MEAN ASSET LIFE'S AND THEIR INFLUENCE ON THE REFURBISHMENT BUDGET OF ELECTRICAL NETWORKS

PRESENTERS

ROBERT (Bob) WALLIS
Business Development Consultant
Merz and McLellan® South Africa

SICELO XULU
Head – Capital Execution
City Power Johannesburg

Objective

The objective of this paper is to illustrate the importance of the assigned asset life "Mean Asset Life" in the management of the assets in an Electrical Distribution System. The paper will also highlight the role of the asset manager and the crucial role management tools can play in the compilation of the refurbishment budget.

Mean Asset Life – Robert Wallis

Asset Register's and the Asset Valuation.

Today we are bombarded with financial jargon that I believe leaves even the accountants confused.

GARP – Generally Accepted Accounting Principles
GAMAP – Generally Accepted Municipal Accounting Practices
IFRS – International Financial Regulation Standards
GRAP – Generally Recognised Accounting Principles

To those of us without the benefit of an accounting degree it seems as though a new set of rules for every new situation, but what does this mean for engineers that are trying to run an Electricity Distribution Network?

Generally, just a lot of personal time swatting up the various new set of rules. All the rules are for the way in which the accounts are presented and what the assets are worth in financial terms, but contribute very little towards the actual management of the network.

(Thankfully in electrical engineering the rules have not changed too much "Ohm's Law" is still Ohm's Law.)

It is clear that the financial reporting and the data required by the Engineers and the Asset Managers are very different. As we all know our networks need maintaining and as they age and deteriorate, various assets need refurbishing and replacing all on somewhat different time scales. The majority of the major items of equipment are very expensive and have long delivery times so the principle of "replace it when it breaks" is clearly not practical to Electricity Distribution Networks where quality of service is the main driver.

The rate of deterioration (Age Curve) and the replacement cost are the important issues in ensuring the continuity of supply. The ideal is to replace the transformer, cable or switchboard the week before it would have failed.

Today Asset Management has become much more complex due to:

? Utilities growing in size
? Networks are becoming more complex
? Utilities are being merged into REDS and Metro's
? Financial constraints
? Need for scenario planning
? National considerations
? Skills shortage, limited budgets
? Other considerations

Generally Asset Management is not well understood by many of the stakeholders of Distribution Networks, furthermore is does not increase the revenue and therefore it is not considered to be high priority.

What most of these stakeholders fail to realise is that these are the assets that generate the existing income and the funding required, simply to maintain the status quo, is huge as will be illustrated later in this paper.

Age Profile

Let us consider the deterioration of the asset. This can happen for different reasons and on various time scales, either due to high loadings, lack of maintenance, environmental conditions, fault conditions, number of faults, design, etc., but as these conditions can be evaluated, careful system data collection can result in the generation of accurate 'AGE PROFILES".

Organisations like CIGRE and utilities around the globe have been collecting data for many years and such curves have been generated by International Consulting Companies that specialise in asset management.

One of the critical considerations is the "Mean Average Life" of the asset. There are some utilities that do not consider that age has any great influence and the main drivers are Condition and Performance. This is true of relatively young networks but it has been proved the actual age has been a very valuable criteria in calculating the remaining life expectancy of assets in older networks with critical quality of supply agreements.

Table 1

		South Africa		EDI Toolkit	UK	
Asset Class	Asset Type	Mean	Std Dev.		Mean	Std Dev.
Transformers	6.6 kV-11kV	40	5	45	55	11
	33 kV - 20 kV	40	5	50	60	10
	88 kV - 275 kV	40	5	50	55	11
Switchgear	6.6 kV-11kV	25	5	45	52	7
	33 kV - 20 kV	25	5	50	52	10
	88 kV - 275 kV	25	5	50	49	10
Underground Cable	11 kV	30	10	45 - 50	85	12
	20 kV- 33 kV	30	10	45 - 50	76	10
	88 kV	30	10	45 - 50	61	9
Overhead Line (88 kV)	Conductor	60	5	50	66	9
	Tower	60	5	50	55	5
Protection	Electromagnetic				50	10
	Static				15	5
	Digital				12	3

As can be seen from Table 1 there is a considerable difference the generally accepted figures in South Africa and the figures used in the United Kingdom. The figure shown in the EDI column as those recommended in the EDI "Toolkit" used for valuation purposes

Diagram 1

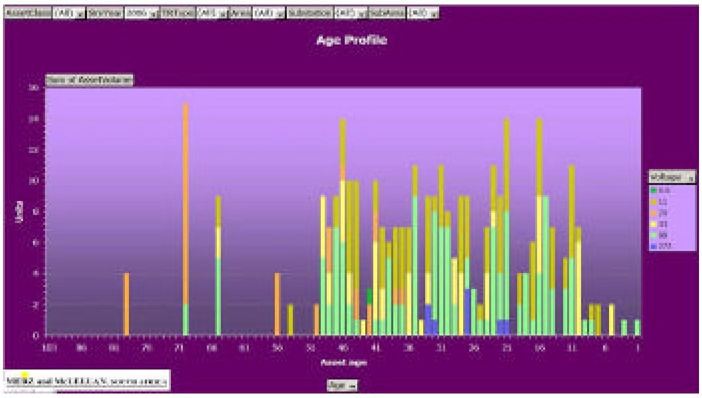


Diagram 1 shows the Power Transformers “Age Analysis” for one of the large electricity distributors in South Africa by voltage level. The data used to compile this analysis will be used in most of the illustrations used in this paper. Here you can see that the assets range form the oldest at nearly 80 years and the youngest being an 88kV unit installed in 2004.

Diagram 2

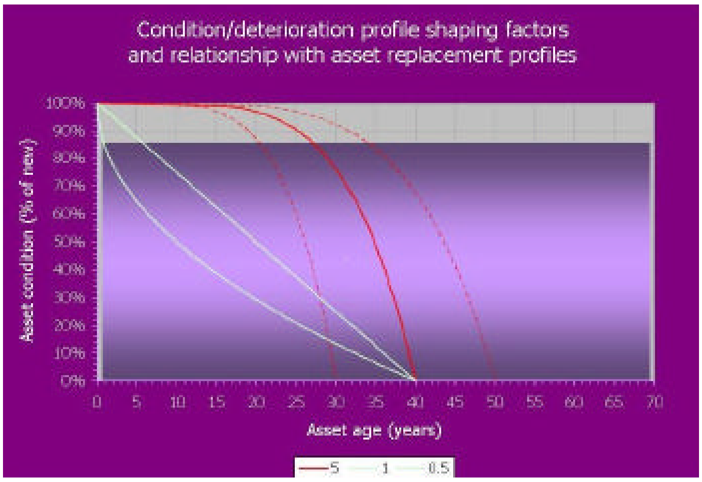
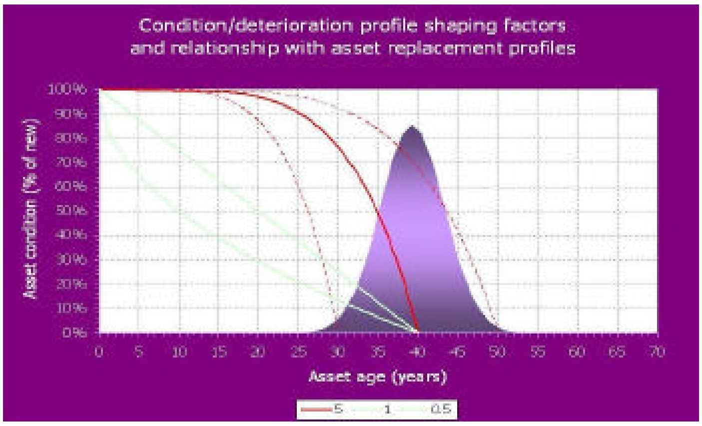


Diagram 2 shows a deterioration curve in red with a deviation of ±10 years. This asset has initially a slow rate of deterioration which increases as it ages. The blue line to the left is the curve for a different asset type that initially deteriorates quickly then slows down as it ages.
The straight line in blue is the standard normally used by the accountants.

Diagram 2b



In Diagram 2b we have shown the Deterioration Curve and the relationship to the Asset Replacement Profile. Asset Managers experienced in using this type of modelling tool can combine their field knowledge of the Asset Class to accurately match the real conditions within the model.

Diagram 3

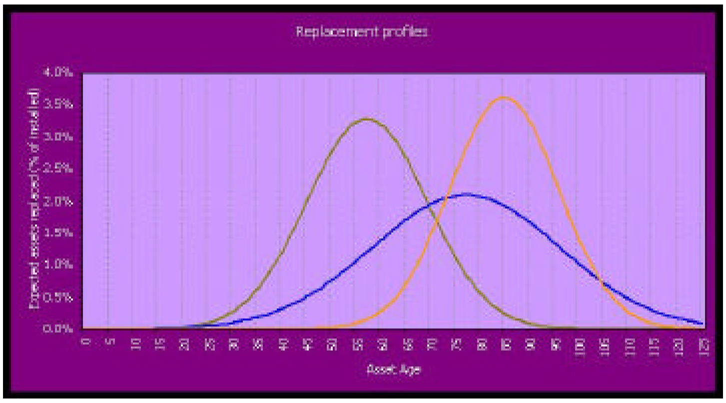


Diagram 3 shows three different replacement profiles

Diagram 4

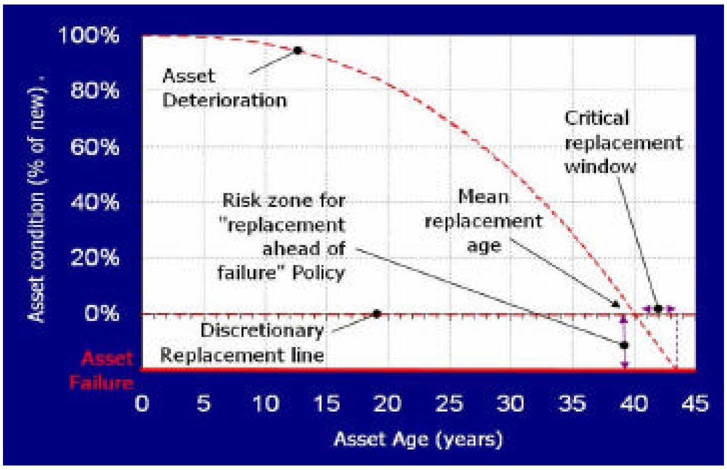


Diagram 4 shows the critical replacement window and the risk zone for “replacement ahead of failure policy”.

It is often necessary, due to financial constraints or practical field problems to delay the replacement of certain assets. Providing the asset is in a suitable condition this situation can be catered for within the model. The critical issues to bear in mind are that all the parameters must be included in the modelling process.

AGE, CONDITION, PERFORMANCE

By using a selected deterioration curve and a replacement profile for a particular asset these can be modelled and combined with the other assets of the same class and an “Investment profile” can be generated for a particular asset class.

Asset Class

Most models use the following asset classes in the modelling of Transmission Networks: Transformers, Switchgear, Overhead lines, Underground Cables and Protection

Diagram 5

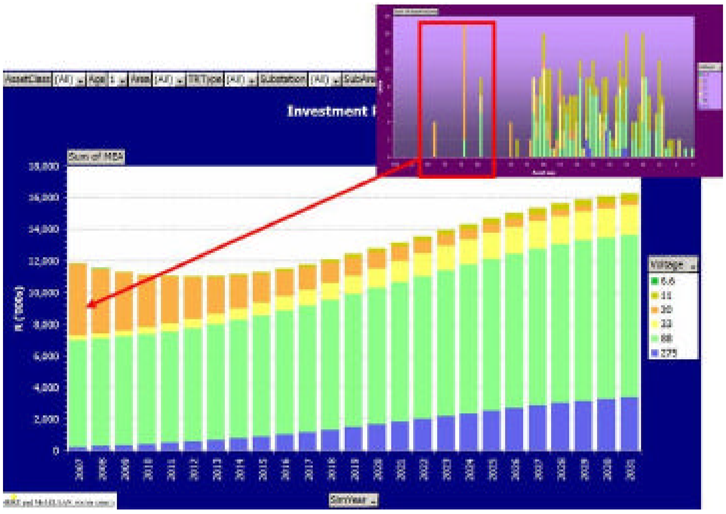


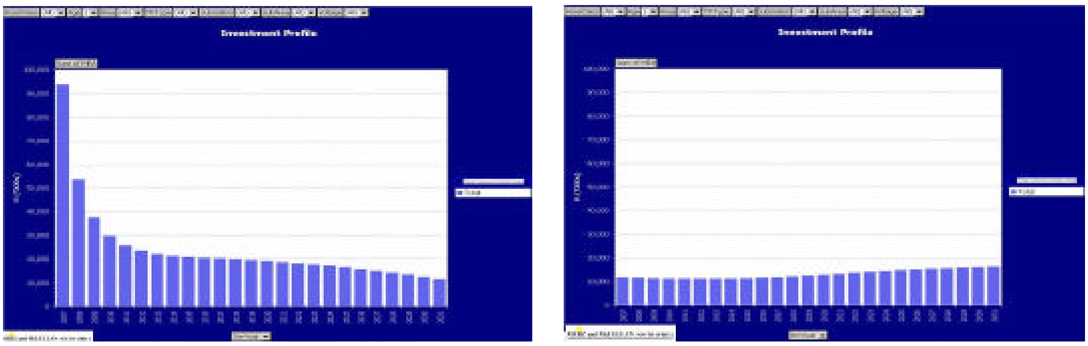
Diagram 5 shows the Investment Profile for the Asset Class of Transformers for a South African utility. The profile shows a present backlog of refurbishment being units still in service that have now entered the "Risk Zone". (Refer inset) This does not mean that the units are unsafe or that a catastrophe is waiting to happen, but is does mean that the units should be inspected, their condition verified and the appropriate action initiated.

If this type of modelling has been used in the budget preparation, funds would be available to order the replacement if required.

The Financial Implications of the "Mean Asset Life"

I refer you back to Table 1 where the different "Mean Asset Life" is compared to various conventions; the next few diagrams will show how these various figures impact on the refurbishment budget.

Diagram 6 & 6b



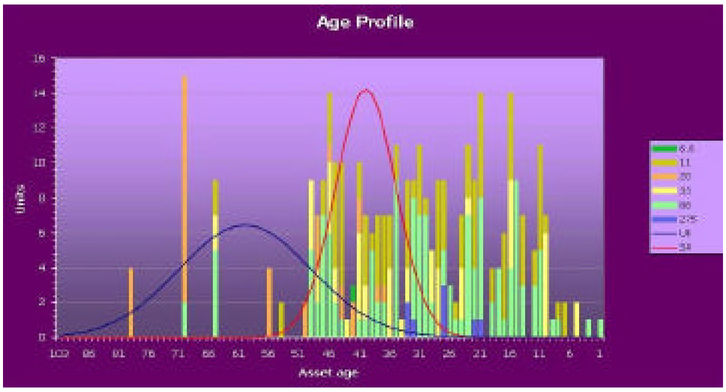
Here you can see that there is a large backlog due to the shortening of the asset life, over R180 million in refurbishment cost over 2007 – 2009, whereas Diagram 6b, shows the same assets but using the longer assets life's applied in the UK. The refurbishment cost is now reduced to R30 million over the same period.

This a reduction of R150 million in one asset class in one utility.

There are 187 utilities of various sizes in South Africa.

It estimated that the replacement cost of the Transmission and distribution networks in South Africa is around R100 billion. If we assume this figure is correct the refurbishment cost of the network will be R1.4 billion per annum.

Diagram 7



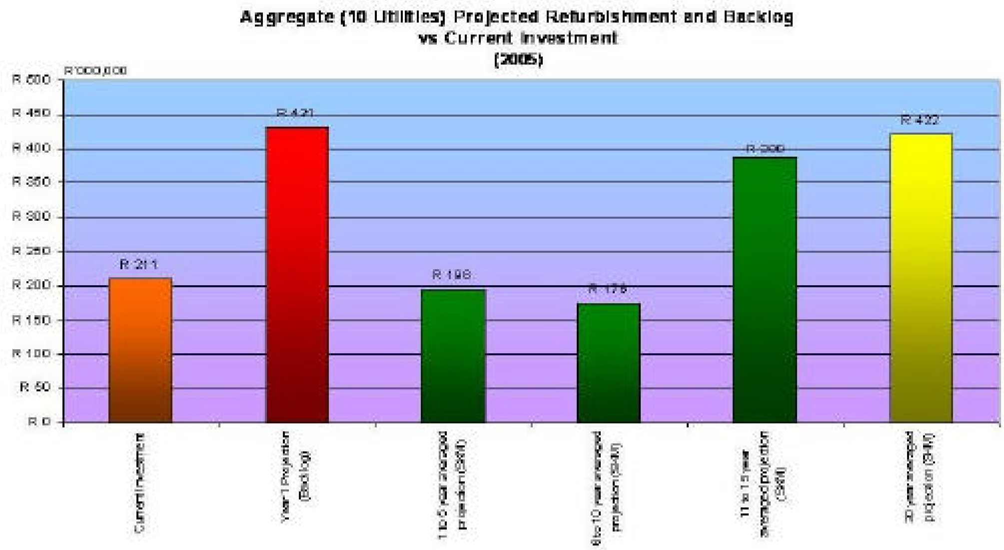
Here the assets under the different curves can be seen clearly and from field experience it is clear that these assets do not need replacement. This data has been taken from age information for the utilities power transformers, supplied to us, up to and including data for 2005.

Diagram 8

Diagram 8 now shows the revised investment profile with more realistic asset life's which in a refurbishment budget that is now affordable. The backlog no longer exists and the refurbishment has been spread over a longer period. Some might argue that this is a distortion of the facts, but if you have assets presently on your system, in good condition and providing the performance required, why replace?

As can be seen from the previous slide refurbishment of the network is critical to the sustainability of the network, quality and security of supply, and that this a necessary cost. To put this cost in perspective we have compared the amount spent in South Africa to the amount spent by Australian Distributors operating similar networks.

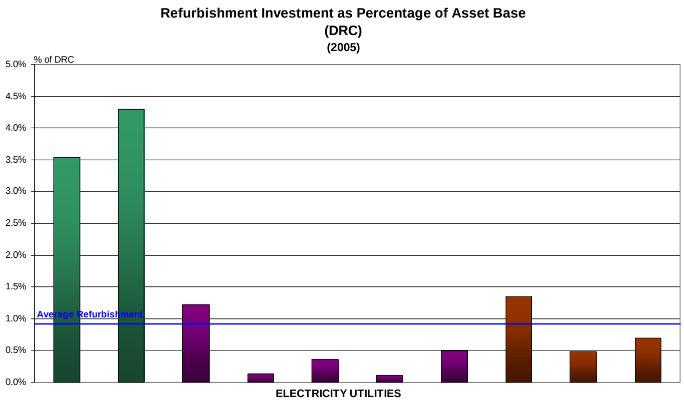
Diagram 9



Column 1 is the current investment ; **column 2** is the backlog; **column 3** 1-5 year projection; **column 4** 5-10 year projection; **column 5** 11 – 15 year projection **; column 6** 30 year projected investment

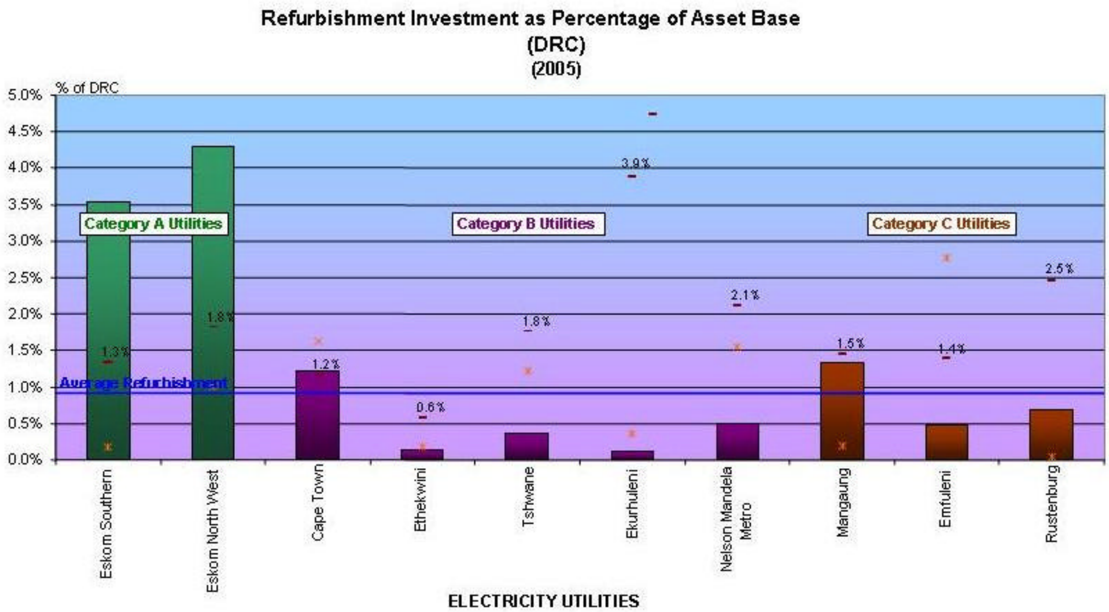
Diagram 9 shows the current refurbishment investment of 10 South African Distributors, the backlog, being the amount of assets that have reached or passed their mean average life date. The diagram also shows the expected investment based on the Asset Profile data supplied by the various distributors. The near future is not so bad but the “Tsunami” is just over the horizon.

Diagram 10



As can be seen in Diagram 10, out of the ten South African distributors 2 are over-investing, 2 meet the national average and 6 under spend considerably. If we remove the 2 overspending distributors the South African average will drop significantly. The important issue is then, the difference in the relative spend of South Africa and Australia.

Diagram 11



As can be seen in Diagram 11 the percentage of refurbishment spent by some of the major Distributors/Metro’s/Municipalities is well below the accepted international norm.

The Role of the Asset Manager – Sicelo Xulu

Data Management

One of the most difficult situations we have been faced with is our data, its format, reliability and storage. As City power has been formed from a number of autonomous municipalities, the data was in different formats and the conversion to a single format was always a task that was deemed to be non critical, hence it was never done. Furthermore the emphasis on new projects has been speed in the delivery of the service rather than data formatting.

Now we are faced with the huge task of collating all the data from the various sources, transferring it into a common format that all departments can utilise without having to build their own databases in order to store the information needed within their own department.

It has become obvious to us at City Power that we have the information somewhere within the organisation but where?, is normally the problem. We have realised that a huge amount of our resources have been wasted researching, gathering and storing information that is duplicated elsewhere. Hence we have now revised our organisation in order to ensure that the emphasis is given to the importance is of IS (Information Systems) and a senior person is dedicated to the management of all the data and asset management.

Condition assessment

There are a number of schools of thought on the assessment of the "life" of an asset.

Some base the life on the manufacturer's recommendations. As can be seem from the earlier part of this paper, experience has shown us that this is in most cases too short a period.

Then there are those who rely on the service conditions and de-rate the life depending upon the stress that the asset is deemed to cope with whilst in actual service and there are others that measure the performance.

In truth the real answer is combination of four:

The age of the asset
The condition of the asset
The service conditions
The performance of the asset

In the past we placed our decisions on one or perhaps two of these various indicators but never a combination of all four.

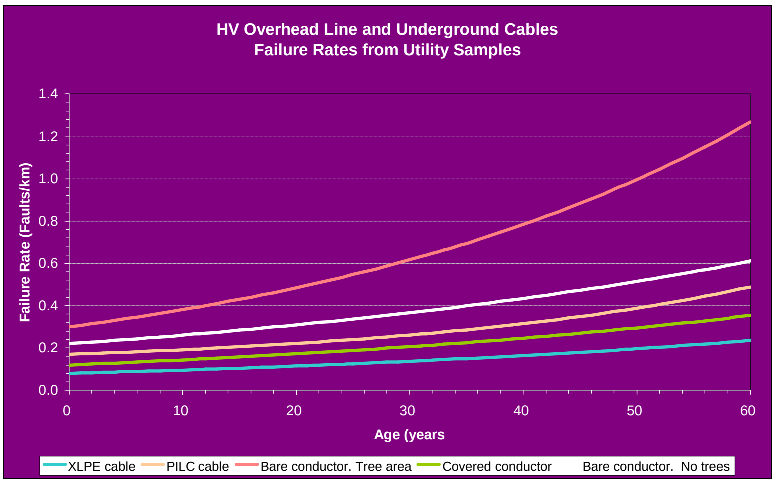
Fault recording and analysis

As mentioned above condition assessment is critical to the decision regarding the asset life. In the case of transmission assets, this is a relatively easy process as the number of assets are relatively few, easily recognisable and identifiable.

In the case of distribution assets this is not so easy and another means of assessment needs to be used. Experience has shown that if the fault data is complete and the fault assessment is meaningful this data will provide a good indication of the actual condition (deterioration) of the particular asset i.e. cable, transformer or switch. We have not completed the installation of this aspect of the model as we have not collected and verified all our fault data. i.e. An outage due to a truck demolishing an overhead support structure or a contractor digging up a cable are not condition related faults and must be treated differently for record purposes.

Diagram 12 shows the outputs that we will generate in the future

Diagram 12



The picture above shows the failure rates extracted from a utility asset management system by correlating historic records of asset failures and their ages. The results are presented for HV overhead line and underground cable. In the case of overhead line the results from the sample are broken down between overhead lines using covered conductor and bare conductor with the latter being subdivided further between the lines running through areas with vegetation and those without. The results for underground cable were split between the XLPE and PILC types.

These curves are then used as input parameters in the expenditure planning tool to examine the optimum strategy to achieve certain Quality of Supply targets imposed by the regulator. The expected evolution of the failure rate under several asset replacement scenarios are used in combination with other measures such as sectionalisation and network automation to achieve the targets at minimum overall cost. Several alternatives can be examined such as the increased use of covered conductor, partial undergrounding and even the “do nothing”. The model is then used to establish the relationship between the cost and benefits of increased quality of supply and demonstrate the merits of the preferred QoS target for the utility.

Criticality

Despite this analysis there are always the exception to the rule and we have to consider the relative importance of the various circuits within the City Power network.
The CBD, hospitals, strategic installations, airports and IT centres. Although these normally have some sort of backup supply, service interruptions are not desirable.
It is therefore essential that these various system requirements are part of any modelling that the Asset Manager undertakes in the course of the replacement or refurbishment analysis.

Modelling and scenario planning

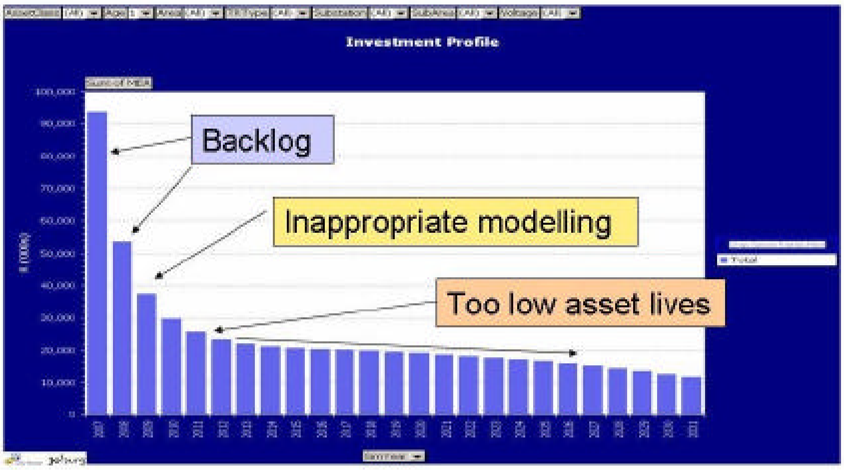
Analysis

During this phase of the modelling process it is essential that the data is verified and the errors in the data caused by incorrect input or source information are rectified before any analysis takes place. To the trained eye most of these errors are quickly identifiable and action can be taken to rectify the situation.

Peaks and smoothing

Once the outputs are verified then the initial analysis can take place and any peaks in the outputs need to be investigated and smoothed where possible.
Peaks are often caused by unrealistic asset life data being used or they can be caused by backlogs. Backlog replacement can be spread over a few years providing the asset condition and performance criteria allow.

Diagram 13

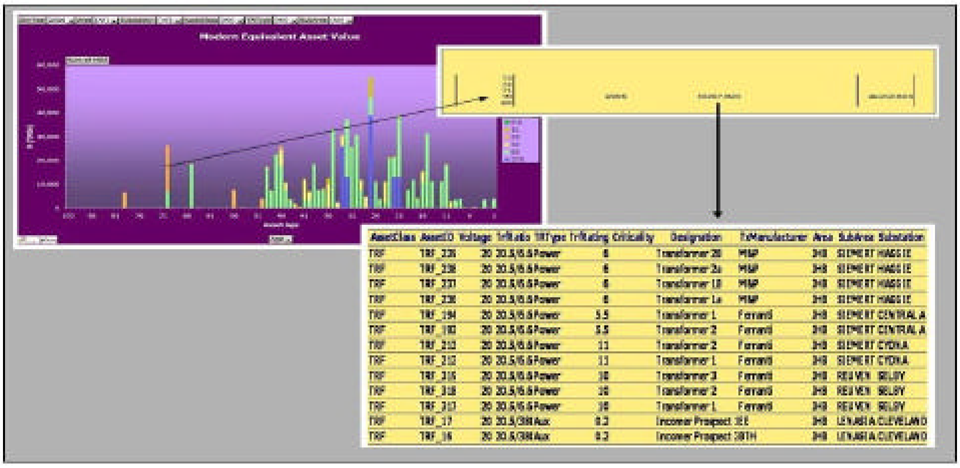


Forecasting

Annual Budget

In past years we have always had the difficulty in convincing the Finance Department and the Management that our financial requirements are vital to the maintenance of the network.
Since the installation of the software we are able to identify our immediate requirements, the critical areas in the near future and then produce scenario's within minutes each showing the results by individual asset in the case of transmission asset and by circuit in the case of our distribution network.
In Diagram 12 the graph shows the age analysis of our transmission transformers, if the asset manager wants to know what individual assets form a particular bar he/she can simply click on to the bar and the value of these units are displayed, a further click on that data and the details of the individual assets are displayed. In this particular instance these are 20kV transformers and will not be replaced like for like. The asset register will reflect that information and that project is budgeted separately, the asset manager can then remove these units from the scenario and that expenditure will then automatically be allocated to the replacement of the next group of assets due for replacement.
These scenarios are generated in seconds so a number of propositions, together with their individual motivation can be assembled, presented and discussed, quickly and efficiently, making the budget process much shorter.

Diagram 14



5 year Plan and medium term forecasting

As can be seen from the attach diagram medium forecasting is far more realistic giving us more credibility with the management resulting in increased support enhancing the efficiency of the company.

The Role of the Asset Manager

As can be seen from the above a great deal of information can be generated by this type of modelling and the interpretation and analysis is crucial to the effectiveness of the decisions we make.
We consider this position to be key to the successful maintenance of our network ensuring we provide the expected quality of service hence we have appointed a senior engineer to manage the assets within the network. His knowledge of the software is important but his knowledge of the network and performance of the individual assets is where the ultimate success lies.

Conclusion

In conclusion it can be seen that the "Mean Average Age" of the asset is critical to the refurbishment budget. Furthermore the "condition of the asset" is crucial in the modelling of network assets.

The management of the network assets is essential and complex, but there are appropriate 'manager friendly' tools to assist us.

Central control of the process, the data management, the analysis and reporting should be the responsibility of experienced asset managers

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Diagrams from the model developed by Dr Floren Castro Sayas, Consultant
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