

Collaborative Innovations

A novel approach for prioritization of product quality improvement in a complex manufacturing environment.

A conversation with Prof Dr. Low Heng Chin, Professor of Statistics at the School of Mathematical Sciences, Universiti Sains Malaysia reveals how her team of researchers is helping businesses prioritize product quality improvement through the use of statistics and AI techniques.

Can you give us a brief background of the project?
 Product quality is critical for business organisations due to a highly competitive, customer driven market. Robust products and reliable services play a key role in ensuring long-term customer loyalty. The aim of our project is to design an information system that will assist in prioritizing product quality improvement based on available data.

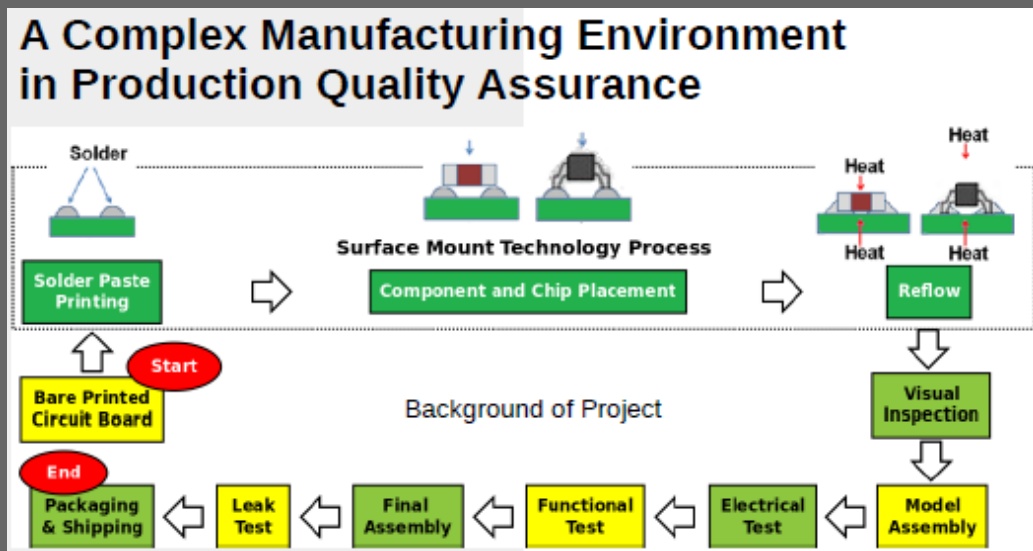
On the onset of our project, we began looking at our study from a high-level systemic view. We then took a data modelling approach to narrow down to potential focus areas for quality improvement. Further analysis was carried out to prioritise critical factors affecting specific product quality issues and subsequent actions were taken on the selected factors. Results were later monitored and impacts validated.



Fifth from left: Prof. Dr Low with the Industry-Academia project team and Dr NorAzmi Alias from CREST (fourth from left)

The project was divided into four major phases. For phase one, we conducted a study on the product life cycle so as to define the entire scope of our study. In phase two, statistical or AI techniques were used to perform data analyses and in phase three, a prototype was created to manage and prioritize product quality improvement. Finally, in phase four, the impacts of the developed information system were assessed, and results were disseminated.

The achievements of this project include a Decision Support System to prioritize the critical parameters at the test stations to allow for early intervention using historical product testing data. A machine learning approach was then implemented, using historical data to support the decision-making process in parameter prioritisation based on data consistency. The prioritized parameters enable users to make intelligent decisions to identify failures to that can be solved at an early stage.



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Who was involved in this project?

Our multidisciplinary project team:

1. Prof. Dr. Low Heng Chin (Project Leader, Statistics background, School of Mathematical Sciences, USM)
2. Mr. Amir Hamzah (Director of Quality, Engineering background, Sanmina)
3. Dr. Teoh Ping Chow (Mechanical Engineering background, Wawasan Open University)
4. Dr. Tan Choo Jun (Computer Science and Economics background, Wawasan Open University)
5. Dr. Teh Sin Yin (Statistics and Operation Management background, School of Management, Universiti Sains Malaysia)
6. Mr. Koay Fong Thai (PhD student, EE Engineering background, School of Mathematical Sciences, Universiti Sains Malaysia)
7. Mr. Ng Wei Chien (Master student, Finance background, School of Management, Universiti Sains Malaysia)



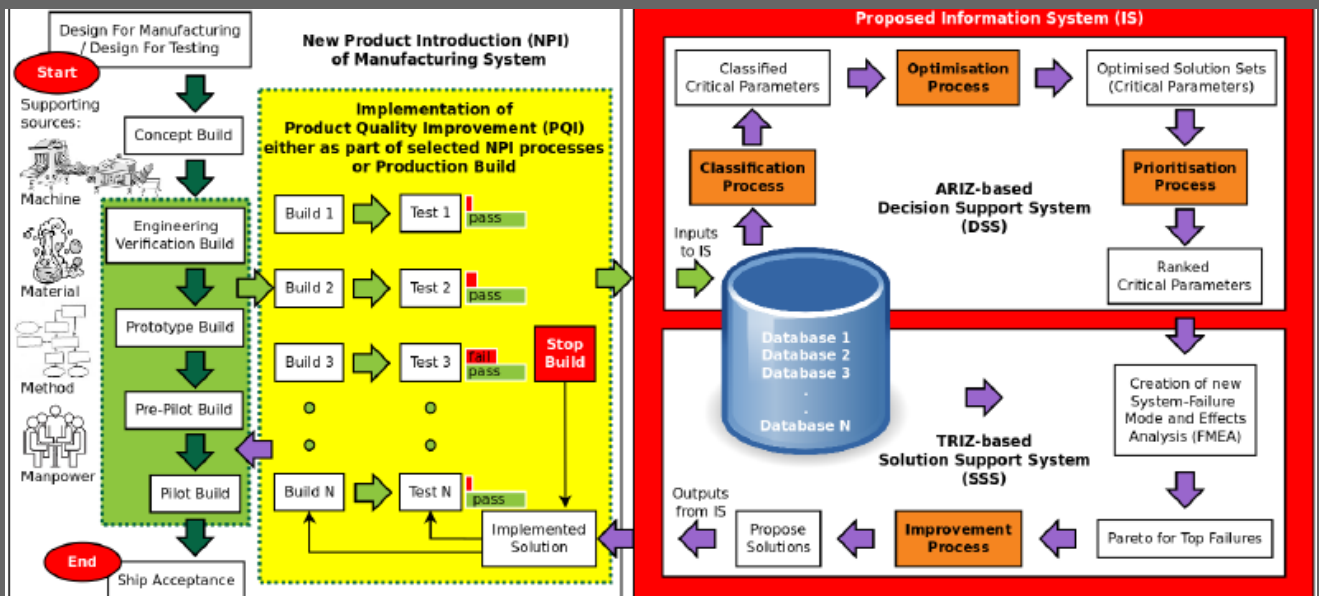
About Prof Dr Low Heng Chin

Professor Dr Low graduated from the University of Liverpool with a PhD in Mathematical Statistics and joined Universiti Sains Malaysia's (USM) Medical Faculty in 1984. She taught Statistics and researched and published in the medical field from 1984 to 1991.

In 1992 she returned from the USM School of Medical Sciences in Kubang Kerian to the main campus in Penang. From 1992 to her retirement in 2020, she linked up with the industries and collaborated with multinational corporations in Penang, among which are Motorola (later Sanmina), Intel, Hewlett-Packard, Robert Bosch, Broadcom, ASE and Infineon, and with SMEs including QDOS, Pensonic and Pentamaster. Her areas of collaboration include quality improvement through the use of statistical and AI techniques.

How was it like collaborating with CREST throughout the project?

We are grateful to CREST for their thorough reviews throughout the duration of the project. In addition, we are appreciative of the opportunities which CREST has given the team members, particularly the students who were allowed to showcase their project accomplishments at various CREST events.



Product Quality Improvement Flow using ARIZ based Decision Support System & TRIZ based Solution Support System

Humanising R&D

Placing robotics at the heart of stroke patient rehabilitation

CREST funded researcher, Dr Yeong Che Fai is combining the worlds of robotics to create rehabilitation devices that are accessible, affordable and effective for stroke patient recovery.

THE SPARK OF AN IDEA

It was in 2010 that Dr Yeong, a researcher cum senior lecturer from Universiti Teknologi Malaysia and serial entrepreneur had the idea to place robotics at the center of patient rehabilitation devices. Dr Yeong was in the midst of completing his PhD at the Imperial College in London and was involved in the development of a rehabilitation robot for stroke patients. He was impressed by the effectiveness of the robot in facilitating recovery whilst at the same time, affording new ways for medical professionals to evaluate patients' progress, whilst at home.

"The value of research and innovation lies in solving real-life problems. I witnessed first hand the positive effects of embedding robotics as part of a healthcare solution and it inspired me to further my research and develop my own therapeutic robot for the Malaysian market." Dr Yeong said.

He added that stroke is a major public health concern in Malaysia with statistics indicating that every year, one out of every six Malaysians suffer from the disease. "Conventional methods with physiotherapists can be labour-intensive, costly, and inconsistent so I thought, why not create a solution to address the issues of cost, accessibility and effectiveness?" Dr Yeong said.

Fuelled by immense passion for robotics and a goal to create a Malaysian success story in this field, Dr Yeong dove into his research upon returning back to Malaysia.



From left: Dr Yeong, Dr Khor Kang Xiang and a team member from the CR2 Haptic project

"The value of research & innovation lies in solving real-life problems." - Dr Yeong

TRACING THE JOURNEY

The journey towards the development of CR2-Haptic was marked by challenges as Dr Yeong faced numerous obstacles at every stage of his journey. "The biggest hurdle I encountered during the initial stages of the project was in maneuvering the intricacies of the local healthcare industry and conveying my research to the right people. Healthcare practitioners in Malaysia lack the mindset and appetite for research; the culture of innovation and research isn't one that is immediately understood or practiced here. Research and development is often deemed as time consuming and costly and ranks low in priority within our local healthcare industry."

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For two years, Dr Yeong approached multiple stakeholders, in hope of getting his idea to the right audience. At the same time, he faced cash flow problems and almost gave up on his project when a chance meeting with Universiti Teknologi Malaysia student, Khor Kang Xiang, changed everything.

Khor was a former student of Dr Yeong and what is interesting is that he too, had the intention of building a robot for stroke patients rehabilitation. It was Khor who informed Dr Yeong about CREST and his intention to bring his idea to Dr Nor Azmi Alias, whom he had met at a previous engagement. Through Khor, a meeting with Dr Nor Azmi and the CREST team was set and thus began the journey for Dr Yeong and Khor as researchers and technopreneurs.

SYNERGY & COLLABORATION

“The CREST team saw the potential in CR2-Haptic and funded our project. We received a RM500,000 grant from CREST, over a period of three years, which allowed us to dive deeper into our research. CREST facilitated linkages with the government by connecting us with key stakeholders within the Ministry of Health, medical device authorities, industry players and funders.”

“The organization has been invaluable in giving us a platform to connect with other stakeholders who we can learn much from in growing our business. I especially like that CREST understands researchers and also industry. Because many of the CREST team members have worked in industry previously, they know the different ‘languages’ people speak and that is the lynchpin that connects us all.” shares Dr Yeong.



CR2 Haptic - compact robot design that provides a wide range of modular units to train for various functional movement

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POISED FOR A BRIGHT FUTURE

By marrying research, technology and innovation into healthcare, Dr Yeong and Khor have been able to develop a compact, portable and affordable rehabilitation robot named CR2-Haptic. The robot which focuses on hand exercises, through playing of games, enables the device to test a patient's hand dexterity through specific functional movements and sends assessment reports on a cloud-based platform to a medical practitioner to chart their progress.

The product which has been in the market for over two years now is making waves overseas. “We are happy with how CR2-Haptic is performing in the market - we enjoy a solid market share locally and a global audience. From the research done on CR2, we were able to create two new products, the first being a bot that helps stroke patients regain balance and the second, an IoT system built specifically for badminton players, with the purpose of allowing them to master their stroke and perfect their game.” Dr Yeong said.

The Global Medical Robotics Market is expected to surpass US\$ 16 Billion by 2025. The major drivers for the market growth are growing geriatric population globally, rising preference for medical robotics for surgery and patient recovery. Rehabilitation robots are expected to witness the highest Compound Annual Growth Rate in the forecast period and we want to ensure that we're ready and plugged into the market to reap the rewards when the time comes!” Dr Yeong said.

Humanising R&D

CREST connects industry with academia to create solutions for the automotive sector

The article traces the journey from research to outcome, through the lens of Associate Professor Dr. Muhammad Nasiruddin Mahyuddin, USM and Encik Noor Hafizi Hanafi, Senior Staff Engineer, from Continental and illustrates the synergies between the two, resulting in the development of 'Vehicle Instrument Cluster Testing based On Real-Time Inspection' (VICTORi), an automated test system for automotive instrument panel, aimed at increasing productivity, efficiency and accuracy in automotive testing.

Collaborations between academia and the industry is one of the best ways for the industry to direct academic research outcomes to solve problems faced by their respective sectors. The second of our humanizing R&D stories takes a look at how Continental Automotive Components Malaysia and Universiti Sains Malaysia (USM), via CREST as the catalyst has made it possible for both parties to collaborate and jointly create solutions for the automotive sector.

WHAT ARE THE PAIN POINTS WHICH VICTORi AIMS TO SOLVE?

Automotive vehicles are equipped with a panel called a cluster assembly or a dashboard which displays vital information to the driver. This includes displaying the driver status, information of the vehicle system and driving conditions. As an integral component in a vehicle, the cluster assembly undergoes vigorous testing to ensure reliability and effectiveness, before the vehicle is deemed safe.

"We were challenged to look beyond the obstacles and imagine possibilities (however wild) that can bring about solutions to the problem" – Dr Nasiruddin

Manual testing is a popular method used to test the reliability of the dashboard. This is no doubt time consuming and often hampered by human limitations, such as exhaustion, thus resulting in judgment errors, during the testing process. In addition, consistency and integrity of the test data is dependent on skill, therefore requiring the product to be further developed from time to time.

To address these issues, Continental collaborated with USM, to develop solutions which will reduce testing and manpower hours, minimize human error, whilst simultaneously increase productivity throughout the entire process.

VICTORi's VALUE PROPOSITION

VICTORi features a custom built product designed and developed to solve Continental's problem in automating its instrument cluster test at an R&D level. The solution was built with ease of use in mind. At a click of a button, VICTORi enables test engineers to write a simple code that enables them to run tests in the most efficient manner. The product is easy to use, customizable and allows for future functionality upgrades.



Dr Nasiruddin (5th from left) and the VICTORi Collaborative R&D Project Team from USM and Continental.

WHAT WERE SOME OF THE KEY CHALLENGES DURING THE COURSE OF YOUR RESEARCH AND HOW DID YOU OVERCOME THEM?

Dr. Nasiruddin: After a bumpy start of negotiating the requirements and ‘must-haves’ for the project, USM was able to fully understand the requirements of Continental, therefore leading to a more fruitful collaboration. It was during this phase, that USM also learnt a golden lesson which is that researchers ought to pay greater attention to the demand and wants of industry. We were also challenged to look beyond the obstacles and imagine possibilities (however wild) that can bring about solutions to the problem that is before us.

Another memorable challenge which USM faced was the agreement on some of the procurement clauses which arose at the start of the project. This was resolved amicably by all parties and the project research agreement was then signed to mark the start of the project.

TELL US ABOUT THE COLLABORATION BETWEEN USM AND CONTINENTAL? HOW DID THIS COME ABOUT?

Noor Hafizi Hanafi: Our partnership started in 2016, where Continental was looking for support from USM to look into the issues regarding our test system. Our corporate offices in Germany and Romania had already developed and launched this project but what was missing was to have someone on board to innovate and create a workaround solution for our cluster assembly. To develop such a technology on a global scale would be an expensive process, therefore we were on the lookout for an alternative to develop this in Malaysia, instead.

We submitted a proposal to USM, having spoken to them in previous occasions and the rest is history.

RESEARCH JOURNEY VIA CREST

Noor Hafizi Hanafi: CREST played a key role in helping us fund the initiative, we were given a small budget to run the project, therefore their financial aid made it possible for us to get the project off the ground.

Dr. Nasiruddin: I learnt a lot during my time developing VICTORi - As a grant recipient, CREST mandates that a review be conducted on a quarterly basis for a period of two years. Each review produced fruitful results as the session was conducted together with the presence of our industrial counterparts, therefore ensuring that each project milestone is in accordance with the expectations of the industry. As part of the grant, CREST imposed a quarterly review on the project, which kept us disciplined in our pursuit of developing solutions in an effective and timely manner. The grant from CREST was also unique as it emphasizes on human capital output as one of the tangible outcomes. We, therefore received constructive feedback and positive criticism from the CREST panel which helped us in evaluating our progress in addition to adhering to specific stands and quality of our solutions.



VICTORi - Vehicle Instrument Cluster Test Operation in Real-time Inspection

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VICTORi's IMPACT ON THE AUTOMOTIVE SECTOR

Dr. Nasiruddin: As the instrument cluster will be autonomously tested by VICTORi, several obvious benefits are expected as a result of the automation process. Firstly, Continental will save up to 160 man-hours of manual testing. This translates to saving up to 800 man-hours in five years and if we are looking at a cost of RM100 per man-hour we will save up to RM80 000 in cost savings!

Aside from industrial impact, VICTORi has also contributed to an outstanding academic impact such as published papers and intellectual property. Patent under the project name 'Automated Test System, Automotive Instrument Cluster' has been submitted and the copyright under the product name of 'VICTORi' has been obtained. We have also published several journal articles on VICTORi and showcased our research at CREST Open Day 2017, ITEX 2018 (where VICTORi was awarded a Gold medal) and Industry4WRD Summit 2019.

VICTORi TODAY

Noor Hafizi Hanafi: VICTORi is currently being tested in Continental's R&D labs on various prototype instrument clusters to further evaluate its test automation effectiveness against manual testing and the latest semi-auto approach. To date, the product has been successful in automating numerous test sequences and is commended by the global Continental team for its efficiency and effectiveness in conducting various tests with next to zero error.

"To develop such a technology on a global scale would be an expensive process, so we looked to USM for support to look into the issues regarding our test system and develop an alternative solution locally." – Noor Hafizi



Final Production Demonstration to Continental Automotive