it also caused the depreciation rate to be greater.

Depreciation over a similar period as the first example results in depreciation shown in Table 4.

Investment More Than Original Amount

Year	BOY Inv.	EOY Inv.	Avg. Inv.	Depr. Rate	Depr. Expense	BOY Reserve	EOY Reserve
a	b	c	d=(b+c)/2	e	f= e*d	g	h = f+g
19X1	$1,100	$1,100	$1,100	7.27%	$80	$200	$280
19X2	$1,100	$1,100	$1,100	7.27%	$80	$280	$360
19X3	$1,100	$1,100	$1,100	7.27%	$80	$360	$440
19X4	$1,100	$1,100	$1,100	7.27%	$80	$440	$520
19X5	$1,100	$1,100	$1,100	7.27%	$80	$520	$600

Table 4

There is no difference in the depreciation expense in this example as compared to Example 1. The higher investment has been compensated by a lower depreciation rate.

Summary

The preceding examples have shown that a different investment level alone would not impact depreciation expense, if the depreciation rate is recalculated based on the correct investment amount. The expense in each of the examples is the same because the net plant in each is the same.

The results in these examples are based on zero percent salvage, an assumption of no additional additions or retirements, and that there is no change in the asset life.

A COMBINED INDEX IN SIMULATED PLANT RECORD ANALYSIS

Kimbugwe A. Kateregga, Ph.D.

ABSTRACT

The simulated plant record analysis (spr) and indexes used for selection among indicated dispersions are reviewed in this paper. It is shown that the index of variation and the retirement experience index, used independently, sometimes fail to provide a dependable selection between competing indications. In such cases, a mathematical combination of the two indexes is offered as a solution.

Introduction

The Simulated plant record (SPR) analysis is used to obtain life characteristics when vintaged records are unavailable. Bauhan[1] discussed its conceptual and practical underpinnings and spearheaded its use in the life analysis of physical plant and assets. Modern mathematical and statistical methods would view the SPR analysis as relying upon a statistical approach called a "transfer function" which Box and Jenkins [2] describe as the determination of a dynamic input-output model to show the effects on the output of a system subject to inertia of any given series of inputs.

Figure 1 is a depiction of the SPR dynamic transfer function. Two time series, an input series A_t and output series R_t representing plant additions and retirements respectively, are observed over a number of discrete, equispaced intervals (normally years).

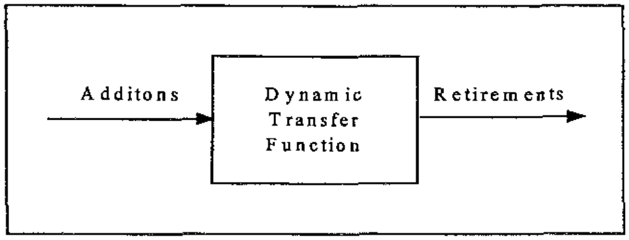


Figure 1 - Simulated Plant Record Analysis Model

The expectation is that an analysis of both series will provide an identification of the underlying dynamic transfer function such that

$$R_t = f(A_t) \quad (1)$$

where $f()$ represents the dynamic transfer function.

In plant life analysis and estimation, the series A_t and R_t completely define a third series B_t of plant balances that represents the cumulative additions less cumulative retirements. The following discussion will confine itself to the determination of the dynamic transfer function using the additions and retirement series. The generalized SPR analysis, however, lends itself equally well to the use of the additions and balances series when special attention is given to the lack of independence that exists in the balances series.

Simulated Plant Record Analysis

Suppose values of these series are available for the most recent time n and for a number of prior periods, and are designated as:

$$A_t = a_n, a_{n-1}, a_{n-2}, \ldots, a_1$$
(2)

and

$$R_t = r_n, r_{n-1}, r_{n-2}, \ldots, r_1$$
(3)

respectively. Forecasts of the R_t series:

$$R_l = r_{n+1}, r_{n+2}, r_{n+3}, \ldots r_1$$
(4)

are required for a period called the lead time l. If the dynamic transfer function is known, then the forecasts can be estimated. Alternatively—and this is the approach SPR utilizes—by specifying the series A_t and a set of plausible functions, the output series of each function is generated (or simulated, in SPR terminology) and tested against the observed R_t series to identify the optimal dynamic transfer function. SPR thus converts the process from a forecasting to a fitting problem.

The assumption is made in this paper that the dynamic transfer function is among the Iowa dispersion types described in Winfrey [9] and in Marston and Winfrey [7]. Iowa type dispersions are defined by both a shape and an average service life. There is, however, no conceptual or empirical restriction to prevent application of the SPR analysis to other curve systems such as the h-Curves described by Kimball [5] or the Gompertz-Makeham set described by King [6].

Denoting by $\hat{R}_t$ the fitted time series of retirements made at time n, the objective is to determine the function that minimizes the sum of squares of the deviations $R_t - \hat{R}_t$ between the actual and the fitted values. The criterion of goodness of fit defined as the sum of square errors represented as

$$SSQ(n) = \sum_{t=1}^{n} (R_t - \hat{R}_t)^2$$
(5)

It is important to note that the Iowa curve minimizing the sum of square errors might not be a reasonable descriptor to the time series. Two indexes, the conformance index (or its reciprocal, the index of variation) and the retirement experience index have been suggested to assess reasonableness beyond the statistical fit criterion. The conformance index, $CI(n)$ was suggested by Bauhan [op. cit.] as the ratio of the average of the n retirements (or balances) to the standard error of estimate derived from the sum of square errors in equation (5). It can be represented as

$$CI(n) = \left[(1/n) \sum_{t=1}^{n} R_t \right] \Bigg/ \sqrt{SSQ(n)/n}$$
(6)

and vary between 0 for a very poor fit to ∞ for a perfect fit. Because of the possibility of very large values of the conformance index, and designed to minimize them, its reciprocal, the index of variation $VI(n) = 1/CI(n)$ is used in practice.

When the process under consideration is forecasting rather than fitting, equation (5) becomes

$$SSQ(l) = \sum_{t=n+1}^{l} (R_t - \hat{R}_t)^2$$
(7)

and equation (6) becomes

$$CI(l) = \left[(1/l) \sum_{t=n+1}^{l} R_t \right] \Big/ \sqrt{SSQ(l)/l}$$
(8)

Retirement Experience Index

In introducing the retirement experience index Bauhan [op. cit.] argued that:

> The merit of a result, however, is not adequately represented by the conformance index. In some cases, the conformance might be very high and yet the result could be questionable because of insufficient experience with the account. For instance, a particular account might show excellent conformance for an average life of 40 years and Iowa dispersion R3. But if the experience with the account covers only 20 years, the retirements of the first year's additions will, according to the discovered pattern, have amounted to only 6 percent and, of course, the retirements of the later additions to a lesser percentage. Any conclusion in such a case that the discovered pattern is representative of the account would be too meagerly supported, notwithstanding the excellent conformance index.

For that reason, Bauhan [op. cit.] suggested the retirement experience index as the complement of the theoretical percentage surviving from the earliest installation at the time of the latest simulated retirement or balance. In accounts with initial dormancy, a more reliable index might be computed using a later, more significant vintage. Denoting by S_x the percent surviving from the earliest vintage, the retirement experience index can therefore be expressed as:

$$EI(n) = 1 - S_x.$$
(9)

Bauhan [op. cit.] proposed a subjective range of "goodness" for the retirement experience index. Because of the arbitrariness of this range, however, the retirement experience index has not attained prevalence as a tool for selection between competing indications.

Both conformance (or index of variation) and retirement experience indexes are not statistical goodness of fit tests. The name "index" distinguishes them from the statistical goodness of fit criterion which, in this case, is the sum of squared errors. The indexes, however, provide an empirical solution to the problem of selecting among dispersions that may be indistinguishable were the statistical criterion used alone.

Bauhan's observation concerning the need for the conformance index is probably better explained by noting that dispersion characteristics may be indistinguishable for stub curves at younger ages. Figure 2 shows a plot of a 25-SC and a 55-O4 Iowa survivor curve.

Until about age 20, the statistical fit routines would generate indistinguishable conformance indexes for both curves. During these early ages, the retirement experience index, however, would favor the 25-SC over the 55-O4 based on the premise that at least the 25-SC is utilizing information that covers a larger part of the range over which it purports to be forecasting. This, however, does not suggest that the actual dynamic transfer process is not a 55-O4. What it suggests is, given the extent of the input time series, the 25-SC would provide a more reliable estimate based upon the available "sample space".

The statistical concept of a "sample space" is defined as the set of all possible outcomes of a defined event. For the event defined as the age of retirement, the sample space for a 55-O4 is 0 through 165 years while the sample space for a 25-SC is 0 through 50 years. With events observed between only ages 0 through 20, the 25-SC has more predictive reliability because it has covered 40 percent of its sample space, than the 55-O4 which has covered only 12 percent. At older ages, however, the statistical fitting routines can more easily distinguish between the two processes.

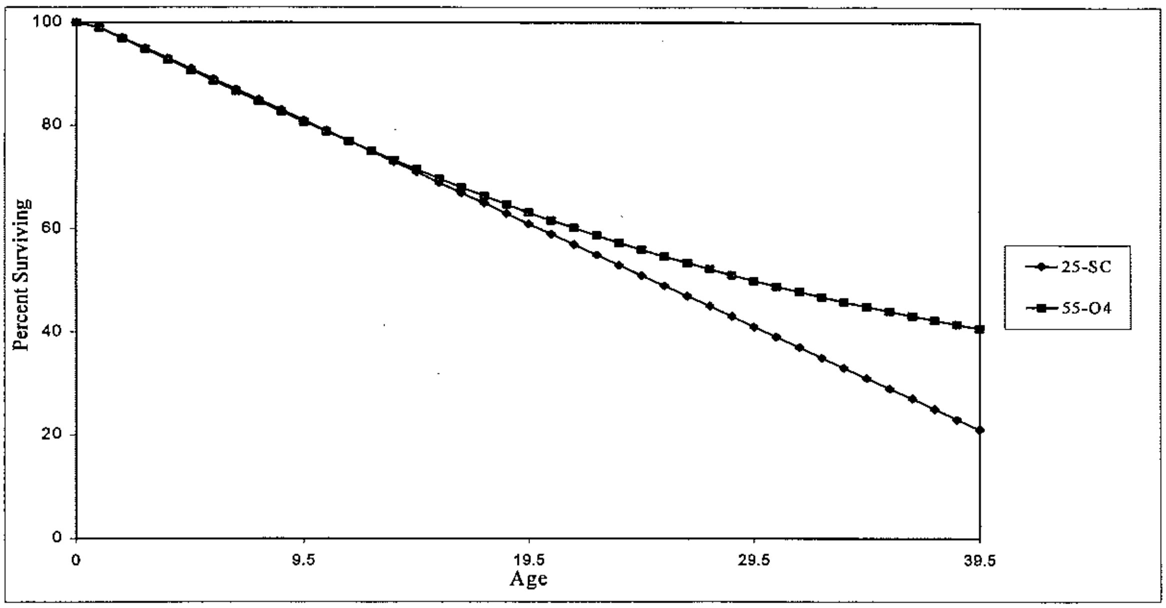


Figure 2. Similarity Between Dispersions at Younger Ages.

Although more robust statistical tests such as the χ^2 proposed by White[8] or the F-test could be used to improve upon the selection criteria, their practicality is limited by time, cost, and ease of use considerations. It is not surprising, therefore, that the practitioners in the field of life analysis and estimation have continued to rely heavily on the original indexes proposed by Bauhan. The situation depicted in Figure 2 is commonly the cause of a type of ranking that selects as best fitting O-curves with unrealistically long average service lives followed by much shorter lives for the remaining Iowa curves. Such a ranking will generally arise as a result of the analysis of an account with a young average age due to either infancy or substantial growth in the account.

A Combined Index

There is no indication in the literature that the formulators of SPR envisioned using the conformance index and the retirement experience index in a way other than subjective "excellent" through "poor" comparisons. More recent research has indicated a need to combine the two indexes in a manner that eliminates the subjectivity associated with earlier uses of the indexes. The recommendation is a combined index of the form:

$$XI(n) = VI(n) / EI(n) \tag{10}$$

that would be called the "combined variation-retirement index" or more simply the "combined index".

Table 1 shows the activity in an account whose retirements are simulated using a 10 percent error Monte Carlo method and a 25-SC Iowa type curve. An SPR analysis of the account in its infancy, with the best ten dispersions ranked using the index of variation, is shown in Table 2. For an account simulated with an average service life of 25 years, it is questionable that a 10 percent error in simulated retirements would generate average service life indications of 40 and 54 years as shown in Table 2. What is conceivably happening is the situation depicted in Figure 2.

Table 1. Simulated 25-SC Account

Year	Additons	Retirements	Balances	Year	Additons	Retirements	Balances
A	B	C	D	A	B	C	D
1950	414,522	4,196	410,326	1975	2,346,859	1,096,933	45,046,400
1951	601,226	14,358	997,193	1976	2,270,438	1,181,023	46,135,816
1952	912,332	31,347	1,878,178	1977	2,660,594	1,311,042	47,485,367
1953	1,309,369	47,604	3,139,943	1978	2,353,482	1,362,270	48,476,579
1954	1,447,207	82,127	4,505,024	1979	2,791,914	1,355,341	49,913,152
1955	1,275,837	101,054	5,679,807	1980	1,388,424	1,474,640	49,826,936
1956	1,358,487	137,141	6,901,152	1981	3,266,973	1,540,622	51,553,286
1957	1,390,774	146,774	8,145,152	1982	2,805,566	1,501,788	52,857,064
1958	1,691,593	172,614	9,664,131	1983	2,888,838	1,518,717	54,227,185
1959	1,869,569	238,338	11,295,362	1984	3,249,310	1,583,251	55,893,244
1960	6,385,279	295,402	17,385,238	1985	4,569,414	1,627,846	58,834,812
1961	1,929,033	375,423	18,938,848	1986	6,289,687	1,682,971	63,441,528
1962	2,303,148	427,675	20,814,322	1987	6,043,476	2,076,489	67,408,516
1963	1,987,954	524,595	22,277,681	1988	5,832,310	1,839,055	71,401,770
1964	1,682,759	511,818	23,448,622	1989	7,041,709	2,052,865	76,390,614
1965	2,465,862	504,645	25,409,840	1990	7,212,766	2,344,733	81,258,647
1966	4,346,226	632,488	29,123,578	1991	8,985,797	2,607,232	87,637,212
1967	3,101,643	631,337	31,593,883	1992	8,908,532	2,449,084	94,096,660
1968	3,005,231	831,728	33,767,386	1993	12,889,608	2,989,931	103,996,337
1969	2,871,712	819,565	35,819,533	1994	6,665,819	3,256,669	107,405,487
1970	3,458,031	836,889	38,440,675	1995	13,598,654	3,194,927	117,809,214
1971	2,688,197	1,034,418	40,094,453	1996	11,721,842	2,910,053	126,621,003
1972	3,366,981	1,050,126	42,411,308	1997	12,582,963	3,347,739	135,856,227
1973	1,804,677	1,110,972	43,105,013	1998	13,847,529	3,012,768	146,690,988
1974	1,696,329	1,004,868	43,796,474	1999	14,951,357	3,419,794	158,222,551

Table 2. 1962-1970 Analysis Ranked by Index of Variation

Curve A	ASL B	SSQ C	VI D	EI E	CI F=D/E
O 3	39.8	0.1606	66	67.80	97
O 4	53.7	0.1610	66	63.01	105
SC	25.2	0.1636	67	88.35	76
O 2	28.1	0.1644	67	81.48	82
R 0.5	22.2	0.2026	74	100.00	74
L 0	25.2	0.2495	82	86.99	94
S -.5	22.3	0.2498	82	99.86	82
R 1	19.9	0.3500	98	100.00	98
L 0.5	23.0	0.4084	105	92.83	113
S 0	20.4	0.5050	117	100.00	117

Table 3. 1962-1970 Analysis Ranked by Combined Index

Curve A	ASL B	SSQ C	VI D	EI E	CI F=D/E
R 0.5	22.2	0.2026	74	100.00	74
SC	25.2	0.1636	67	88.35	76
O 2	28.1	0.1644	67	81.48	82
S -.5	22.3	0.2498	82	99.86	82
L 0	25.2	0.2495	82	86.99	94
O 3	39.8	0.1606	66	67.80	97
R 1	19.9	0.3500	98	100.00	98
O 4	53.7	0.1610	66	63.01	105
L 0.5	23.0	0.4084	105	92.83	113
S 0	20.4	0.5050	117	100.00	117

Table 4. 1991-1999 Analysis Ranked by Index of Variation

Curve A	ASL B	SSQ C	VI D	EI E	CI F=D/E
R 2	24.3	4.221	71	100.00	71
R 2.5	23.3	4.392	73	100.00	73
S 1.5	21.3	4.996	77	100.00	77
S 1	22.7	5.158	79	100.00	79
R 1.5	25.4	5.674	83	99.91	83
S 2	19.3	6.132	86	100.00	86
S 0.5	23.9	6.428	88	100.00	88
R 3	23.1	7.106	93	100.00	93
L 2	21.4	7.156	93	99.75	93
L 1.5	22.9	7.634	96	98.47	97

Key to Tables 2-4:

ASL:	Average Service Life (Years)
SSQ:	Sum of Squared Errors x E+11
VI:	Index of Variation
EI:	Retirement Experience Index (%)
CI:	Combined Index

While the anomaly in this case is created by analyzing an account in its infancy, a similar situation occurs for mature accounts that are experiencing substantial growth. In effect, the relatively large recent vintage additions in combination generate a situation similar to that depicted in Figure 2 for a single vintage. Although this effect has been called "model failure" in some SPR literature, a more descriptive term for it might be along the lines of "infancy/growth" effect or anomaly.

Table 3 shows the situation when this effect is counteracted using the combined index. In this case, the ranking, at least for the best 5 dispersions, is more in line with indications that would be expected from the original simulation of the account.

The effect of the combined index, therefore, is to discount the predictive abilities of a model that has not covered a significant portion of its sample space. As an account matures and stabilizes, the need for the combined index is dissipated because the retirement experience index for most dispersions approaches unity. Table 4 shows the 10 best ranked dispersions using the most recent activity when the account is more than 30 years old. At this mature stage, there is no distinction in ranking between the index of variation and the combined index.

Conclusion

The index of variation and the index of retirement experience as used in the SPR method are shown to fail in selecting a reasonable dispersion under certain conditions of infancy and growth. Without introducing a new index, a combination of the two indexes, called the combined index, is suggested to address indications generated in the infancy stages of an account or in accounts with high rates of growth. Indications from the new index are shown to be indistinguishable for relatively mature accounts or accounts showing normal rates of growth. Although statistically more robust tests are available to address this and similar situations and anomalies encountered in SPR analysis, their practicality is limited by time, cost, and ease of use considerations.

Aknowledgements

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ECONOMIC DEPRECIATION?

NARUC Staff Subcommittee on Depreciation

INTRODUCTION

The Finance and Technology Committee of the National Association of Regulatory Utility Commissioners (NARUC), at the February, 1997 Meetings in Washington, D.C., requested that the Staff Subcommittee on Depreciation prepare a discussion paper comparing economic depreciation with traditional regulatory depreciation.

There is much discussion today in federal and state decisions, comments from industries, and various academic papers on the use of economic depreciation. Unfortunately, some use the terms "economic life" and "economic depreciation" synonymously. This paper clarifies and discusses the differences between these terms and the more traditional depreciation terms.

Traditional Regulatory Depreciation

Traditionally, regulatory depreciation is an accounting issue. The objective of computing depreciation is to allocate the cost or depreciable base of a group of assets over the service life, on a straight line basis, by charging a portion of the consumption of the assets to each accounting period. The accounting principle upon which depreciation is based is called the matching principle. Under the matching principle, the goal of depreciation is to provide for a reasonable, consistent matching of revenue and expense by allocating the cost of depreciable assets over their estimated useful life.

The federal government regulatory agencies and state public utility commissions (PUCs) typically prescribe Uniform Systems of Accounts (USOA) for utilities they regulate. The USOAs contain the rules and regulations that the utilities must follow. For example, the USOA for telecommunications carriers prescribed by the Federal Communications Commission (FCC) provides the following instructions for depreciation: "(g) Depreciation Accounting - (1) Computation of depreciation rates...(iii) The company shall keep such records of property and property retirements as will allow the determination of the service life of property..."(18 CFR§32.2000(g)(1)(iii)). Currently, most federal and state PUCs use some form of service life and require a straight-line method on which to base depreciation charges. The life of an asset refers to the period of time during which the depreciable plant is in service. Generally, regulators have determined that only assets that are used and useful in the provision of utility services should be included in Plant In Service accounts. Presumably, these assets are revenue producing assets.

Determination Of Service Life And Economic Life

Traditionally, regulatory agencies determine service life by considering past and future forces of retirement. Such forces considered are wear and tear, action of the elements, inadequacy, economic and technological obsolescence, changes in demand, requirements of public authorities, and management decisions. NARUC's *Public Utility Depreciation Practices* defines economic life as "The total revenue producing life of an asset". Economic life also considers the forces of retirement as they relate to future revenues generated by a particular group of assets. Service lives of a group of assets using either traditional or economic viewpoints should therefore be expected to be similar when considering the same future forces of retirement.

ECONOMIC DEPRECIATION

Economic depreciation is not a new term and has evolved over time. In the 1960s, for example, economic depreciation was defined as "...the cost of depreciable assets consumed during a year, expressed in terms of purchasing power of the original investment. Economic depreciation can be calculated by adjusting either the actual-cost depreciation base or the actual-cost depreciation accrual so as to produce an annual depreciation accrual reflecting changes in the value of money brought about by price-level changes".[1] During the 1980s, the term was attached to the theory that measures depreciation by the periodic change in present value of an asset's remaining cash flows. More recently, economic depreciation has been defined as the change in the value of an asset during a given year.[2]

DISCUSSION

The straight-line method of depreciation provides for uniform allocation of expense to each accounting period during the service life of the assets. Economic depreciation is driven by the income generated by an asset or assets. It is therefore a measure of change in the value of a group of assets from one year to the next. In theory, economic depreciation differs from traditional regulatory depreciation in that economic depreciation rates will not be on a straight-line basis. This is because future income used in the economic depreciation model varies from year to year.

Since either traditional or economic viewpoints consider the same future forces of retirement, the service life or economic life of an asset should be the same. The period of time the depreciable assets are in service is the service life. The period of time the assets are producing revenues is the economic life. If the assets are in service, it then follows that the assets are producing revenues. Perhaps the revenues being produced are not the same amount as in the past; however, this is not a life issue.

As seen above, there is a marked difference between determining the economic life of an asset or a group of assets, which is the period over which depreciation occurs, and the depreciation accrual pattern, which could be calculated using the economic depreciation model. Economic life is expressed in terms of time while economic depreciation is expressed in terms of value.

One example of the differences in accrual patterns between traditional and economic depreciation is shown in Table 1. This example assumes a $1,000 investment, a 5-year service/economic life, a 5% annual inflation rate, and a 3% real rate of interest.[3] Column B shows depreciation accruals based on a straight-line method. These accruals are developed by dividing the investment by the service/economic life of 5 years. Under straight-line depreciation, accruals are constant each year. Columns C and D are examples of economic depreciation. Column C shows that when revenues are increasing, depreciation accruals are greater in later years than in earlier years. Column D shows that when revenues are declining each year, the annual accruals are greater in the earlier years than in the later years. A graph of these accrual patterns is shown in Figure 1. It must be noted that when assumptions concerning inflation, interest rates, or revenues change, the economic depreciation schedules must be recalculated.

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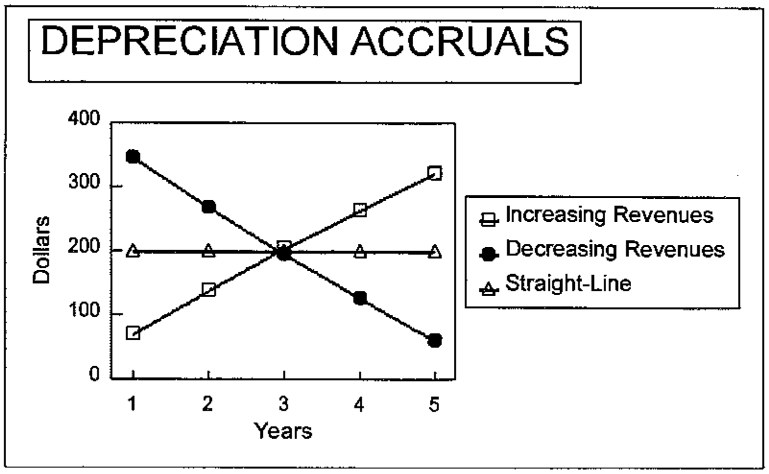
[1] Paul J. Garfield, Ph.D. and Wallace F. Lovejoy, Ph.D., *Public Utility Economics*, (Prentice Hall, Inc. 1964).

[2] See, for example, Michael L. Katz and Harvey S. Rosen, *Micro economics*, 2nd Edition, (Burr Ridge, IL: 1994). Page 213.

[3] See Appendix 1.

ACCRUAL ECONOMIC



PATTERNS

DEPRECIATION VERSUS STRAIGHT LINE

Table 1

ASSUMPTIONS

Investment = $1,000
Average Service/Economic Life = 5 years
Annual Inflation Rate = 5%
Real Interest Rate = 3%
Straight-Line Depreciation Rate: 100%/5 = 20%

		Economic Depreciation with	
Year	Straight Line	Increasing Revenues	Decreasing Revenues
A	B	C	D
1	200	72	346
2	200	139	269
3	200	204	196
4	200	264	127
5	200	321	62

Figure 1

Based on the foregoing analysis, it is clear that the straight-line method of depreciation is a simpler calculation of depreciation that results in equal annual accruals for each of the five years. On the other hand, economic depreciation is more complex and requires more judgement and annual re-evaluation of the future interest rates, demand, future revenues, and a subsequent modification of the depreciation amounts.

Notwithstanding that service life and economic life should be the same, and having explained the differences between economic and traditional depreciation, the remaining question is which method should be used by regulatory agencies. Proponents of economic depreciation have made statements that regulators have required Incumbent Local Exchange Carriers (ILECs) to utilize depreciation lives for their plant and equipment that are longer than the economic lives used by competitive firms. This is an argument over the life of assets rather than the value of assets. Bell Atlantic and NYNEX, in comments to the FCC, stated that current commission-mandated depreciation methods do not reflect the loss in economic value.[4] Shooshan and Jackson, Inc., in their primer prepared for the United States Telephone Association (USTA), state that the economic value of the asset in place would always be less than the cost of replacing it with another model that, new or used, is expected to contribute more to the firm's earnings.[5]

Conversely, testimonies submitted on behalf of some Alternative Local Exchange Carriers (ALECs) in certain state PUC proceedings proffer that not all cost-reducing technologies operate to the detriment of existing technologies; some cost-reducing technologies are complementary to existing technologies and give rise to increasing cash flows from existing assets over time. Further, it is important to consider "demand-enhancing technological progress"; that is, change that causes the demand curve to shift upwards, perhaps as a result of improvements in quality or in the form of new products brought about as a result of the technological change. According to these testimonies, the effect of such demand-enhancing technological progress is not to reduce the value (and the resulting cash flows) of existing networks, but rather to increase their value[6].

NARUC, in its 1943 and 1944 reports [7], stated that the cost of plant is a definitely known amount and is not subject to the vagaries of estimates of value or of replacement cost. An embedded cost depreciation base conforms to the accepted accounting principle that operating expenses should be based on cost and not be influenced by fair value estimates nor by what costs may be at some future time. NARUC further stated that the claims advanced in support of economic depreciation were lacking in probative force. As a result, economic depreciation has not been used in a regulatory environment.

From an accounting perspective, the

[4] See Joint Comments of Bell Atlantic and NYNEX, CC Docket No. 92-262, January 29, 1997.

[5] Shooshan & Jackson Inc. "*Primer on Capital Recovery, Regulatory Treatment of Taxes and Cash Flow Financial Analysis*," January 1987.

[6] See Direct Testimony of Dr. Michael A. Crew on behalf of AT&T Communications of the Midwest, Inc. and MCIMETRO Access Transmission Services, Inc., State of Iowa Department of Commerce Utilities Board, Docket No. RPU-96-9, April, 1997. See also Direct Testimony of Richard B. Lee on behalf of AT&T Communications of Delaware, Inc. Before the Public Service Commission of Delaware, Docket No. 96-324, February, 1997.

[7] See NARUC, *Reports of Committee on Depreciation for The Years 1943 and 1944* (Washington, DC: NARUC, 1943, 1944).

straight-line depreciation method continues to be appropriate for calculating depreciation rates. Since the early 1980's, regulatory depreciation procedures have been continuously modified and the process now reflects changes in both the business and technological environment. For example, for telecommunications carriers, the accumulated depreciation reserve ratio has increased significantly from approximately 20% in the early 1980's to nearly 50% today.[8] This ratio is an important indicator of the accuracy of past accounting results and current financial well being. It represents the portion of a carrier's current investment that has already been charged to depreciation expense. Notwithstanding, many ILECs argue that they have an economic value problem (i.e., the economic value of the network is less than its book value). Although the economic and accounting values for ILECs' assets may be different, the available evidence indicates that economic values of the assets are above accounting values, not below. The market value of all outstanding Regional Bell Operating Company (RBOC) shares is more than two times the total RBOC book equity. Additionally, sales of telecommunications exchanges and companies as well as sales of publicly traded stock have been at a premium, demonstrating that the economic value of the ILECs' assets are substantially greater than their book value. This is further confirmation that traditional straight-line depreciation methodology is working.

SUMMARY

Depreciation charges based on service life or economic life rather than the time value of money remains appropriate. Forecasting additional items, such as revenues, expenses, and future inflation rates in a valuation process, will add less stability and more complexity to the current depreciation process. In addition, as discussed above and as indicated in previously discussed ALEC testimony submitted in PUC proceedings, there may be an increase in value of the assets rather than a decrease in value. Although, the economic and accounting values for LECs' assets may be different, current financial information indicates that economic values of the LECs' assets are above the accounting values, not below.

[8] Filings with the FCC.

Appendix 1

In the two scenarios shown below, the revenues (Column D) are calculated assuming prices increase 5% per year with varying physical units of output (physical quantity). The fourth column shown for the decreasing revenue scenario is calculated assuming prices increase 5% per year but physical units of output decline each year. The nominal values each year are then discounted to the present value assuming an 8% nominal interest rate.

ECONOMIC DEPRECIATION VERSUS STRAIGHT LINE

Increasing Revenues:

YEAR	INFLATION RATE	OUTPUT UNITS	OUTPUT VALUE (REVENUES)	DISCOUNT FACTOR	PRESENT VALUE	ANNUAL ECONOMIC DEPRECIATION	ANNUAL STRAIGHT LINE DEPRECIATION
A	B	C	D=B*C	E	F=D/E	G=(F/PV TOTAL)*$1000	H=20%*$1000
1	1.000000	200	200	1.000000	200	72	200
2	1.050000	400	420	1.080000	389	139	200
3	1.102500	600	662	1.166400	568	204	200
4	1.157625	800	926	1.259712	735	264	200
5	1.215506	1,000	1,216	1.360489	894	321	200
TOTAL			$3,424		$2,786	$1,000	$1,000

ECONOMIC DEPRECIATION VERSUS STRAIGHT LINE

Decreasing Revenues:

YEAR	INFLATION RATE	OUTPUT UNITS	OUTPUT VALUE (REVENUES)	DISCOUNT VALUE	PRESENT VALUE	ANNUAL ECONOMIC DEPRECIATION	ANNUAL STRAIGHT LINE DEPRECIATION
A	B	C	D=B*C	E	F=D/E	G=(F/PV TOTAL)*1000	H=20%*$1000
1	1.000000	1,000	1,000	1.000000	1,000	346	200
2	1.050000	800	840	1.080000	778	269	200
3	1.102500	600	662	1.166400	568	196	200
4	1.157625	400	463	1.259712	368	127	200
5	1.215506	200	243	1.360489	179	62	200
TOTAL			$3,208		$2,893	$1,000	$1,000

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