Forewords to the Special Edition

It is not enough for an algorithm to do some cute analysis – it also has to do no harm.

The phrase "caveat emptor" is an old Latin aphorism meaning "Let the buyer beware." But how can you guarantee what you are buying will do what it is supposed to do? And if it does not perform as expected, then who is at fault? Machine Learning and Artificial Intelligence (ML/AI) systems often make great claims about the effectiveness and ability of algorithms and applications – from self-driving cars to investment analyses. But we need to look beyond the hype and the successes to set and measure expectations.

As journalist John Naughton noted in an Observer article on September 6th, imagine if pharmaceutical companies were held to the same standards as tech companies. The drug development process would consist of dreaming up a new molecule, showing some dramatic results in clinical trials and then launching a drug onto the market. Who would be interested in a COVID-19 vaccine which prevents the disease, but may cause harm in other ways?

With ML/AI there is an analogy with the food industry in the United States. The Pure Food and Drug Act of 1906 was enacted to ensure that food product ingredients were of adequate quality, but the later Federal Food, Drug & Cosmetic Act of 1938 required that food products demonstrate safety before they were sold. For ML/AI systems we are in a similar situation. While we may be able to show that the algorithms are well constructed and provide possible benefits, can we show that they do no harm?

Applying advanced ML/AI systems requires care and forethought – what are the expectations? After all, we are using historical data to try and predict the future. Does this even make sense when more than 90 % of the benefits of ML can be extracted through data cleansing and standard statistical tools? Any ML/AI algorithm could act in unexpected ways – and if the algorithms are not clear and transparent, the reasons for the anomalous performance may be impossible to identify and correct. Doble's Asset Health Index system, for example, relies on standards and guidelines for diagnostics and failure mode identification with benchmarking against millions of test results to identify true anomalies and outliers.

To quote Warren Buffet from 2009, discussing models used in the financial crisis:

"Constructed by a nerdy-sounding priesthood using esoteric terms such as beta, gamma, sigma and the like, these models tend to look impressive. Too often, though, investors forget to examine the assumptions behind the models. Beware of geeks bearing formulas."

When considering ML/AI systems, set expectations, look for transparency and logic, ensure that safety is demonstrable and be skeptical of grand claims. Remember that Latin phrase, "caveat emptor."

Dr. Tony McGrail, Doble Engineering Company

Digitalization, along with decentralization and decarbonization, is one of the three trends (3Ds) impacting the global energy sector. Because of their strategic importance in electrical networks, transformers will be a focus of international efforts in power asset digitalization, hence this special edition of Transformers Magazine.

CIGRE recognizes the importance of this topic for the electrical industry. In 2020, it created an advisory group within its Study Committee A2 (transformers) with the objective of developing a vision and a strategic road map with regards to transformer digitalization.

It is generally acknowledged by CEOs that the digital shift will significantly impact the power industry. However, digitalization strategies have to be properly executed in order to yield maximum benefits. All the essential elements of the digitalization value chain must be correctly implemented in a cybersecure manner, namely: data acquisition (i.e. sensors, IEDs, maintenance records, and design characteristics); data validation and storage; computational intelligence (i.e. anomaly detection, diagnostics, and prognostics); user interface (HMI); and last but not least, actionable information.

To support this transformation, the international transformer community should identify the processes in the transformer lifecycle that could benefit the most from digitalization and then define the priorities for future developments. Ongoing research and development activities with regards to advanced analytics (physical, statistical, artificial intelligence or hybrid modeling) will provide new opportunities to valorize the large amount of available data.

Looking ahead, digital transformation will foster the development and implementation of asset digital twins. This is another case where transformers will likely be identified as one of the top priorities. Simulating the multiphysical (thermal, dielectric, and mechanical) behavior of transformers in real time and integrating digital twins in utilities operation and maintenance systems will require an incredible degree of collaboration between manufacturers and utilities, as well as academic and research institutions. Working in silos is definitely not an option in this case. In order to carry out a successful digital transformation, the power delivery industry must work together like never before.

Dr. Patrick Picher, Hydro-Québec's Research Institute IREQ

Power and energy businesses are going through a digital renaissance. Ever-decreasing cost of computer hardware coupled with their ever-improving reliability, continuously lowering barriers for developing more efficient software and a rapid growth in machine learning frameworks is opening new doors for transformer manufacturers internally and externally. Internally, digitization is paving the way for improved manufacturing practices. Manufacturers are finding new ways to leverage data in many areas, such as, improving quotation systems, standardization of transformer designs, optimizing transformers for cost and performance etc. Advancement in sensor technologies is helping manufacturers develop new quality control methods. Software solutions leveraging these new techniques can help transformer manufacturers improve quality, reliability, delivery times, inventory costs, rework costs and overall bottom line.

Externally, digitalization is changing the inspection landscape. Increased availability of wireless technologies and the upcoming 5G standard growth will boost the penetration of digital transformer products. Digitalization can help customers to closely monitor their assets and open new frontiers of predictive and prescriptive maintenance. Utilities and industrial customers alike can leverage the asset data to optimize system performance based on the asset data and further drive down the operations and maintenance costs. In many ways, this can prove to be a paradigm shift: moving from preplanned, time-based or reactive maintenance to a proactive condition-based maintenance of assets. The importance of using asset health data for optimizing system reliability cannot be understated.

The wide-ranging discussion in this issue of Transformers Magazine provides a perspective into how the transformer industry can leverage digitization and digitalization to build products for the future of the power grid. We sincerely hope that you enjoy reading this issue and the great work done by our authors.

Jaydeep Deshpande, Eversource Energy

Patrick Picher

Patrick Picher has been working as a researcher and project manager at the Hydro-Québec's Research Institute (IREQ) since 1999. His research interests are mainly focused on diagnostics, monitoring and modelling of power transformers. Since 2003, he was involved in several international CIGRE working groups related to transformer Frequency Response Analysis (FRA), thermal modelling, intelligent condition monitoring, condition assessment indices and the influence of geomagnetically induced current. He was Secretary of CIGRE Study Committee A2 (transformers) from 2010 to 2016 and he is now the Canadian representative on this committee. He graduated from Sherbrooke University, Canada, in 1993 with a B.Eng. in electrical engineering and received his PhD degree from École Polytechnique de Montréal, Canada, in 1997. Mr. Picher is a registered professional engineer and a member of IEEE (Senior Member), CIGRE and IEC TC 14 (Canadian mirror committee).

Humberto Moreno Paramo

Humberto Moreno Paramo obtained a diploma in Electrical Engineering at Univerdad de Guanajuato. He has had eleven years of experience in different kind of transformers: distribution and medium power transformers, as well as dry and oil immersed. He is currently working as an Electrical Designer Specialist for cast resin distribution transformers in Siemens Gas & Power S.A. de R.L., a factory located in Mexico.

Tony McGrail

Dr. Tony McGrail of Doble Engineering Company provides condition, criticality, and risk analysis for substation owner / operators. Previously, he has spent over 10 years with National Grid in the UK and the US as a substation equipment specialist, with a focus on power transformers, circuit breakers, and integrated condition monitoring, and has also taken on the role of substation asset manager identifying risks and opportunities for investment in an ageing infrastructure. McGrail is a Fellow of the IET, past-Chairman of the IET Council, a member of the IEEE, ASTM, ISO, CIGRE and the IAM, and a contributor to SFRA and other standards.

Ashkan Teymouri

Ashkan Teymouri was born in Zanjan, Iran, in 1993. He received the BSc degree in electrical engineering from K. N. Toosi University of Technology, Tehran, Iran, in 2015. He also received the MSc degree in electrical engineering (power systems) from Amirkabir University of Technology (Tehran Polytechnic), Tehran, Iran in 2017. Currently, he is a PHD candidate in electrical engineering (high voltage engineering and power systems) at Amirkabir University of Technology (Tehran Polytechnic), Tehran, Iran. Mr Teymouri has also collaborated with the Iran Transfo Company, Zanjan, Iran since 2017.

Robert L. Middleton

Robert L. Middleton was born in 1948 in Winnipeg, Canada. He received his degree in Electrical Engineering from the University of Manitoba in 1971. He is a registered professional engineer in the Province of British Columbia. He has an extensive background in generation and transmission engineering including quality assurance. He has served on several CSA, CIGRE and IEC working groups and co-authored numerous technical papers. Mr. Middleton is presently the Chief of Technology and Engineering for RHM International, a manufacturer of high voltage dry-type current transformers, bushings, and cable terminations. Prior to joining RHM International he worked over 40 years at two western Canadian provincial electrical utilities.

Jaydeep Deshpande

Jaydeep Deshpande currently works at Eversource Energy as a Program Manager, Substation Analytics. He leads analytics, machine learning and AI initiatives to support various parts of the business. Prior to Eversource, Jaydeep worked at ABB as a R&D Engineer in the transformers business unit.

Pedram Elhaminia

Pedram Elhaminia is currently the managing director of Enerjan Co., the consultant company of Maschinenfabrik Reinahusen Co. in Iran. He has been working in the transformer industry for 7 years in different areas including transformer design, transformer maintenance-repair, transformer accessories and transformer monitoring and digitalization. Mr. Elhaminia holds a PhD in electrical engineering, with the PhD thesis on wind turbine transformer design and 8 publications in the field of transformers.

Girish Jois

A technocrat with over two decades of experience from automotive, aerospace and energy industries, worked at varying positions in engineering, technology, consulting and business. Girish Jois is currently working as Digital Transformation Specialist and PMO at SGB SMIT group, a dedicated transformer manufacturer from Europe. With his previous international expertise in renowned manufacturing and consulting companies in Product Development, Information Technology and business areas, he helped companies to develop competitive advantage by applying digital technologies to solve business problem . He has championed the cause of creating value by integrating digital twin, system engineering, product complexity management, and knowledge-based engineering solutions.