Managing a utility's assets: new software shows how

Asset management is no longer just about using our people, factories, equipment and processes wisely. Just as importantly, it's about planning for performance and shareholder value over the long haul.

The value of a utility's network assets is typically several billion dollars. Optimizing how these assets are managed is therefore critical to a whole range of business targets, including delivering the best financial returns and improving customer service.

ABB Corporate Research has been exploring asset management processes and how they can be optimized to improve utility performance. AMPS/U – for Asset Management Process Simulation for Utilities – is the new simulation tool it has developed to help asset managers find the best management protocol by simulating different scenarios and counting their cost in profits and customer service.

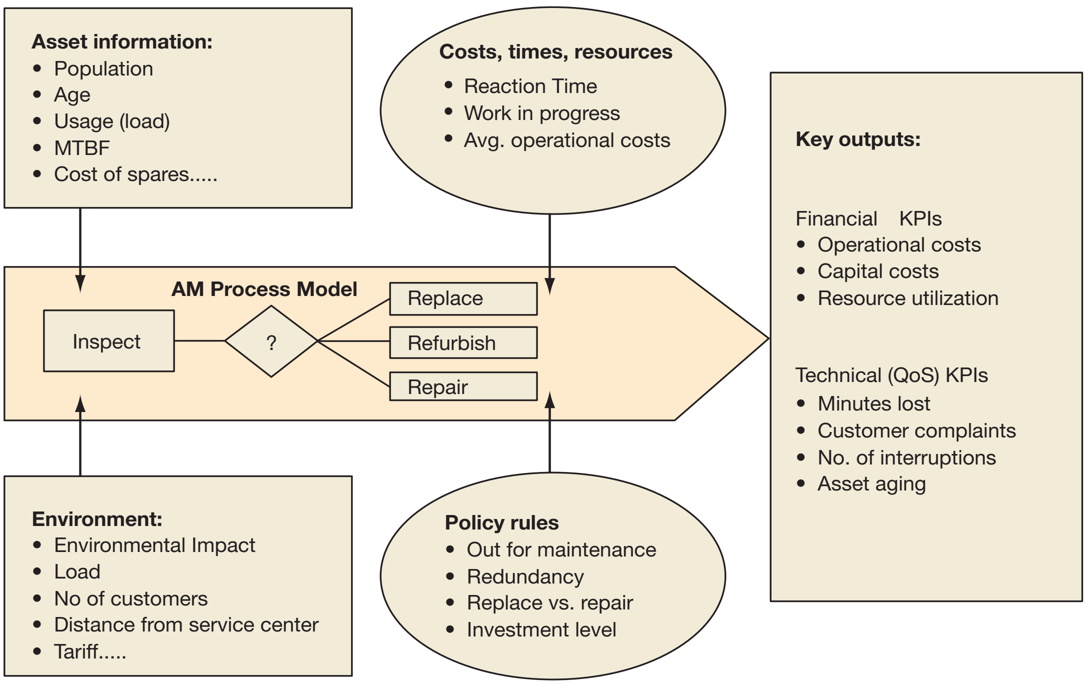
Software solution

The model (see figure 1) is capable of tracing the number and cost of failures, lost minutes and aging assets. Results also allow us to trace process bottlenecks among assets or caused by resource constraints. The performance indicators can be followed globally, for the whole network, as well as for asset clusters or resource pools.

The simulation requires only a small number of data, this although even a small distribution network with about 5000 customers may involve as many as 15,000 assets. The software reduces the input data by grouping the assets under broad process-related categories, like oil transformers.

In addition to the asset data, the model incorporates enterprise resource data, including hourly rates,

1 Data flow in the asset management process simulation model



resource type, processing time, spares availability, asset loading and redundancy in the network. And it takes into account decision patterns, such as a preference by the utility for replacement rather than refurbishment, plus features like the number and types of customers relying on a particular asset.

Events and process actions considered include failures, scheduled maintenance (including inspections), repairs, refurbishment and replacement.

All of these are used to assess a suggested process in terms of capital and operating costs, necessary resources, asset degradation and, most importantly, service quality. Processes can be simulated for periods of six months to 10 years.

The process model makes use of a commercial simulation toolbox, controlled by a user-friendly interface (see figure 2) that allows real-time monitoring of key performance indicators.

The results allow an estimate of some risks for the whole enterprise – such as financial and quality impacts – as the model is able to run multiple simulations and contrast the results. Their statistical significance stems from the fact that randomness and probability-distribution features are used to obtain them.

The product at work

As a simple example let's look at one of the most common assets: customer service. Specifically, we'll look at an overhead line connection (CS-OHL) that includes the nearest pole link, fuses and electricity meter at a residential customer location. Using the model we can study the impact (and cost) of maintenance on the reliability of the asset pool.

The sample simulation results (see table) are for maintenance for the one asset type: CS-OHL, simulated for a period of five years for 3100 assets. The simulation is run for three scenarios representing higher, medium and lower levels of maintenance.

2 AMPS/U user interface

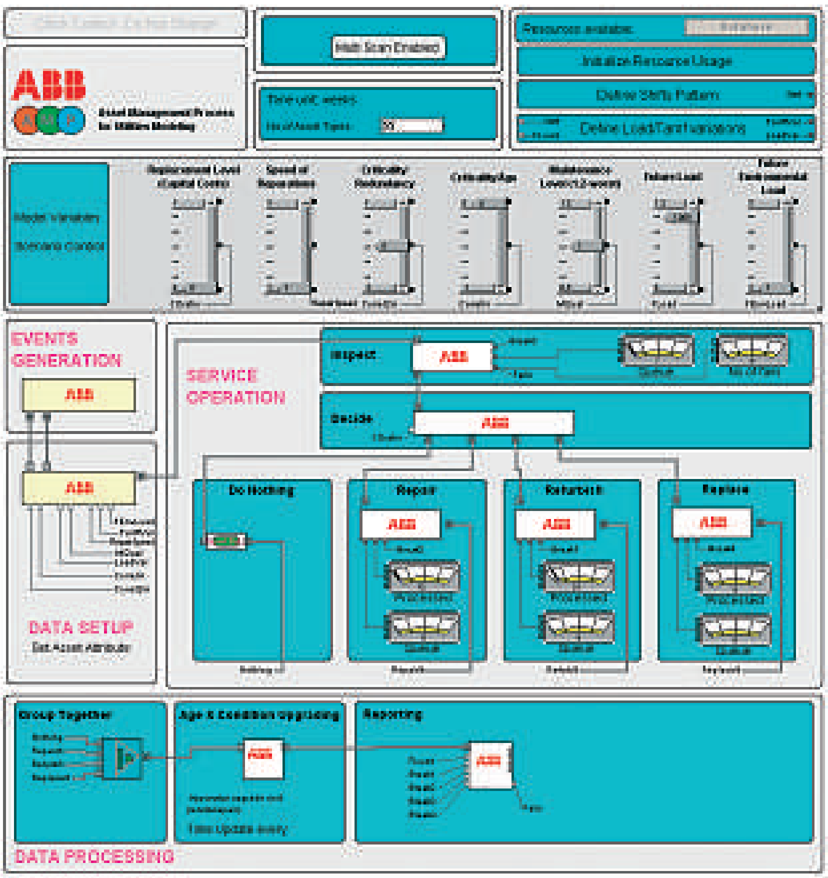


Table
Impact and cost of maintenance intensity on asset pool reliability

CS-OHL	Aging	Costs	No. of faults	No. of replacements
Less	2.073254	40	52	207
Normal	0.776392	66	47	325
More	-0.89843	104	41	476

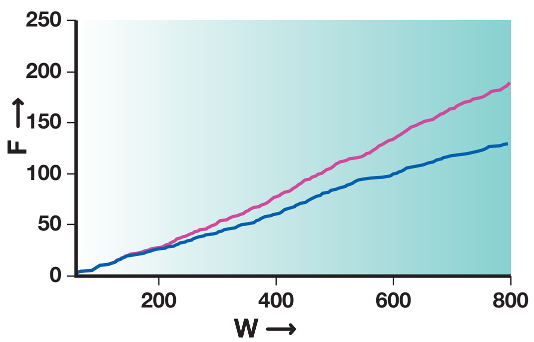
Figure 3 shows the fault dynamics in the CS-OHL population over a 15-year period for two selected scenarios: 'lower' and 'higher' levels of maintenance.

Although the costs rise drastically (about 50%), it can be seen that asset failures in the system decrease by approximately 20%. An optimal maintenance scenario for these assets can now be chosen depending on regulations and priorities. From a long-term (15-year) perspective, the fault rates diverge even more significantly, eventually differing by as much as 30%.

This simple example gives an idea of how the results can be analyzed by asset managers according to their specific interests.

Most interesting are the global performance indicator values, valid for the whole utility and the asset population as a whole. Fast set-up, relatively simple data requirements and a short simulation time make the tool very user-friendly.

3 Number of faults versus time in weeks for two scenarios: 'less' (red curve) and 'more' (blue curve) maintenance



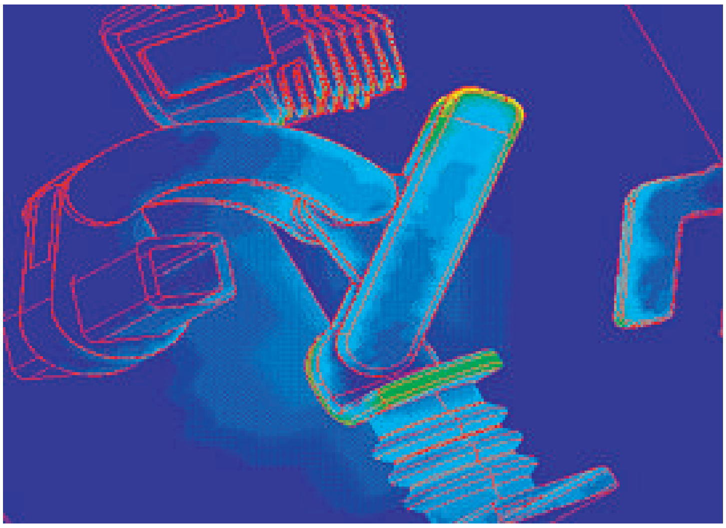
A new dimension in 3-D simulation: MBIT takes ABB engineers to the top of the class

An advanced simulation technology is making engineering design at least three times faster, so products come to market much quicker than before.

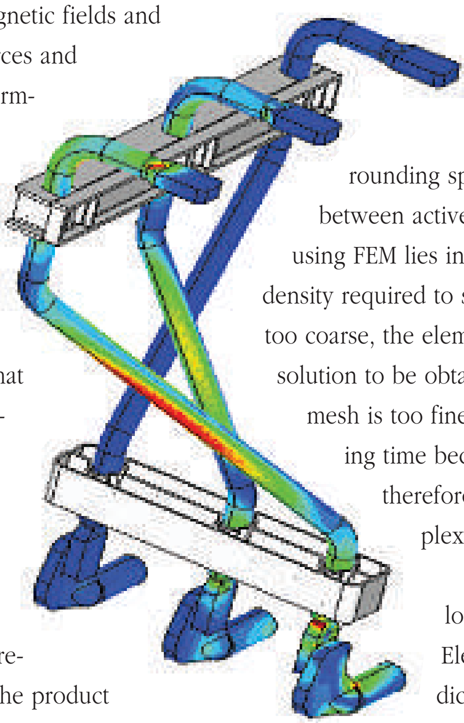
ABB Corporate Research, together with the Swiss Federal Institute of Technology (ETH) in Zurich, has developed a numerical tool called MBIT-POLOPT which enables fast and complex three-dimensional simulations. With this software, a standard desktop computer can perform product simulations that once required at least 10 processors.

Various mathematical methods of solving integral and differential equations have long been used by designers to simulate real product performance. What MBIT–POLOPT does is accelerate this process using fast algorithms – approximations developed by MIT which solve clusters of math problems with no compromise in accuracy.

The result is that simulations can be much more comprehensive. ABB engineers can simulate designs with a degree of complexity that is between 10- and 100-times greater than before. An entire switchgear unit can be simulated, instead of just single breaker components. Or temperature changes in every part of a power transformer can be simulated, rather than those in just one section as previously. And there is less need to build costly models and experimental set-ups while the prototype is being made.



MBIT-POLOPT is already proving useful. For example, it has allowed the design time for high-voltage aspects of MV switchgear in Norway to be reduced by a factor of three. And in testing it has been used to analyze dielectric and thermal designs of ABB products, provide a 3-D simulation of electrical field distribution and stresses, calculate flux distribution and forces in steady-state magnetic fields and calculate magnetic field losses, forces and temperature distribution in transformers for time-harmonic magnetic fields. Tests were performed using a standard desktop computer with 1 Gbyte RAM and Linux operating system. Comparison of the results with those of a mathematical method that does not use fast algorithms, BEM-POLOPT, confirmed the advantages of MBIT-POLOPT.

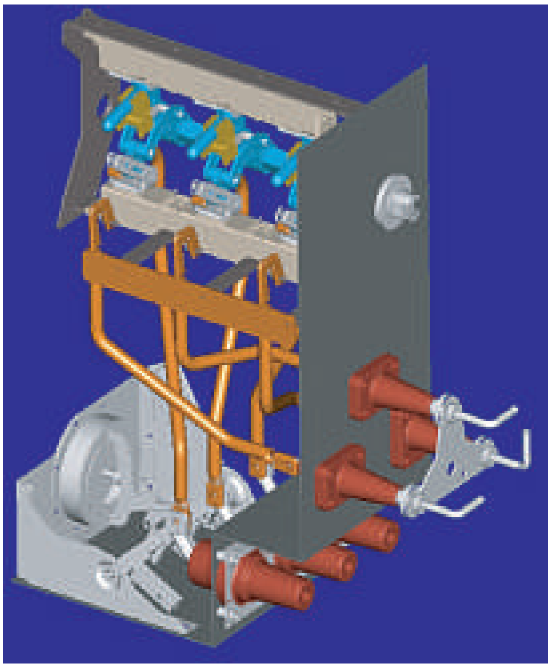


The origins of MBIT-POLOPT

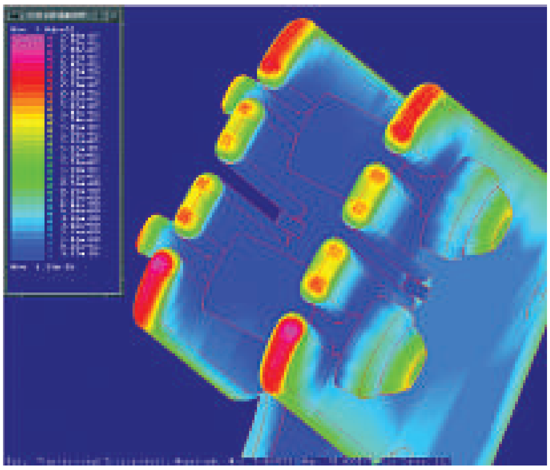
MBIT-POLOPT was developed in response to intense competition in the product development area, and the need to speed up design and move faster to market. To achieve this, engineers must understand the physics of geometrically complex products long before they are built. This means understanding the combined effects of the electrostatic, magnetic and mechanical (fluid) forces governing these products. Normally, this is a time-consuming and challenging computing task requiring careful selection of the methods employed.

Nowadays, most commercially available packages are based on the Finite Element Method (FEM). To use FEM, the geometry of the device in question must be divided into a collection of nodes or elements – a process known as discretization, or clustering. Putting it simply, it's like throwing a mathematical net or 'mesh' over the device. With FEM, the complete device must be meshed, including the surrounding space and insulation media between active parts. Therefore, the art of using FEM lies in choosing the correct mesh density required to solve a problem. If the mesh is too coarse, the element will not allow a correct solution to be obtained. Alternatively, if the mesh is too fine, the cost in terms of computing time becomes unacceptable. FEM is therefore highly unsuitable for complex 3-D geometries.

ABB product designers have long preferred the Boundary Element Method (BEM) for predicting how a product will be-



have in situations that might impact on it. With BEM, only the boundary of the domain of interest requires discretization, reducing computational time considerably. In fact, ABB developed its own proprietary platform featuring classic BEM, known as BEM-POLOPT, to support and accelerate electromagnetic and dielectric tasks and design processes. However,



despite its reliability in simulating forces and interactions among possible events, today's fast-paced markets call for a still-faster tool.

The basis for this new fast tool was developed at MIT, where a team led by Jacob White performed the first numerical implementation of fast algorithms using the already-established Multipole Clustering Technique. They called the achievement, MBIT, or Multipole Based Integral Technique. Researchers at ETH in Zurich, together with ABB scientists, were quick to see the potential of these fast algorithms for product simulation. They found a way to couple MBIT's quick problem-solving with ABB's 3-D simulation platform (BEM-POLOPT) and created the super-fast MBIT-POLOPT.

The power of MBIT POLOPT

MBIT-POLOPT saves on memory because of how computers store mathematical solutions in a simulation. Classic BEM-POLOPT solves huge numbers of integral equations and the computer stores all resulting coefficients as a matrix. This matrix is very dense, requiring vast amounts of memory, and this is what results in the long computing time. But because MBIT-POLOPT approximates the exact mathematical BEM formula and solves clusters of elements in a pre-defined way, it generates a sparse matrix, saving memory and therefore computing time.

Because of this, prototypes can be developed without building costly experimental models.

And ABB engineers can count on the best-available tool for 3-D simulation, allowing them to refine and perfect the most complex of products in record time.