Semaine d'Étude Maths-Info Entreprises (SEMIE)
Schneider Electric Subject Proposition
Electro-Technical Assets Ageing Models

"Is it possible to design an ageing model for electro-technical products, leveraging one, several, or combination of specific characteristics?"

Context

It exists a large bibliography on ageing models for electronic devices. But for electro-technical assets (circuit breakers, power transformers, contactors, switches, power lines…), up to now no general models are yet available and proven to be representative.

Objective

Schneider Electric is looking for a fresh perspective on *Electro-technical Assets Ageing Models*.

The objective of the proposed research subject is to complement the 3 years-long existing effort on corrosion driven in cooperation with the Department of Probability and Statistics in "Laboratoire Jean Kuntzmann".

Scientific panorama

In the Electro-Technical world of today, we can classify assets along two different categories.

Asset Type

- Dynamic: most of the time, these assets are in operation, until a failure may prevent them to operate according to their mission and requirement (e.g. power transformers, switches, contactors….). For these dynamic assets, we usually are able to access operating data and measurements, such as speed, torque, or number of operations per time unit. From these historical data, when available, we can derive some educated guess about ageing.
- Static: most of the time, these assets are not operating, until some critical event triggers their operation (e.g. circuit breaker). Usually, these are safety devices. For these static assets, we usually have very few or no data from the asset itself.

As an analogy, let's consider the example of a car: most of its components are dynamic (engine, wheels, brakes, …), and some are static (airbag).

Ageing factors

We can consider a general perspective on ageing factors, split in three families:

1. Material: ageing will depend on the asset's material characteristics. For example, on high-end cars, the brakes' material will be ceramic, which will withstand a higher number of operations than the brakes which equip regular cars.
2. Environment: these conditions include temperature, hygrometry, pollution, vibration… The

asset ageing will depend on the level of these various external parameters. Thus, operating an asset under a tempered climate, or in the middle of Sahara, or Polar Arctic circle, will drastically change the ageing.

3. Solicitation: the way the asset is operated (once a year, or 100 times a day) in its applicative context, will also impact its ageing. We can consider the example of a car, for which the drivers' style (race or quiet) will largely impact the wear of tires, brakes, oil, …

Heads up

Literature is full of partial and specific ageing models, based on mechanical, electrical, or endurance data and models. Our expectation here is to try a synthetic approach combining the various factors, to derive a realistic ageing indicator, more representative of real conditions and of a real business needs.

In a nutshell: our problematic is the following: "*Is it possible to design an ageing model leveraging one, several or combination of the above-mentioned characteristics?"*

Business Stake and success factor

From a business perspective, a success measure of this effort will be, the same way you have a simple dashboard in a car, to have a "Green/Orange/Red" gauge to describe the global ageing of the assets of the Electrical System, and therefore allow estimating the need to call urgently the maintenance team.

Moreover, if you consider that our modern life hugely relies on energy then you can understand that the availability of the underlying electrical distribution system required to energize our buildings, plants, homes, schools is critical. This electrical distribution system is made of electrical, electro technical, electronics components we need to be able to monitor in order to foresee any failure putting at risk critical systems such as in Hospitals, Nuclear Power plants, etc.

That's why the better we are in predicting equipment's end of life the safer our life will be.

Information and Data Sources

- MILitary HanDBooK MIL-HDBK 217 (version F)
- Non-electronic Parts Reliability Data (NPRD)
- Offshore RELiability DAta (OREDA database)
- FIDES imitative
- IEC ageing standards (IEC 60076-12 on dry power transformers, IEC 60076-7 on oil immersed power transformers….)
- EN ISO ageing standards (EN ISO 11844-1 on corrosion….)

Elements of bibliography

- Accelerated degradation tests with successive measures - M. Abadie, M. Chevalier & al. – Accelerated Life Tests, Pau, June 2014

- Offre MP4, http://www.sepem-industries.com/salon-permanent/produit-conseil-et-expertise-%E2%80%93-offre-mp4-id594-par-schneider-electric-1806.html#.UqbcgtLuJHQ
- Offre MP4, http://www.schneider-electric.ca/sites/canada/fr/produits-services/services/services-conseil-mp4.page
- C. Cocozza-Thivent, Processus stochastiques et fiabilité des systèmes, Springer-Verlag, 1998 ;
- Pages Alain et Gondran Michel, Fiabilité des systèmes, collection de la Direction des Etudes et Recherches d'Electricité de France, Eyrolles, 1980
- A. Rauzy, Y. Dutuit, J.-P. Signoret, M. Chevalier, I. Morlaes, A.M. Lapassat, S. Combacon, F. Brugère, and M. Bouissou, Arbres de Défaillances et Diagrammes Binaires de Décision, In Actes du 1er congrès interdisciplinaire sur la Qualité et la Sûreté de Fonctionnement. pp 47–56, 1994
- A. Rauzy, Y. Dutuit, J.-P. Signoret, M. Chevalier, I. Morlaes, A.M. Lapassat, S. Combacon, F. Brugère, and M. Bouissou, Computation of Prime Implicants of a Fault Tree within Aralia, In Proceedings of the European Safety and Reliability Association Conference, ESREL'95. Bournemouth – England. pp 190–202, June 1995.
- J.-P. Signoret, M. Boiteau, A. Rauzy, and P. Thomas, Disponibilité de production: les nouveaux outils sont arrivés, In Actes du congrès LambdaMu'14. October, 2004
- Y. Dutuit, A. Rauzy, J.-P. Signoret, and P. Thomas, Disponibilité d'un système en attente et périodiquement testé, In Actes du colloque Qualita'99. pp 367–376, 1999
- C. Folleau, Reliability-Centered Development of Deep Water ROV ROSUB 6000, Marine-Technology-Society-Journal, pp. 55-71, Mai/Juin 2013
- M. Chevalier, L. Buchsbaum, N. Argaud : « Shortcut from electrical networks to Petri nets », Congrès Qualita 2015
- M. Chevalier, L. Buchsbaum : « MP4 : une méthode pour optimiser le capital industriel », Lambda-mu 19 (Dijon).

Contact Point

Mr. Marcel Chevalier
Schneider Electric
Technology / Analytics Application & Programs
37, Quai Paul-Louis Merlin
38050 Grenoble Cedex 09
Work Phone: +33 [0] 476 822 982
Mobile: +33 [0] 608 707 895
Internet Address: Marcel.Chevalier@Schneider-Electric.com