An Introduction to Model-Based Management Of Failsafe Electrical Power Infrastructure

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No matter how good a Scrabble® player you are, you're not going to outwit a super-computer programmed to play Scrabble… just like the world's grandmasters in chess can no longer defeat supercomputers programmed to play championship-level chess.

The reason is simple: both games have a finite number of squares on the board, a finite number of pieces, and a finite number of moves each piece can make. Though it's not a trivial exercise, every possible move – and the resulting counter-moves and counter-counter-moves – can be modeled within the computer as a meticulously-crafted "logic tree."

So whatever move you (as the opponent) elect to make, the computer has already taken it into account, and has its responding counter-move ready. Although it seems to you to be a dynamic, fluid game, to the supercomputer, it's a rote series of very predictable static processes.

In the case of Scrabble, such a supercomputer would be programmed with all 20,000+ pages of the Oxford English Dictionary… giving it the world's most formidable vocabulary, totaling more than 616,500 words and 350 million combinations of letters. It would have hundreds of millions of combinations of words it could play anytime, anywhere on the game board; and – since a supercomputer can process all of its options in a few hundredths of a second – its response time is instantaneous.

So, while you think you are cleverly playing words like "energy" (worth 10-30 points) the supercomputer is waiting to play worlds like demythologizers (up to 1682 points), benzoxycamphors (up to 1830 points) or singhiozzerebbe (up to 2118 points.)

In short, you wouldn't have a chance… but the good news is that your torment wouldn't last long, either.

The Perfect-on-Paper Power Systems Model

What does this have to do with power systems modeling? Potentially, a great deal.

Think of your power systems CAD model as being the power systems equivalent of that Oxford English Dictionary, but written by the most brilliant electrical engineer you could find: it's brimming with all of his or her about all of the equipment, components, and operating specifications they selected for inclusion in your electrical power infrastructure.

Everything he or she knows about how which components to use, how they are connected to the systems, breaker settings, etc., is all codified in the power systems model… which, like the Scrabble game, is a finite facility, consisting of a finite number of components, operating with finite specifications for each.

Therein lies the problem, and the opportunity: as detailed as the finished power systems model is, it is merely *static knowledge*. Like the dictionary that never gets read and retained, the electrical engineers design intent remains stored as an electronic CAD file, long after the facility is physically constructed. Like that unread dictionary, his or her design intent becomes a competitive advantage that is never put to use in the real world.

But what if all of that static knowledge could be repurposed, in "live mode" and applied to the dynamic conditions of a live operating environment?

Introducing Analytics

Complex analytical models are all around us. They perform highly sophisticated analyses of mind-boggling scenarios – like FICO scores, data mining, and even potential atmospheric conditions – to make astonishingly accurate "predictions" about future events.

Their goal, of course, is to optimize operations (e.g. process a large number of credit applications to determine applicants' credit-worthiness) while preventing undesired outcomes (e.g. a mortgage company lending a princely sum of money to someone who is likely to default.)

But in the case of electrical power infrastructure, Power Analytics applies expert knowledge – in this case, the domain expertise embedded into the model by the electrical engineer designing it – and continually compares it to the live, on-line operations. This is achieved exclusively through the combined use of two products in the Power Analytics Paladin® family:

- **Paladin® DesignBase™** is the industry's most powerful and productive CAD modeler for the design, simulation, and analysis phase. Consisting of more than 50 integrated programs – the most extensive offering in its class – Paladin DesignBase helps to ensure that a power system is optimized before construction, by validating operational system performance at both the macro- and micro-levels.

- **Paladin® Live™** takes the DesignBase model and re-deploys it in "live" mode, continually probing for deviations between the "as-designed" system specifications and actual operating parameters. The instant the slightest deviations are detected, they are rigorously diagnosed… alerting facility staff to the nature of potential problems that could ensue, and their resolution.

Working together, the Paladin DesignBase model and Paladin Live are in constant communication with one another, checking thousands of measurements throughout the electrical power infrastructure every second.

Using the DesignBase model as its benchmark – and because Paladin Live analyzes system performance on such a deep level – it generates a wealth of vital operational information about system health, reliability, capacity, and energy efficiency to guide facility planning.

This embedded expertise reports precisely how well the facility is operating, how much capacity is remaining, and the overall health of its power infrastructure.

It is the world's only software application in which the original CAD model is redeployed in a live environment, to continually calibrate actual and as-designed specifications. As a result of this synergistic approach, facilities enjoy an unprecedentedly high level of reliability and manageability, while minimizing energy and operating costs.

Outthinking Power Issues Before They Make Their Move

In short, Power Analytics is a lot like the Scrabble-playing supercomputer; only this time, the computer is on your side, preempting power problems and inefficiencies before they can make their move against you. This "model-based" methodology achieves two immediate benefits for users:

1. It eliminates the need for hard-coding or customization: Paladin Live comes on-line having already assimilated all of the raw information contained in the Paladin DesignBase model, aggregating the expert knowledge of the system designer, component specifications, and all other operational information.

2. It enables facility personnel to be both aware and fully-informed the instant conditions are ripe for anomalies to occur; thus, it enables them to take whatever action is necessary to preempt conditions from reaching the "problem" stage.

But how is the static data actually synchronized with live data? Paladin Live uses a methodology called "Predict, Prevent, Present" – in which the system maintains an uninterrupted, 360° view of electrical power infrastructure. It is constantly examining, testing, validating, and learning about the integrity of all internal components, in order to accurately:

- **Predict** Learn to identify conditions that precede power failures
- **Prevent** Isolate impending point-of-failure
- **Present** Report potential problems and recommended actions to owner/operator

The term "learning" is not used lightly: Paladin Live is now in the process of incorporating a first-of-a-kind "neo-cortical pattern/sequence recognition" technology called HTM, enabled by a new type of machine learning called "associative memory." Developed in cooperation with Numenta, Inc. (Menlo Park, Calif.) this new capability will enable Paladin Live to literally learn via "on-the-job-training," amassing extremely broad and deep expert knowledge regarding everything it observes about a site's operations.

Once completed, this will enable the system to display "experiential learning" – in which future events become predictable by virtue of past Paladin Live observations and aggregated knowledge.

For example, after intelligently assimilating knowledge about alarms, it can ultimately master the pattern and sequencing of alarms, in order to accurately predict the location of impending failures, their context, and even their cause.

Summary

For those who are passionate about the integrity of their electrical power system design, Power Analytics creates an intriguing two-fold opportunity: the opportunity to design a "Perfect on Paper" project... and then, the chance to make that design become the basis of a "living model" that protects the facility they worked so hard to create.

Users who have invested hours and hours into the development of their designbases are on the verge of an exciting new era: the opportunity to see firsthand how their once-pristine electrical system designs are performing in the harsh, real-world environments. And, more importantly, to identify any threats or inefficiencies that would prevent their infrastructure from operating at optimum levels.

It's like the sports coach who relishes designing ingenious new plays on paper… and then gets to witness their effectiveness in a live game environment against their most formidable rival.

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