Editorial

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Product development process plays a very significant role in ensuring reliability of any product and achieving competitive advantage. However, increasingly challenging and dynamic global market forces manufacturers to develop their new products faster and with better performance. Therefore, the necessity to produce high-quality and reliable products faster and at lower cost requires companies to 'anticipate and prevent' problems as early as possible in the product development process. It requires reliability community to play a proactive role at an early stage to identify reliability issues and concerns, develop more efficient and effective design tools and practices, and effectively integrate these tools and practices into product development process.

Building reliability into products is no more a wishful thinking; it is now a requirement dictated by the consumers. However, the competition dictates that the requirement of building reliability into products is brought up-front at the product development process itself. Design concepts during the product development process not only impact unit product cost, but also the reliability of the products. With this reality comes a need to ensure the effectiveness and efficiency of the product development process. The anticipation and prevention of problems up-front at the design stage is a prerequisite to build reliability into products during product development process.

Our 'Call for Paper' invited perspective authors to submit papers addressing the theme of the special issue. In total, we received 20 paper submissions in response to the 'Call for Papers.' Each paper was reviewed by two or three subject experts. Based on the review comments from reviewers and our own reviews of the papers, we accepted a total of ten papers. These papers provide excellent coverage of issues and concerns of product reliability, design tools, and development processes essential for building reliability into product design.

The challenges and pressures faced by product development processes have been growing by an increasing rate year over year, requiring from us further discipline and rigor to deliver product with speed, quality, and affordable cost structure. The **first** paper, 'Perspectives and challenges for product reliability assurance in product development process', highlights these emerging challenges and their impact on product development domain. The paper also provides some suggestions for further research to build on product reliability.

Translation of product level reliability goals into reliability specifications and subsequent reliability specification allocation at lower levels during design process has been a challenging task. Interestingly, the first paper highlights reliability target setting/cascading of complex products is one of the potential research areas. The **second** paper, 'Reliability specification in new product development', attempts to address this challenging area. In this paper, the model is used to describe the process of establishing the desired reliability performance and driving the reliability specifications that will ensure the desired performance.

The **third** paper, 'Design-for-six-sigma for multiple response systems', demonstrates how to allocate means and tolerances for multiple response systems by changing the traditional focus of Six Sigma (i.e. defect reduction) from the manufacturing stage to the product design stage. The paper presents probability-constrained-optimisation tool for operational design for Six Sigma (DFSS) by blending together appropriate features of design-for-quality and reliability-based design. The paper presents a case study which shows all the features of the approach and suggests its practicality and potential.

The **fourth** paper, 'Reliability-based design optimisation of vehicle drivetrain dynamic performance', presents a methodology to design a vehicle drivetrain to meet specific vehicle performance criteria which usually involve trade-offs among conflicting performance measures. This paper describes a methodology to optimise the drivetrain design including the axle ratio, transmission shift points and transmission shift ratios considering uncertainty. A complete vehicle dynamic model is developed using the bond graph method. The optimisation is performed using both the Simulink vehicle dynamic model and the metamodel. A vehicle example illustrates the design methodology.

The **fifth** paper, 'A single-loop method for reliability-based design optimisation (RBDO)', proposes a robust single-loop RBDP algorithm for both normal and non-normal random variables, which greatly improves on the existing single-loop, single-vector (SLSV) algorithm. It collapses the nested optimisation loops into an equivalent single-loop optimisation process by using the Karush–Kuhn–Tucker optimality conditions of the inner reliability loops in the outer design optimisation loop converting therefore the probabilistic optimisation problem into a deterministic optimisation problem. Two numerical applications, including an automotive vehicle side impact example, demonstrate the accuracy and superior efficiency of the proposed single-loop RBDO algorithm.

The **sixth** paper, 'Risk-averse reliability optimisation in electronic product design with component and non-component failures', proposes a practical reliability prediction model for estimating failure rates of printed-circuit-boards (PCBs) during the development stage. Unlike traditional reliability prediction models focusing only on component failures, this paper presents a new method that further considers non-component failures due to design, software, manufacturing and process. The reliability models and optimisation method proposed in this paper provides an integrated tool for estimating and optimising the reliability of a new electronics product. The optimisation method is demonstrated by the design of a DC/analogue instrument board used in the automatic test equipment (ATE) in semiconductor industry.

The design decisions made early at concept stage are very crucial, since consequences of the decision are far away and little is yet known about product's life cycle. Nevertheless, early design decisions have a high influence on the life cycle characteristics of a product. The **seventh** paper, 'Effecting product reliability and life cycle costs with early design phase product architecture decisions', presents a method to determine a relative comparison of product architectures based upon a model of life cycle costs that can be assessed very early in the design process. The method utilises reliability distributions, relative cost estimates and cost incurrence distributions. The paper demonstrates the proposed method on a real industrial case study of an energy-producing device.

The **eighth** paper, 'Application of fuzzy methodology to build process reliability – a practical case', presents an integrated framework based on fuzzy methodology to build and improve reliability aspects in the system. The framework makes use of both qualitative and quantitative techniques to analyse the failure behaviour of a complex industrial system. The paper demonstrates the applicability of the methodology by taking a real life case from process industry.

The **ninth** paper, 'Functional guarantee – a new service paradigm', formulates a conceptual framework for design and delivery of a new service paradigm. As the core of the framework, integrated risk management enables viable delivery of the required quality of functionality from the equipment. The framework utilises operational learning and feedback mechanisms for operational risk management. The framework allows the producer to meet customers' needs and reduce risk of loss, while constantly looking toward improving profitability. The paper also presents challenges in the implementation of the framework.

The **tenth** paper, 'Development of low-cost smart-card-based secure and reliable information exchange system with tamper-proofing features', presents development of a customised smart-card-based system to transfer information in a secure manner from one central server to identified client sites with information tamper protection. One of the primary aims of the proposed system for secure information exchange is to make it reliable, robust and inexpensive (client side). This paper describes a key-based generic but customised encryption system that also incorporates a tamper-proofing feature enhancing reliability of the process incorporating information exchange.

We hope that readers will find these papers stimulating and will understand some of the research challenges and future research directions. The main intent of this special issue is to motivate paradigm shift in product development research.

The Guest Editors would like to thank all the authors for submitting and revising papers for the special issue. We also wish to extend our sincere thanks to those individuals who acted as reviewers for the papers submitted to this issue. Lastly, the Guest Editors would like to express their sincere appreciations to Dr Mohammed Dorgham, the Editor-in-Chief, and Ms Liz Harris, the Journal Manager, for their advice, help and support to make this special issue come true.