Special Issue on Robust Design and Reliability of Power Electronics, IEEE Transactions on Power Electronics, May 2015

POWER electronics is entering more and more applications as the world is becoming more electrified. We see power electronics being a key technology for renewable energy generation and long-distance power transmission, as well for hundreds of other applications across a variety of industries. Aircraft, cars, ships, and other autonomous energy systems are also being equipped with more power electronics. To master these technologies, it has for many years been clear that a combination of the control, power, and electronics disciplines is essential, such as that proposed by William E. Newell in 1974 and illustrated in Fig. 1(a).

As many power electronics-based products become mass-produced and incorporated into critical locations, much more attention is being paid to the reliability and robustness of power electronics products. This drive is paralleled by a push for power electronics technology to become cheaper in combination with decreasing size, increasing efficiency, achieving higher power density, and being robust for very high loads. It is known that electronic equipment is stressed by many factors, including mission profile, temperature, humidity, vibration, cosmic rays, etc., which degrade components. Therefore, in order to meet the expected lifetime of a product (and keep the failure rate at an expected value), the next paradigm in power electronics should have a better design for reliability, wherein many new disciplines are taken into account. Fig. 1(b) illustrates this and includes analytical physics for physics of failure analysis and lifetime modeling; design and verification for taking a better simulation approach for design using lifetime models and data about the mission profile; and control and monitoring, which puts more intelligence into a product when it is operating.

Power electronics is a field that will continue to be challenging as new components enter the market (such as wide-bandgap devices), new materials are used for packaging, and better models and simulation tools are needed, in addition to cost-efficient test methods. Also, putting more intelligence into the product will require new communication as well as data-handling methods in order to keep costs low.

For this Special Issue on Robust Design and Reliability in Power Electronics, 127 manuscripts were received and 45 papers were finally selected for publication. This issue is organized into three sections: analytical physics (15 papers), design and verification (11 papers), and control and monitoring (19 papers). The topics addressed include the basic wear-out phenomenon in new power devices, robust design methods, and fault detection and fault handling of power converters, among others. It is the editors' hope that these papers will be a source of inspiration for new research, as this topic is only in an emerging state—especially in academia.

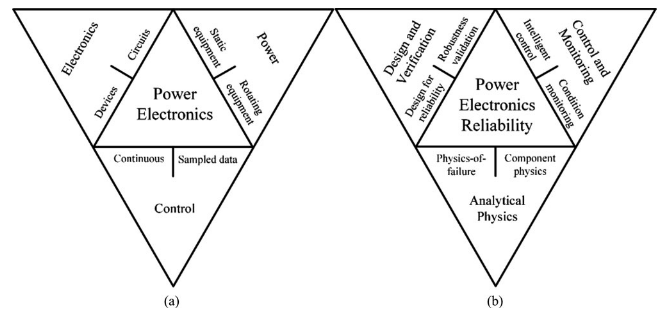

Fig. 1. Concepts in power electronics design: (a) disciplines proposed in 1974 by William E. Newell. (b) Disciplines for reliable and robust design of power electronics.

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