CONDITION-BASED DEPRECIATION FOR INFRASTRUCTURE ASSETS

Dr Penny Burns
Infrastructure Economist
Visiting Research Fellow, Economics, University of Adelaide

A TIME FOR CHANGE

There has been some argument lately about whether depreciation should be applied to infrastructure assets. Most of the arguments are quite specious, but some, such as those of the 'renewals accounting school', at least have the merit of recognising a real problem with the traditional formula-based approach to depreciation, when applied to infrastructure assets, namely that it overstates real program costs. It also gives false and misleading readings on rate of return, written-down asset valuations and future liabilities.[1] However, it is argued here that the solution is not to discard the notion of depreciation altogether, but rather to develop a more relevant means of measuring depreciation for infrastructure assets.

As infrastructure assets are gradually being brought to account and, as a result of the work of the Australian Accounting Research Foundation, the Public Sector Accounting Standards Board and the current inquiry into accounting consistency within government trading enterprises, we are searching for methods which are accurate and reliable, but, above all, useful to managers and those responsible for evaluating managerial performance, it is perhaps an appropriate time to submit the current proposal for examination.

In November last year, the Premier of New South Wales wrote the following to all delegates to a Forum on Financial Reporting for the Australian Public Sector, a forum designed to obtain agreement to common accounting practices across the country:

> As you are already aware, in Australia, different approaches are being followed and planned by various governments and other public entities in their accounting, budgeting and financial reporting and there is a grave risk that these differences will continue and possibly increase unless positive action is taken to achieve a harmonised approach.

The broader vision and information required for more effective decision making goes well beyond accrual accounting. It embraces awareness of the need for:

- flexibility in asset management – including acquisition and particularly disposal
- ensuring that assets and obligations are part of management decision making in addition to cash flow considerations ...
- planning and managing forward commitments.

There is an opportunity now to ensure that accounting practices are developed that recognise the special needs of infrastructure assets. Road authorities are doing this and the water industry is also in a position to take action. Not to consider these important issues now may commit infrastructure accounting to costly and cumbersome depreciation practices for a long time to come. In Australia, we are now at a decision point in terms of accounting practices for infrastructure assets.

CONDITION-BASED DEPRECIATION FOR INFRASTRUCTURE ASSETS

It is in the spirit of this need and desire for better management information and improved accounting practice that I submit this proposal for a condition-based depreciation method suitable for the management of infrastructure assets. The benefits are:

- greater ease of calculation;
- greater credibility, accuracy and relevance because depreciation is a by-product of operational management;
- a more useful presentation format for management.

The methodology makes three claims which it would be sensible to state up-front. The first is that while infrastructure assets should be depreciated, the way in which depreciation is calculated can be improved. The second is that standard depreciation methods can be applied if sufficient detail is available, but the end result is cumbersome and fails to recognise the interrelatedness of components that is so important for infrastructure assets. Because of this, it provides information in a form which is less directly useful for decision making. The third is that if standard depreciation methods are applied at the current level of aggregation, serious distortions occur in written-down valuations, projections of future liabilities and evaluations of rate of return, and distortions increase over time. All of these claims are explained and addressed below.

Beginning on this page is a discussion of the characteristics of infrastructure assets that would benefit from a consistent depreciation treatment based on condition assessment rather than a formula approximation. Both the conceptual and measurement problems of establishing economic lives for infrastructure assets are considered.

The nature of depreciation and its relationship to a change in condition of the asset, that is, its ability to supply a future stream of services, is examined on pages 93 to 97. This section also considers the distortions that arise if formula depreciation methods are applied to infrastructure assets at the current levels of aggregation. Disaggregating infrastructure assets is shown only to bring new problems in its wake.

The concept of condition-based depreciation is introduced on page 97 and it is shown that, far from being only a theoretical concept, condition-based depreciation is currently being used by the Road Traffic Authority in New South Wales. A broader method than the detailed annual condition assessment used by the road authority is then developed that can apply to any infrastructure agency and this, too, is shown to be capable of practical application, with a version of the model being used in the water industry in the UK.

The discussion on pages 100 to 104 broadens the contention that this method of developing depreciation measures for infrastructure assets is cheaper, quicker, more accurate and more reliable than the standard formula approach and provides agency management with a valuable management tool that has a number of other benefits.

INFRASTRUCTURE ASSETS

Infrastructure assets are defined as networks (such as water and sewer pipes or electricity grids) and complex facilities (such as hospitals, generation stations and dams). Their characteristics are that they have very long lives and are essentially renewable rather than replaceable.

Not all public assets are infrastructure assets. Major exceptions would be loose plant and equipment, machinery, rolling stock and motor car fleets. Furthermore an infrastructure asset which has a normal expectation of infinite life extension by renewing rather than replacing, would become an ordinary asset, subject to standard and periodic writing down of value, if for any reason it should acquire a finite life expectation, for example, if it should become surplus to requirements or obsolete and if the agency should plan to write it out of the books within a certain number of years.

Problems with defining and measuring economic lives for infrastructure

The long life of infrastructure assets makes the estimation of economic lives very difficult. Very few engineers have experienced the wearing out of infrastructure assets that they themselves have installed, even for road assets where the lives are, for infrastructure, reasonably short, at about 30 years.

Moreover, it is also difficult to establish exactly what constitutes economic life – that period of time beyond which it is economically worthwhile to replace rather than to continue to repair and maintain. Is the life of a facility such as a hospital, the life of its longest living component – usually the foundations – or some weighted average of components? If we adopt the weighted average approach, as was done in the Public Accounts Committee reports on asset replacement, the interpretation cannot be that after this period of time the asset will have been depreciated to zero or some salvage value, but rather that in this period of time the asset will have required replacement expenditure equal in real values to the original capital expenditure. For example, the weighted average economic life of a housing trust house was estimated at around 52 years; that did not mean, however, that at 52 years the asset would be ready for demolishing. Indeed, so many elements of the house would have been replaced that the house would still be probably around 75per cent of new.

The impact of interdependence on the definition of economic lives

While it is possible to deal with infrastructure aggregates by disaggregating them into their replaceable parts, each of which can be depreciated to zero, to do so involves heavy accounting and information collection costs and loses sight of the interrelatedness of the parts, which is the very essence of the infrastructure asset.

For example, a sewer network is a set of sewer pipes that work together as a whole. If you take out one particular length of sewer, either the flow stops or, by installing bypass links, the other sewer lengths take up the job. In other words they are *interdependent.*

As another example, consider a road that is resealed every 7 years and has a substructure life of 30 years. In year 28 it is technically due for the fourth reseal, but if we go ahead with this fourth reseal at this time, then only two years after that, everything going according to plan, we will be digging up this reseal to rehabilitate the substructure! Under these circumstances the economic life of the third reseal would be extended.

The point is that *where elements are interdependent, economic lives are also interdependent* and it does not make sense to treat the elements as separate assets. This, however, is what we must do if we follow the standard depreciation procedures. Fortunately there is an alternative.

DEPRECIATION AND DEPRECIATION FORMULAS

Depreciation represents the amount of potential service ability, or asset value, that has been used up in the year's operations. This using up is related to a 'change in condition'. Where there are many assets, to individually assess the condition of each asset would not only be very time consuming but also unnecessary, as we can readily apply the law of averages and adopt simple formulas which, more or less, reflect the pattern of condition change that we expect from the asset. This is fine for simple assets, i.e. assets that are replaced when they become worn out or technologically or otherwise obsolescent. But infrastructure assets are different. As already stated, they are not so much replaced as renewed. That is, parts of the asset remain in as original condition while others are replaced. These assets do not follow the monotonically declining residual value pattern that all the depreciation formulas characteristically assume.

Monotonically declining residual value patterns of standard formula-based depreciation

In Figure 1, three common formulas are illustrated. They are:

- a declining balance method (common with motor vehicles or assets subject to rapid fashion or technological obsolescence, which lose a lot of value as soon as they are taken out of the showroom, but which then decline in value more slowly);

- an increasing balance method (where condition, and therefore depreciation, changes little in the initial years but accelerates as the asset ages);
- the straight line method, which assumes that the amount of depreciation is constant over the asset's lifetime and, due to a lack of better information concerning the pattern of condition changes, is the one most commonly used.

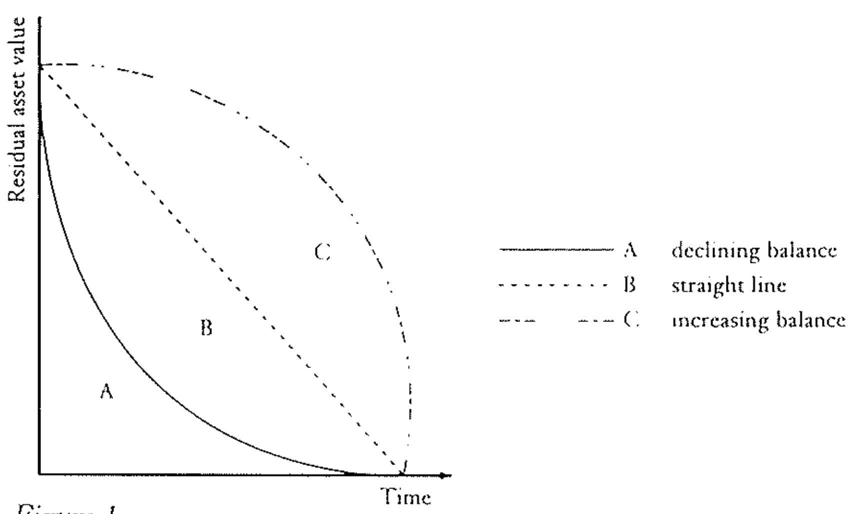

Figure 1

All of the methods assume that the residual value declines towards some end point, either zero or some salvage value, and at no point in time increases (except for inflation which can be taken care of by a general revaluation). Depreciation is made good only at the very end – by the replacement of the asset.

There is a problem with long-living, renewable rather than replaceable, infrastructure assets, for these do not have residual values that decline monotonically over time, but rather values that follow a saw-tooth or zig-zag pattern. This is shown in Figure 2. In line D, representing a typical infrastructure asset, depreciation is being made good continuously, even if somewhat unevenly and in lumps. The same amount of wear and tear is taking place over the period under all four line patterns but in line D, depreciation is being made good in bits whereas in lines A to C, depreciation is made good in one lump sum at the end of the period.

Figure 2 illustrates the typical pattern of renewal in an infrastructure asset such as a water network. Residual values run down as pipes gradually corrode or crack. Repairs are then carried out or sections replaced, bringing that part of the asset stock back to 'near new' condition. This occurs in a systematic, although not necessarily regular, pattern over time. Even towards the end of its supposed 'life' of 80 to 100 years (based on the average economic lives of components), the network is still giving service close to the optimum as a result of all the extensive renewal work that has been carried out.

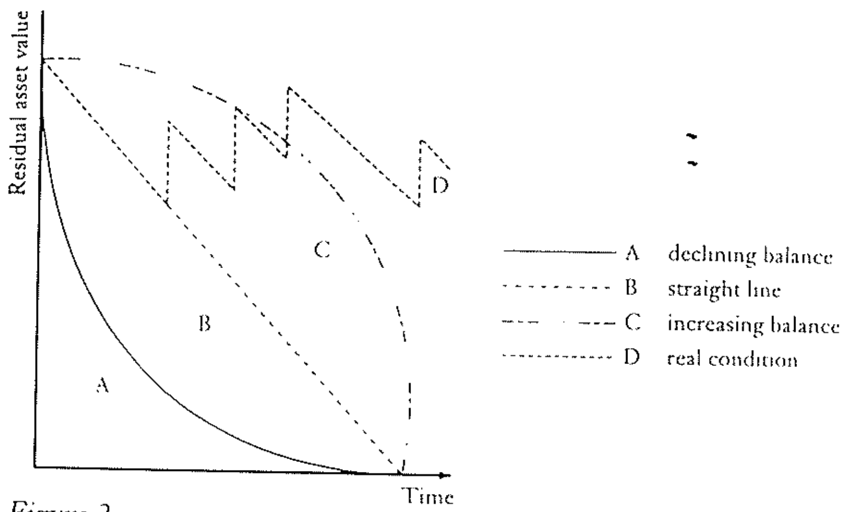

Figure 2

Depreciation formulas lend themselves to overstatement

Compare the actual residual values shown by the zig-zag curve with the values given by the traditional straight-line formula depreciation method. The straight-line method understates the value of the asset for most of its operating life and simultaneously overstates the future liabilities of the water industry. This is because the depreciation methods do not take into account the amount of depreciation that is continuously being 'made good'. The reason that infrastructure assets *are* so long living is, in part, this ability to continuously, if in a lumpy fashion, make good their wear and tear.

The tendency of formula-based depreciation to overstate future liabilities can lead to inordinate levels of funds being built up over time if these depreciation figures are translated into depreciation provisions.

Charges reflecting such depreciation provisions overstate the true cost of services. One reason that this occurs in practice is that it is very difficult to tell which expenses are of a recurrent, or maintenance, nature and which of a capital, or replacement, nature. Unless detailed age and value information is kept on all components, it is not possible to withdraw from the books the value of individual components replaced to maintain operational viability. In practice (and in fact recommended in the early draft release version of the NS Capitalisation guidelines), much component replacement is expensed, thus double-counting operating costs, understating asset values and overstating future liabilities as shown.

Renewals accounting not an appropriate answer

Recognising some of these problems, renewals accounting proponents argue that, since infrastructure assets such as water systems are continuously maintained over time, they do not depreciate and thus depreciation should not be charged. They argue that, instead, repairs and renewals should be charged in the year in which they occur.

Sometimes, in support of this expensing proposition, it is argued that eventually a water system, for example, will mature to the stage where the amount of renewal activity each year approximates the average amount of wearing out. In theory this is true – however, for it to apply in practice, the water system would have to have had no changes or additions for a period equal to at least twice the life of its longest living component in order to have allowed renewals to settle down into a reasonably distributed and regular pattern – *in other words the system would have had to have no change for about 200 years or more!* No Australian water system can claim this, nor claim to be anywhere near it. Renewals, in practice, are not constant; they are lumpy and they are increasing as age brings more and more of previous years' system expansion into the renewal time. Thus the renewals accounting approach is not appropriate.

However, I think that those who argue for 'renewals accounting' see it as the *only* alternative to the formula-depreciation method which, as we have shown above, does not represent conditions in infrastructure-providing agencies at all well and, in fact, systematically overstates the rundown of the system. Renewals accounting supporters want to avoid a depreciation method that overstates. So should we all! An alternative is needed but it must be one that avoids the problems of both renewals expensing and formula overstatement.

CONDITION-BASED DEPRECIATION

Such an alternative is condition-based direct assessment of depreciation. This is more than merely a concept: it is already being applied by the Road Traffic Authority in New South Wales.

Road condition is continually assessed as part of the management and operation of the road system, and the RTA can calculate not only the current condition but also how much it would cost to bring the road back to a 'fair' condition or to an 'as new' condition. Comparing the beginning and end year state assessments gives the amount by which the road network has deteriorated over the year. This amount is then a charge on the income and expenditure account and is shown in the balance sheet as a deduction from the value of the asset. It is called a 'provision for restoration' and equates, in part, to the accounting concept of depreciation. It has been accepted by AARF and the Auditor-General as complying with AAS 4 'Depreciation of Non-current Assets'.

What is omitted is the element of technological or economic obsolescence which may result in a road being closed and removed from the asset stock. This unpredictable element is included in the RTA accounts by way of note only at this stage.

It is, of course, far easier to determine the condition of above-ground assets such as roads than below-ground assets such as water, sewer, or gas pipes or underground electricity cables. It is also far easier to determine the condition of a road, with only a few quality parameters, than to determine the condition of a hospital or electricity-generation plant, with hundreds. The operational and management needs of roads require annual assessment of all parts of the asset or road network, but most infrastructure assets do not require each component to be annually assessed, at least not in detail.

However, a similar assessment of annual condition change of the overall asset can be carried out for all infrastructure assets, by way of a rolling 20-year forward estimate of capital maintenance, based on condition assessment and life-cycle analysis. This is being applied, in principle, in the water industry in England, although in a more rough and ready fashion than the method I am advocating.

How it works in practice

In simple terms, the agency assesses what needs to be done to maintain the operating capacity of the asset – be it a water network, an electricity grid, a teaching hospital, or whatever. It considers all the work to be done by way of major maintenance, replacement or rehabilitation, simply to maintain the current capacity and standard of operation. (A master asset plan would add upgrades and extension, i.e. new capital works, to this assessment of capital maintenance, to make a complete asset-management plan.)

This condition-based assessment of capital maintenance activity does not require an assessment of economic life as such. Rather, it requires an assessment of whether the residual life of any component of the asset will be reached within the forecast period (the next 20 years). If no action will be required in the next 20 years, the component does not feature any further in the forward estimates. This is considerably easier – and therefore can be undertaken in a cheaper, more relevant and more accurate manner – than estimating economic life itself.

For an asset with an expected average economic life for its class of a round 60 to 100 years, it is extremely difficult to judge the relevant life with any degree of reliability. However, as the asset approaches the end of its life, more information is to hand and the job is easier and more reliable. Presumably if one were to wait until the economic life had been reached, accuracy would be assured – but only at the cost of no planning time. Judging the point at which the residual life of an asset is reduced to 20 or so years is a compromise between absolute knowledge (at the end of the asset life) and what amounts, at the beginning of its life, to pure guessing. It also means that in any one year's rolling plan, many components need not be closely examined.

Figure 3 presents a sketch of what an asset-management plan would look like. Much more refined models are now capable of being developed in many infrastructure industries, especially the water industry, and would include maintenance (routine and major) and repair, as well as the component refurbishment and replacement included here. The plan is, in effect, a projected cash-flow budget for capital maintenance.

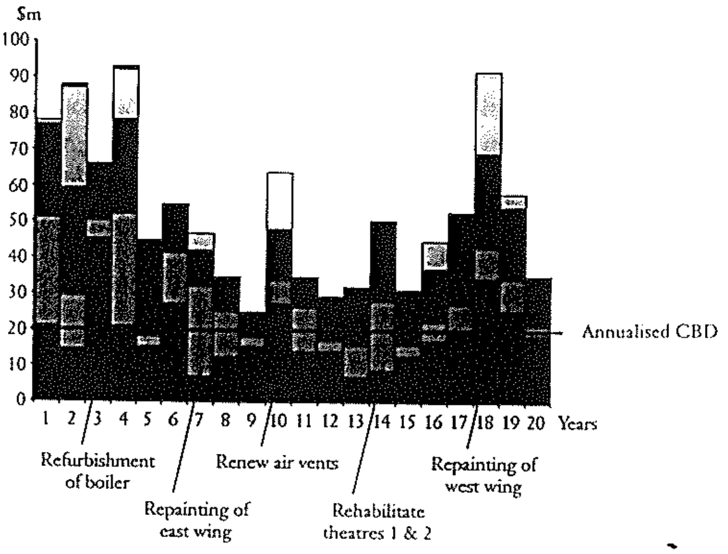

Figure 3: Asset management plan – forward cash budgeting tool and calculation of condition-based depreciation

By taking the beginning-of-the-year annualised present value of forward renewals caused by system usage as the renewals expense, the excess of this annualised amount over actual maintenance and refurbishment would represent asset deterioration, which would then become a charge against the income and expenditure account for 'asset restoration', as in the system operated by the RTA. The balance sheet asset value would be adjusted for the asset deterioration by recording a deduction for provision for asset restoration.

For example, if the annualised present value of future renewals from the beginning of the year to end year 20 gave a figure of $300m and the actual upkeep expenses of the year, maintenance and refurbishment were $250m, then $50m would become a charge against the income and expenditure account for asset restoration and would be deducted from the asset values in the balance sheet.

In the income and expenditure statement there would be:

Expenditure		
Upkeep (Maintenance and Refurbishment)	$250m	= Annualised present value of forward renewals
Provision for Asset Restoration	$50m	

In the balance sheet there would be:

Assets		
Assets		
less: Provision for Asset Restoration	$50m	= Written-down asset value

In years in which actual maintenance and refurbishment exceeded the annualised amounts (the zags in the zig-zag pattern), the provision for asset restoration would be negative, bringing the total of upkeep and provision to the annualised present value. Similarly, when asset condition was improved by large refurbishment work, the written-down asset value would reflect this improvement in condition.

When asset-management plans are a part of the ordinary operational and management business tools of the agency, condition-based depreciation is a *costless spin-off*. Using the 20-year capital maintenance forecast, the annualised present value of expected future renewals expenditures caused by system usage would fairly reflect *real, condition-based depreciation*. Capital consumption is measured directly by the costs of its reversal.

This is, in effect, the equivalent for all infrastructure of the condition-based depreciation operated by RTA, which is expected to be adopted by all road authorities.

Because the annuity approach averages the renewals expenditures over the period, the amount in the provision account at any one time is unlikely to be extensive – unlike the provision for depreciation calculated by formula on current valuations – and therefore is unlikely to be seen as a 'hollow log' or 'attractive to politicians' or any of the other practical problems that agencies fear in providing for longer term viability.

OTHER ADVANTAGES OF CONDITION-BASED DEPRECIATION

If all the above is not reason enough to seriously consider condition-based depreciation now, let me suggest some others.

Easy adjustment for new knowledge

As plans are redrawn on a 20-year annual rolling basis, large renewals at the end of the period can easily be introduced into the depreciation pattern and have only a minor immediate impact on the annualised averaged net present value of capital maintenance. Similarly, information about new technology, new standards and new options can likewise be introduced in a smooth manner. Replacement costs and economic lives do not have to be separately recalculated, for this is done automatically in the renewal provisions. Depreciation adjusts from year to year to take account of new knowledge but changes are small and easy to assimilate.

Cheaper

As agencies develop their future plans for management purposes, analysis of future renewal costs will be needed anyway; *they are not an extra cost imposed by the accounting system!* The alternative envisaged by the adoption of commercial depreciation practices, on the other hand, would require the collection of considerable data on the replacement costs and economic lives of individual components, much of which is not much use to management since the decision to renew any individual component of an asset is made on a judgement of what it would do *to the asset as a whole*, rather than with respect to component economic life (which, as we argued above, is because of interdependencies, problematical to determine anyway). With condition-based depreciation, asset registers can be used for managing assets rather than for collecting data for accounting purposes.

More reliable and auditable

Information required by management for its own purposes is more likely to be accurate, relevant, and kept up to date than information put together purely for an outside purpose. This has been widely known and recognised. So using operationally based asset-management plans for depreciation will provide more reliable information for accountability simply because this is the information used by management.

It may be objected that engineers in agencies are unable to predict the maintenance and renewals expenses needed to ensure the longer term viability of infrastructure. If this is the case then it is important that this problem be known and addressed. Disguising the inability of management to manage, which is what this amounts to, by applying formula-based depreciation methods that are independent of the actual condition of the asset only prolongs a bad management situation.

In practice, the assessments of in-house engineers and technicians will need to be validated by an external technical auditor in order for the values to be accepted by the Auditor-General. Engineering consultants are available to do this work and their examination of the assumptions, data and techniques used by the in-house staff will ensure that condition assessments improve over time – and this is, in fact, an excellent way of spreading the use of 'best practice' condition assessment.

Real condition-based depreciation is independent of asset valuation

There are many different ways that asset valuations can be calculated and valuations will vary with the purpose for which they are designed, e.g. market values, replacement values, reproduction values, insurance values. Difficulties arise because only one of these valuations can be chosen for balance sheet purposes, and whichever valuation is chosen will be useful for some purposes but not relevant for others.

For example, it is common today to value assets on a modern equivalent asset (MEA) basis. Where assets are heavily underutilised, perhaps because of past, unfulfilled growth expectations, a MEA approach would value the asset at the replacement cost of a smaller, more efficient, design. Or where technology has led to improved options now being available, the MEA will give a lower value than pure replacement 'as is'. This is appropriate for establishing the 'real value' of assets and, therefore, for determining the rate of return on the asset base. However, the MEA may not be appropriate for estimating costs of renewal if, for the time being at least, it is not economic to consider the complete replacement of the current asset with a new one. In this case, renewal costs are more properly based on the costs of replacing components within the old configuration, which may be a different cost altogether.

Condition-based depreciation avoids the difficulty of using one valuation for two, possibly conflicting, purposes, by directly estimating depreciation from the condition of the asset and *not as a percentage of its balance sheet value.*

Operationally simpler

The use of condition-based depreciation with its reserve for renewals approach eliminates the difficult border-line judgements of what is maintenance and what is repair, replacement or refurbishment. This is how it should be, since maintenance and refurbishment expenses are both used to continue the viable operating life of the asset, and separation into different categories is therefore rather artificial.

Fits with accounting standards

Condition-based depreciation is conceptually in agreement with the accounting standards, but as it has not been thought about in this way, it may be necessary for some of the issues to be clarified.

Overseas practice

The water industry in the UK has adopted a very similar system, which is referred to as 'infrastructure accounting'. This is *not* renewals accounting! The water industry recognised that the 'mature system' argument of smooth and continuous replacement did not apply and addressed the problem of lumpy renewals by proposing a system of accruals and deferrals to moderate the distorting effects of cycles of renewal activity so that the annual charge against revenues approximates long-run average expenditure.

The water industry uses asset-management plans constructed over 20 years but tends to use the level of expenditures predicted for the later part of the period as the 'long-run average' rather than calculating an annuity over the total period. Apart from the conceptual problem of assuming the long-run average to be equal to any one particular period, choosing the last period of the 20-year forecast, when forecasting ability is notably less accurate and knowledge less detailed the further out in time we are moving, reduces the relevance of the data. The annualised approach suggested here minimises both of these problems.

Management and accountability

When the water industry in the UK was privatised, asset-management plans were required at the changeover point. Since then, comparison of asset-management plans with those existing at the time of changeover enable the pattern of progress to be charted. Managements are thus able to demonstrate accountability for – and to gain credit for – their asset-management improvements, which can be documented by reference to the earlier plans.

The asset-management plan process also provides a 'what if' modelling capacity. It becomes a very useful means of demonstrating to politicians and others both the initial and the continuing costs of standards improvements and changes in the level of service.

And finally, but definitely not least, the process itself can calculate the renewal costs necessary to maintain long-term viability of the existing systems at stated standards. This is an essential planning tool both for the existing system and for planned enhancements and extensions.

SUMMARY

Condition-based depreciation, being a natural outcome of managerial and operational activity, is:

- cheaper;
- more accurate;
- more reliable.

And the asset-management plans on which it is based have numerous operational advantages for the infrastructure industries and a successful history in the UK water industry, where they have been in operation now for about five years.

Notes

1 A number of the objections to depreciation are listed in the AARF discussion paper no. 17 'Financial Reporting of Infrastructure and Heritage Assets by Public Sector Entities' by Tom Rowles.