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VOL 1 2022

Fast-Forwarding Frontier Technologies

Technology is constantly evolving. In order to truly embrace the advantages of the fourth industrial revolution, Malaysia needs to have its finger on the pulse of frontier technologies at all times. As a name that has become synonymous with technological innovations, SIRIM is well-equipped to take the country to the next level.

Through the years, SIRIM has always played a prominent role in advancing the nation. Today, we have the right experience, expertise and ecosystem in place, and are properly positioned to spearhead high-end research, development and innovations. With SIRIM Digital Factory, we look forward to accelerating the growth of frontier technologies in a multitude of sectors – from focusing on gene engineering to advancing the medical sector and championing a greener world; from establishing a platform for the rise of robots to putting a wealth of data to good use. The possibilities are infinite, and SIRIM is confident of harnessing each and every one of them.

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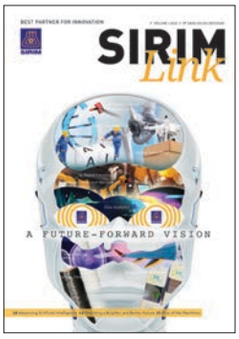

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Progressing with Advanced Materials

Adapted from an article by Ts. Nurul Haszeli Ahmad, Senior Principal Consultant, Group Digitalisation & Information Technology, SIRIM

As Malaysia continues striving to achieve high-income nation status, one thing is certain in this era of the fourth industrial revolution. It is imperative to embrace frontier technologies to move forward.

Tengku Intan Narqiah Tengku Othman
Chief Digital and Information Officer, Group Digitalisation and Information Technology, SIRIM

Breaking Barriers with SIRIM Digital Factory

The Malaysian government has high hopes for the country to be a hub for frontier technologies. Among others, this will facilitate the attraction and retention of the best local and foreign talents. SIRIM is well positioned to help the country to achieve this.

Key technologies that are able to drive Smart Manufacturing and Smart City aspirations include Blockchain, Quantum Computing, Internet of Things (IoT), Industrial Internet of Things (IIoT), Internet of Everything (IoE), Big Data and Artificial Intelligence, Autonomous Technology and Drones, Nanotechnology, Biotechnology, Advanced Materials and more.

"Through the years, SIRIM has consistently been at the centre of the nation's industrial ecosystem as a total quality and technology solutions provider. This has included facilitating the growth of small and medium enterprises (SMEs) in particular with the provision of research and development, and testing, inspection and certification (TIC) services with regards to Smart Manufacturing and Industry 4.0," explained Tengku Intan Narqiah Tengku Othman, Chief Digital and Information Officer of Group Digitalisation and Information Technology at SIRIM.

In increasing its momentum to propel frontier technologies forward, SIRIM realised that there was a need to implement digitalisation programmes to completely transform the organisation's IT infrastructure and business systems. This led to the conception of a digitalisation roadmap, a five-year strategic plan for the implementation of top-notch IT infrastructure and systems, and a specialised innovation hub that is able to support all the business ecosystems – from idea formation to realisation to commercialisation. The latter was trademarked as SIRIM Digital Factory and commenced in November 2021.

"Through the years, SIRIM has consistently been at the centre of the nation's industrial ecosystem as a *total quality* and *technology solutions provider*. This has included facilitating the growth of small and medium enterprises (SMEs) in particular with the provision of research and development, and testing, inspection and certification (TIC) services with regards to *Smart Manufacturing* and *Industry 4.0*."

SIRIM Digital Factory is driven by three pillars: SME-centric, Rakyat-centric and Frontier Technology. "With the first pillar, the Digital Factory will focus on innovations related to SME needs, mainly in the areas of Smart Manufacturing and Industry 4.0 technologies. The Rakyat-centric pillar ensures that the innovation has a positive impact on the people, while the last pillar, Frontier Technologies, focuses on all the key technologies that are instrumental for today's Smart Manufacturing, Smart City and Smart Citizen implementations," elaborated Tengku Intan.

ACCELERATING INNOVATIONS

According to Tengku Intan, SIRIM Digital Factory aims to resolve the challenges faced by industries to become a hub for frontier technology innovations that benefits industries in the region. To do this, it employs a Garage Innovation methodology.

Defining A Digital Factory

A digital factory typically encompasses a network of digital models that resembles physical factory operations. It uses technology to share information digitally across the operations and enables the use of data from people, equipment and systems to facilitate continuous improvements.

Challenging Beginnings

From SIRIM's prior experiences in serving industries, it realised that there were numerous hurdles that needed to be overcome when it came to helping industries with grant-based projects, collaborations or product commercialisation and intellectual property licensing. These included:

- → *Lengthy legal process and development time*
- → *Low percentage of commercialisation or uptake of innovative products & services*
- → *Limited source of funding for investment in new technologies*
- → *Insufficient expert workforce and capabilities to work on identified problems or ideas*

"This is an established approach to stimulate innovation, which has been adopted by many renowned companies, including IBM, Apple, Microsoft, Amazon and Google," shared Tengku Intan. "It mimics a normal garage concept, having a small number of engineers to solve a problem within a short period of time. This speeds up the process of converting an idea into a minimally viable product or solution and, subsequently, an enterprise-scale adoption, which enables the introduction of new revenue streams and business models, transformation of workflows or reinvention of customer experiences at a lower cost with fewer team members," she said.

There are four main principles underscoring the Garage Innovation concept. These are Agility, Skunkworks, Sandboxing and Minimum Viable Products (MVP).

4 PRINCIPLES that define GARAGE INNOVATION

Agility

Ideas are developed into desirable outcomes within a few weeks instead of months or years

Skunkworks

A small team is separated from everyday deliverables to focus on radical innovation, encouraging risk-taking and rapid experimentation

Sandboxing

Small-scale execution in a controlled or simulated environment

Minimum Viable Products (MVP)

The solution is realised with basic features to get customer feedback in a short time span

For typical research and development projects, experts are assigned to their projects for varying durations, ranging from six months to a few years, adopting Technology Readiness Levels. The Agility principle allows experts to rely on high frequency and iterative improvement, encouraging flexibility and quick responses to validated feedback.

Skunkworks principles emphasise radical innovation, isolating a small team from business-as-usual deliverables so they can focus on the high and hard goals. In keeping their attention on innovation, the team is protected from bureaucracy and encouraged to take risks and rapid experimentation approaches to arrive at the desired outcome(s) within a shorter time span.

The third principle, Sandboxing, necessitates a test run of the innovation within a smaller, controlled or simulated environment with a small number of actual users to gauge the success of the innovation. Meanwhile, the final principle, MVP, aims for an initial solution realisation with sufficient features to obtain early customer feedback faster.

"By embracing the Garage Innovation concept, SIRIM Digital Factory is able to ensure that we optimise our resources and expertise to encourage successful implementations and desirable outcomes while obtaining the necessary feedback within a short period of time," explained Tengku Intan.

A PARADIGM SHIFT

SIRIM Digital Factory is set to shift SIRIM from a conventional setup to an open innovation paradigm. This is anticipated to yield enormous business impacts, including higher revenues, inclines in returns-on-investment (ROI) and cheaper and speedier solutions.

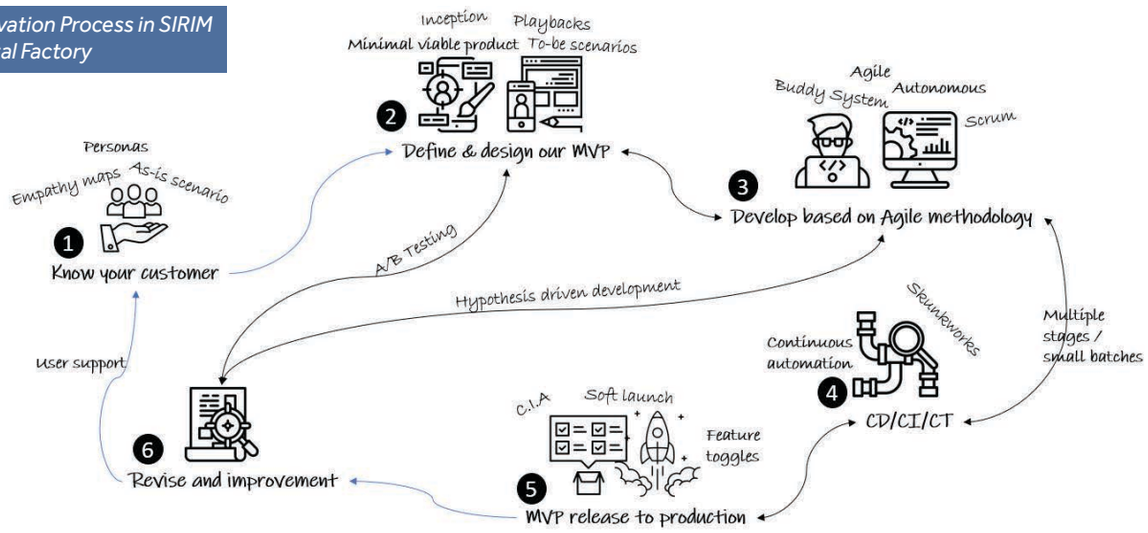
This is a trend that we see among many companies. InnoCentive, for example, saw its ROI grow to 182% within two months, and was able to produce solutions that were 10 times cheaper and four times faster compared to a conventional research and development approach. In fact, its Open Innovation Marketplace has been utilised by many companies including the National Aeronautics and Space Administration (NASA), Defense Advanced Research Projects Agency (DARPA), AstraZeneca and Novartis!" said Tengku Intan.

> By embracing the ***Garage Innovation concept***, SIRIM Digital Factory is able to ensure that we ***optimise*** our ***resources*** and ***expertise*** to encourage ***successful implementations*** and ***desirable outcomes*** while obtaining the necessary feedback within a short period of time.

Through SIRIM Digital Factory, SIRIM expects to expand its innovation hub and engage with innovators from external ecosystems. "The framework and structures used here are totally different from that used for conventional research and development. For one, the application of an agile project management methodology allows for the distribution of innovation orchestrated via a vast network of innovators and improvised collaboration," she added.

SIRIM Digital Factory applies design thinking and DevOps approaches in its innovation process. The process begins with the identification of the affected parties, which then leads to the wireframing of possible solutions. This is followed by the agile development process in accordance with the solution identified. After that, a series of MVPs is conducted with revisions made as needed to ensure that the production solution is practical and accepted.

Innovation Process in SIRIM Digital Factory



Building Better Innovations Faster

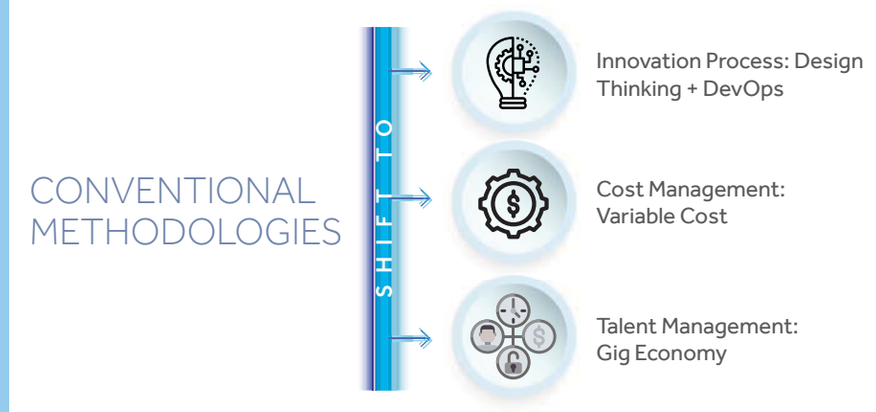
Design thinking *refers to a hands-on problem-solving process that prioritises the user's needs by employing logical observation of people's interactions with their environments to derive innovative solutions.*

DevOps *on the other hand comprises a set of practices combining software development (Dev) and IT operations (Ops) with the aim of increasing the efficiency and speed of the systems development process to ultimately shorten its lifecycle and increase its competitive advantage.*

"When it comes to cost management, SIRIM Digital Factory focuses on variable cost, rather than fixed cost. This is a shift from the normal costing approach. It will be based on performance and dynamic matrices to contribute to a more cost-effective research and development process," shared Tengku Intan.

SIRIM Digital Factory also demands a shift in talent management, emphasising gig economy to enable the recruitment of on-demand talent at the right time for the right price. This also opens up opportunities to gain new and fresh ideas, and encourages agility and speed in delivery.

The SIRIM Digital Factory Paradigm Shift



> We look forward to embracing these ***new methodologies*** to encourage exploring, developing and commercialising new innovations that will ultimately put ***SIRIM*** on the map as the ***centre of innovation***.

TOWARDS GREATER SUCCESS

The benefits of SIRIM Digital Factory are plenty. For the industry, it will become a catalyst for the players to innovate and evolve from their current status as conventional manufacturers into technologically advanced manufacturers, which can facilitate profit increase, cost reduction and processing time improvement.

The Garage Innovation concept will encourage pushing boundaries to achieve new innovations by allowing the experts to focus on the challenges and eventually generate more ideas and solutions.

SIRIM Digital Factory is also an essential player in helping SIRIM in its aspirations to become a RM1 billion company in the near future as it has the potential to generate more opportunities and additional revenue streams for the organisation.

"We look forward to embracing these new methodologies to encourage exploring, developing and commercialising new innovations that will ultimately put SIRIM on the map as the centre of innovation," concluded Tengku Intan.

More often than not, the phrase Artificial Intelligence conjures up visions of a futuristic world of infinite possibilities with humanoid robots at our beck and call. While this is, indeed, probable, it is still a long way off. Nevertheless, SIRIM is set to pave the way for Malaysia to move forward in this arena.

Dr. Mohd Shahrul Azmi Mohamad Yusoff
Director, Industrial Centre of Innovation in Smart Manufacturing,
SIRIM Industrial Research

There are many advantages to adopting Artificial Intelligence (AI). Perhaps the most significant is the increased efficiency it offers. While we're not quite at the stage envisioned by Isaac Asimov yet, it is undeniable that AI is a key pillar in the progression of the fourth industrial revolution.

AI is where human intelligence is simulated in machines, allowing the latter to adopt traits associated with the human mind, including learning and problem-solving. "The word 'artificial' denotes a copy of something natural that is produced by humans. When combined with the word 'intelligent', we get a machine with human intelligence but without the presence of a brain," explained Dr. Mohd Shahrul Azmi Mohamad Yusoff, Director of the Industrial Centre of Innovation (ICI) in Smart Manufacturing at SIRIM Industrial Research.

According to him, AI allows the machines to work and react like humans. While traditional AI comprises a series of algorithms derived from data inputs, compared to typical machines, AI has the ability to 'learn' from data. The more data it is fed, the more intelligent it gets.

With digitalisation occurring at a rapid speed, a myriad of information is now readily available at our fingertips. Dr. Mohd Shahrul cites the country's MySejahtera application as an example where people's movements can be easily tracked to help contain the spread of COVID-19. "The ubiquity of Facebook and all the social media platforms also illustrates how widespread AI is in our daily lives. Now we have robots and drones as well," he added.

> The word *'artificial'* denotes a copy of something natural that is produced by humans. When combined with the word *'intelligent'*, we get a machine with *human intelligence* but without the presence of a brain.

Advantages of AI

- *Increased precision and decreased error rates*
- *Speedier task delivery*
- *Ability to perform repetitive tasks tirelessly around the clock*
- *Streamlined workflows*
- *Optimised data analysis, leading to more informed/ unbiased decision-making*
- *Minimised risk to humans in handling dangerous tasks*

Advancing Artificial Intelligence

FLYING HIGH

AI drones, in particular, have been gaining popularity, largely due to their increased availability as the technology becomes more cost-effective. As unmanned aerial devices, drones can be used for a variety of purposes. With the incorporation of AI, they bring forth another realm of possibilities. Some, if not all, of their operations can be automated, making it easier for data collection from previously less accessible environments.

"You have two main parts to the drone – the control and the payload. The former determines the capability of the drones to go further or manoeuvre better. The payload, on the other hand, captures data that can be analysed by the AI, and the output can then be utilised by us. The possible outcomes can be tremendous. It could be like having an angel looking after you in the sky!" shared Dr. Mohd Shahrul.

The agricultural sector is one of the industries that can reap the benefits of present AI drone technology. In plantations, for example, drones are employed for spraying pesticides and fertilisers. Drones are also a favourite tool used in the creative industry. "In the medical sector, perhaps one day you'll get your medications handed to you by drones," added Dr. Mohd Shahrul.

Nevertheless, Malaysia has a long way to go in terms of embracing AI. Today, we are still using available tools, rather than inventing new algorithms. In terms of drone usage, for example, the AI tends to be focused more on the control component, not the data analysis.

> You have two main parts to the drone – the *control* and the *payload*. The former determines the capability of the drones to go further or manoeuvre better. The payload, on the other hand, captures data that can be analysed by the AI, and the output can then be utilised by us. The possible outcomes can be tremendous. It could be like *having an angel looking after you in the sky!*

> We have been synonymous with the growth of science and industry since our establishment. We play an important role in the nation's ecosystem. You can be sure that we will bring *AI to the forefront for the benefit of all!*

PROGRESSING FORWARD

As the pulse of the nation's research and development, SIRIM can play an important role in helping to advance our AI capabilities. This includes conducting finite element or computational fluid dynamics analyses to study the motions and controls of drones.

SIRIM is also working with municipal councils and other relevant authorities to see how this technology can be applied to benefit our communities. Another area that SIRIM can look into is in the formulation of proper standards to ensure that there is proper governance for the usage of AI drones.

No matter what, Dr. Mohd Shahrul is confident that SIRIM is up for the task. "We have been synonymous with the growth of science and industry since our establishment. We play an important role in the nation's ecosystem. You can be sure that we will bring AI to the forefront for the benefit of all!"

In the world that we live in today, data equals money. Is Malaysia ready to tap into this wealth and put it to good use?

Raja Zurina Raja Mohamed Ali
Senior Researcher, Industrial Centre of Innovation in Smart Manufacturing, SIRIM Industrial Research

Alongside the advent of the fourth industrial revolution came the acknowledgement that data is king. In fact, big data analytics is one of the technological pillars identified as an integral part of Industry 4.0, and according to the Malaysia Digital Economy Corporation (MDEC), the big data energy market in Malaysia is anticipated to expand to USD1.9 billion by the year 2025 (2021: US1.1 billion). This proves that the demand is there.

However, not many organisations, small and medium enterprises (SMEs) especially, have been able to reap the advantages of big data analytics and, as such, its level of adoption in the country remains low. This is where SIRIM's Software and Data Analytic (SDA) cluster can step in.

"Big data analytics offerings are fairly new in Malaysia and can be quite costly. This means that only certain organisations will have the means to utilise data analytics to forecast demand for their products, for instance," said Raja Zurina Raja Mohamed Ali, Senior Researcher, Industrial Centre of Innovation in Smart Manufacturing, SIRIM Industrial Research.

Big data analytics offerings are fairly new in Malaysia and can be quite costly. This means that only certain organisations will have the means to utilise data analytics to *forecast demand for their products*, for instance.

SOFTWARE AND DATA ANALYTIC (SDA) CLUSTER

VISION	MISSION
Towards Data-Driven Governance	Increase adoption of digitalisation and data analytics via 5 principles

1. CUSTOMISATION
2. AFFORDABILITY
3. LOCALISATION
4. REPLICATION
5. REUSABILITY

The Dynamics of Data Analytics

Consequently, being able to conceive and develop effective big data solutions is imperative to aid in the increase of big data analytics adoption among Malaysia's industry players. Currently, the SDA team is focused on SMEs in the manufacturing sector, in particular.

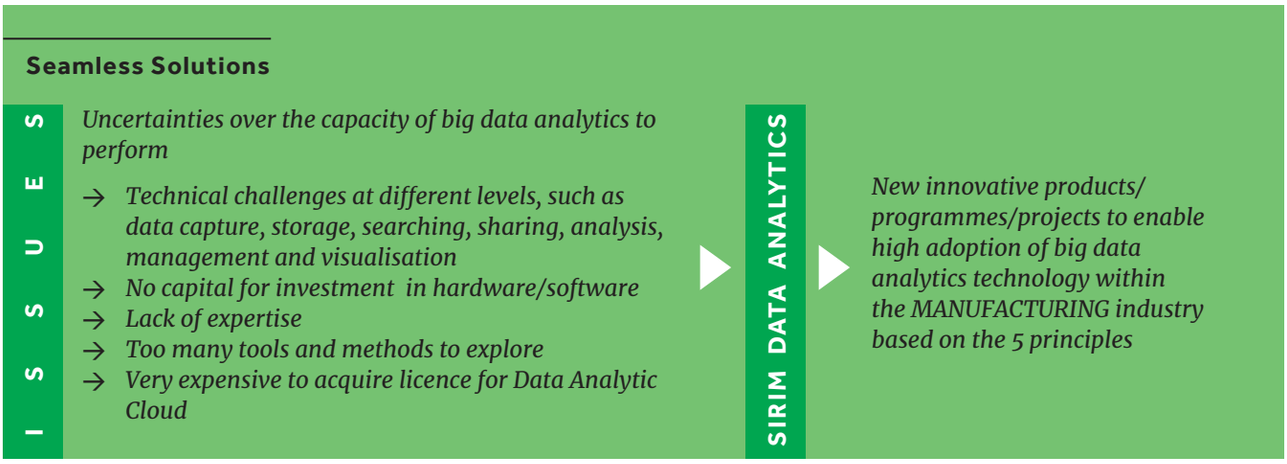
According to Raja Zurina, the SDA cluster will look at initiating and conducting projects related to software and data analytics technology. These will uphold five principles identified by the SDA cluster, i.e. customisable, affordable, localised, replicable and reusable.

"We are also developing a roadmap and action plan for both the project as well as competency development, so that ultimately we will be able to offer comprehensive solutions towards facilitating the investment of data analytics software technology in SIRIM," she said.

A BOOST FOR SMEs

Many SMEs are unaware of the benefits that big data can offer them in terms of increasing sales, revenue and productivity. Additionally, they may have concerns on the time and monetary costs involved. This is especially true for those involved in manufacturing as they are usually more focused on the production process.

"The SMEs could be familiar with the term 'big data', but they may not know or are sceptical on what to look out for, where or how to get started, or even how big data analytics can benefit them!" shared Raja Zurina.



In its attempts to develop solutions that encompass all five principles of being customisable, affordable, localised, replicable and reusable, SIRIM aims for them to be shared by all industry players. As such, one aspect to take into consideration is reusable manufacturing analytics.

"Conducting data analytics can be a very drawn-out and time-consuming process – from collecting the data to getting extended data that supports the data modelling. With reusable manufacturing analytics, we can engage in single-time analytics and repackage the data component thereafter so that it can be reused by different companies," explained Raja Zurina. At the end of the day, the whole process will become cheaper, faster, easier and, therefore, more attractive to the SMEs.

The SDA team has accomplished numerous projects in recent times, one of which is a solving industry-wide project (SIWP) funded by the SIRIM-Fraunhofer secretariat that involves the design and development of a customised enterprise resource planning (ERP) system for the food and beverage sector.

"ERPs can typically cost a lot, especially when customisation is needed. They can also be very complicated and, hence, difficult to deploy. We tried to simplify the system according to the requirements of the food and beverage sector, and managed to come up with a cheaper, easier and more user-friendly solution, making it easier for food and beverage industry players to get on board with digitalisation," continued Raja Zurina.

> We are also developing a *roadmap and action plan* for both the project as well as competency development, so that ultimately we will be able to offer *comprehensive solutions* towards facilitating the *investment of data analytics software technology* in SIRIM.

Prominent Portfolio

Some of the projects that the SDA cluster has completed to date are:

- *Customised Enterprise Resource Planning (ERP) System for Food and Beverage Manufacturing*
- *Electronic Quality Management System (EQMS)*
- *eMeeting*
- *Technology Audit/Uptake Portal*
- *SIRIM Industrial Research (SIRIM-Fraunhofer Secretariat) Dashboard*
- *Eco-Industrial Park (EIP) Dashboard*
- *Inventory Management System*
- *Water Level Monitoring System*
- *Entrepreneur Development Programme with State Economic Planning Units (UPEN, PU)*

Moving forward, they are looking at repeating the success of the customised ERP system for other sectors, including the plastic, chemical and machinery & equipment industries.

Additionally, there are also a number of projects in the pipeline. "There are several projects that are being proposed under the 12th Malaysia Plan. We are also looking at collaborating with strategic partners including government agencies like the National Institute of Occupational Safety and Health (NIOSH) and relevant Departments of Occupational Safety and Health (DOSH). Among others, we are looking at aspects such as digitalisation, manufacturing analytic usages, analytic exchange portals and Hazard Identification, Risk Assessment and Risk Control (HIRARC) with data analytics capabilities," elaborated Raja Zurina.

> Conducting data analytics can be a very drawn-out and time-consuming process – from collecting the data to getting extended data that supports the data modelling. With *reusable manufacturing analytics*, we can *engage in single-time analytics and repackage the data component* thereafter so that it can be *reused by different companies*.

OVERCOMING HURDLES

She reiterates that there are many issues within the industry that need to be addressed. These include a lack of coordination, lack technological awareness and adoption, and high adoption costs as specified in the national policy on Industry 4.0.

"At present, most of the data analytics solutions come from overseas. They are very expensive and the after-sales service can be lacking or non-existent. This means that if the company has a problem with the system, they are unable to obtain the proper guidance and, as such, will be unable to use them to their full potential."

Besides that, the systems may not be aligned with local business processes and requirements, which is why localisation is also an important element in the design and development of a proper system for usage here in Malaysia.

With the identification and implementation of the five principles in conceiving its data analytics technology, SIRIM hopes to overcome all these issues and support the government's endeavours to help our economy move seamlessly into the Industry 4.0 era.

"We cannot preach to the manufacturing industry players about Industry 4.0 without understanding what their problems and limitations are. It doesn't make sense for them to spend up to RM1 million on an ERP system, since this is not a manufacturing priority, especially after the hardships they had to endure due to the COVID-19 pandemic. Now, their priority is to survive, and our role is to help to give them cheaper and easier options," added Raja Zurina.

Consequently, the SDA team at SIRIM is confident that, with proper funding support, it will be able to build up its technical competencies to provide the appropriate solutions that will fulfil the country's national objectives as we journey down the Industry 4.0 road.

Championing the Nation's Economy

Under Malaysia's national policy on Industry 4.0, there are four goals for the manufacturing industry.

- ↑ *Increase productivity*
- ↑ *Increase revenue*
- ↑ *Increase innovation*
- ↑ *Increase high-skilled workforce*

Genome or gene editing is a form of genetic engineering that involves manipulating the DNA of living organisms to disable specific genes or correct faulty ones. While previously technology only allowed for random DNA insertion, today, researchers are able to target a single DNA chain, a specific region of the cell or even a particular side of the body with the goal of enhancing the cell's good properties and/or weakening or eliminating the harmful ones.

This has given rise to a myriad of possibilities, and SIRIM is excited to play an instrumental role in advancing the technology. According to Dr. Zool Hilmi Ibrahim, Researcher at SIRIM's Industrial Biotechnology Research Centre (IBRC), one of the greatest potentials of gene editing is its ability to elicit the contributions of genetics to diseases. "With the availability of more accurate cellular operations, some diseases caused by genetics can now be corrected!"

Traditional biotechnology involves crossbreeding different animal or plant species to acquire the desired traits. However, the process is time-consuming and the outcomes are random. "In contrast, now, with the advent of modern biotechnology and genome technology, humans can modify genetic information at chromosomal or DNA level. This is more specific and allows us to obtain the desired traits within a shorter time span," chimed in fellow Researcher Mohd Fairuzuddin Faizan M. Yusoff.

> With the availability of more accurate cellular operations, some ***diseases caused by genetics can now be corrected!***

> In contrast, now, with the advent of modern biotechnology and genome technology, humans can ***modify genetic information*** at chromosomal or ***DNA level***.

What if you could give every organism a perfect life story? Genome or gene editing rewrites DNA by correcting flaws, promising better, faster, cheaper and much more, including the potential to treat or prevent diseases.

Left
Dr. Zool Hilmi Ibrahim
Right
Mohd Fairuzuddin Faizan M. Yusoff
Researchers, Industrial Biotechnology Research Centre, SIRIM

Genesis of Gene Editing

Genome or gene editing is transforming the research landscape, providing scientists insights into how genes operate. The excitement surrounding this technology is fuelled by its potential to:

- *treat/prevent/eradicate diseases and genetic disorders in humans*
- *enhance medicinal capabilities*
- *make animal to human organ transplant safe*
- *improve traits of crops and livestock*

Rewriting a Brighter and Better Future

THE PROGRESSION OF GENE EDITING IN MALAYSIA

The Malaysia Genome Institute was established in the early 2000s to provide research infrastructure for National Biotechnology Agenda laid out in the Eighth Malaysia Plan. In 2010, the Department of Biosafety Malaysia (DOB) was formed to regulate and monitor all gene editing activities in the country. SIRIM is among 54 universities and research institutes that have a committee reporting to the DOB.

The COVID-19 pandemic placed the spotlight on the importance of genome research. In fact, the Malaysia Genome Institute has been renamed the Malaysia Genome Vaccine Institute to reflect its new task of developing a vaccine for the virus. This is a collaborative effort with SIRIM. Additionally, cancer therapy is also being developed by Universiti Kebangsaan Malaysia (UKM) and the Medical Molecular Biology Institute (UMBI), while Hospital Universiti Kebangsaan Malaysia (HUKM) is concentrating on gene therapy.

Nevertheless, gene editing in the country can still be considered to be at an infancy stage and there are numerous wrinkles that need to be ironed out. "Gene editing is relatively new in Malaysia. As such, there are still many questions and concerns about this field, particularly in terms of biosafety and biosecurity," shared Dr. Zool.

Besides that, there is also the issue of developing manpower and the necessary competencies. At IBRC currently, there is only a handful of people working on gene editing. "We need to expand our team to at least four to five times its current size to be able to work at an optimal level. If not, we'll always be many steps behind other countries," revealed Fairuzuddin.

Dr. Zool agreed, citing a need for higher investment in human capital to build the nation's capacity in this area. "Currently, I'm the only PhD holder in our team here. Compare this to South Korea, where I pursued my PhD. There were nine postgraduate holders working in the laboratories at that time!"

PROPELLING GENE EDITING FORWARD

Dr. Zool, who studied at the Korea Research Institute of Bio Science Technology, co-developed a CRISPR/Cas9 system for yeast. "SIRIM now has the capability to begin genome editing in numerous strains of microorganisms, such as bacteria, yeast and fungi," he said.

> *SIRIM* now has the *capability* to begin *genome editing* in numerous strains of microorganisms, such as bacteria, yeast and fungi.

Enhancing the Bioplastic Industry

Polylactic acid (PLA) is a type of plastic made biologically from fermented plant starch. To enhance the product and reduce environmental consequences, gene editing can be used to manipulate or change the metabolic pathway of the yeast.

To this end, SIRIM, together with several small and medium enterprises (SMEs) like Maribumi Starchtech Sdn Bhd, is conducting research on engineering yeast to produce polylactic acid (PLA) for manufacturing bioplastics.

According to Fairuzuddin, the CRISPR/Cas9 is the most advanced technology being used by a few institutions in Malaysia at this time. "CRISPR/Cas9 is species-specific, which means that if you design a system for one species, it cannot be utilised for another," he explained. "This distinguishes SIRIM from other institutions, since we have the expertise to develop a CRISPR/Cas9 system for novel microorganism species, the facilities and the network to effectively serve the industry."

In line with its focus on industrial biotechnology when it comes to genetic engineering, SIRIM recently looked into the potential of micro-algae in addition to bacteria, yeast and fungi. Besides that, there have been demands from the industry to undertake gene editing using human cell line.

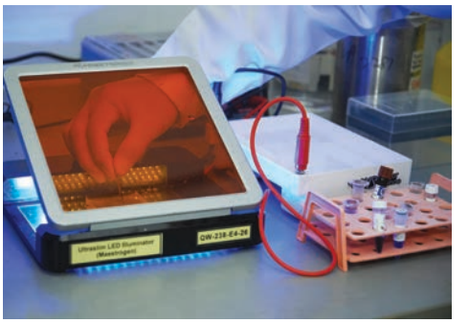
SIRIM has also taken an interest in the health industry. For example, the number of Thalassemia patients in the country is increasing and gene editing can speed up the diagnosis and possible treatment of the disease. Recently, the organisation met with a number of major stakeholders and private sector representatives in order to enhance the detection of diseases such as Thalassemia. "We also intend to use our CRISPR-Cas9 technology to develop a cure or treatment for Thalassemia patients in Malaysia," Dr. Zool stated.

Identifying food security and health as primary concerns in Malaysia and around the world, he hopes that gene editing can play a role in overcoming them. "In terms of food security, for example, genetically modified organisms (GMOs) that have been proven to be safe can be used to contribute to animal feed production and increase our food supply," he said.

FORGING AHEAD

In the short term, SIRIM would like to see the formation of clearer regulations or guidelines for the relevant players in the country to enhance the activity of gene editing and ensure that the products meet certain benchmarks and are accepted by the Malaysian public. "Internally, we are eager to strengthen our competencies in genetic engineering and ascertain that our facilities meet the appropriate standards," added Dr Zool.

> We also intend to use our *CRISPR-Cas9 technology* to develop a cure or treatment for *Thalassemia patients* in Malaysia.



For the mid-term, SIRIM looks forward to supporting SMEs and biotechnology industry players in producing excellent items that are equal to those being produced in developed countries like the UK, US and South Korea in terms of quality.

"Our long-term goal, on the other hand, is to contribute to high-impact research, particularly in the health sector. We aim to provide solutions for future gene therapies," explained Dr. Zool.

Malaysia still has a lot to achieve the field of genetic engineering, and a revolutionary transformation is necessary if the country wants to truly tap into the potentials of gene editing technology. Our awareness and knowledge in this area is rapidly increasing. SIRIM looks forward to synergising the nation's expertise and experience to propel this technology forward.

> Our long-term goal, on the other hand, is to contribute to *high-impact research*, particularly in the *health sector*. We aim to provide solutions for future *gene therapies*.

Printing the Pathway to Better Medical Implants

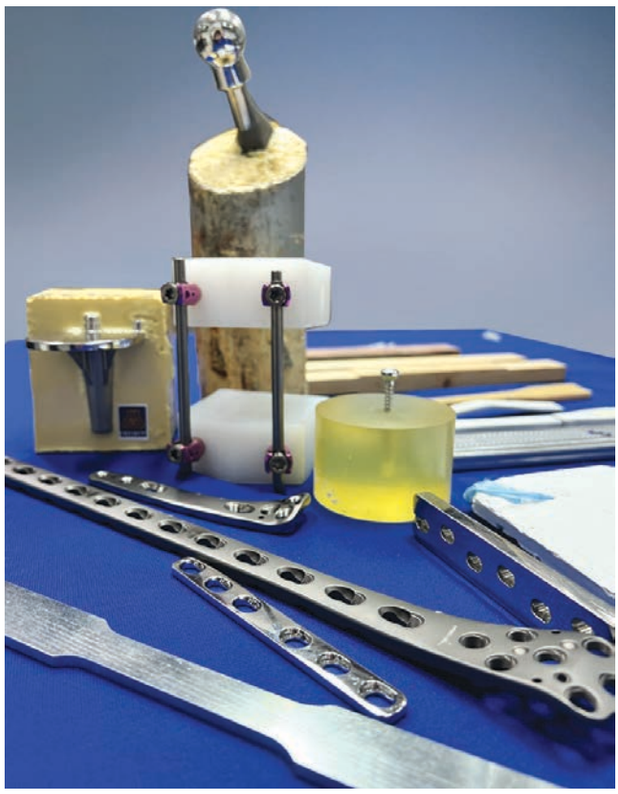
While polymer 3D printers have been in use in Malaysia for over a decade, the introduction of metal 3D printers in recent years has allowed the country to further raise the bar, opening up a whole new world of possibilities in healthcare and other sectors.

Dr. Rosdi Ibrahim
Director, Industrial Centre of Innovation in Biomedical, SIRIM Industrial Research

Metal additive manufacturing, often known as metal 3D printing, is rapidly transforming the global landscape in a wide range of industries, with one of its most significant contributions being in the healthcare sector. Malaysia is well-known when it comes to additive manufacturing, having embarked on polymer 3D printing since 2011. However, it was only with the commencement of the 11th Malaysia Plan in 2016 that SIRIM truly ventured into metal 3D printing. Since then, SIRIM has been making inroads with the technology, particularly in the country's medical implant field.

According to Dr. Rosdi Ibrahim, Director of SIRIM's Industrial Centre of Innovation (ICI) in BioMedical, the metal 3D printers have tremendously improved patient implant offerings in the country, resolving numerous restrictions faced by conventional methods. "This method is becoming increasingly popular owing to its capacity for producing patient-specific implants that are based on each individual's exact measurements. To date, 20 patients have successfully undergone surgery for oral, maxillofacial, dental, hip and knee implants using metal 3D printing," he shared.

> This method is becoming increasingly popular owing to its capacity for ***producing patient-specific implants*** that are based on each individual's exact measurements. To date, ***20 patients have successfully undergone surgery*** for oral, maxillofacial, dental, hip and knee implants using ***metal 3D printing***.



Perfectly fitted

Conventional methods of producing implants, such as metal injection moulding, induction melting or machining technology, apply broad-sized measurements, which will require some form of modification or adjustment during surgeries so they can fit the individual patients. Patient-specific parts, on the other hand, means that each implant is tailor-made according to each patient's unique measurements, allowing for a better fit.

When it comes to patient-specific implants, the measurements are obtained by scanning the patient's body using Magnetic Resonance Imaging (MRI) or Computed Tomography (CT) Scan machines. The data is converted using CAD-CAM software into a Standard Tessellation Language (STL) file, which is a format that represents the surface geometry of a 3D object without the use of colour, texture or other features. This STL file is then transferred to a metal 3D printer that will subsequently print out exactly what is scanned.

"With patient-specific implants, surgeons will not have to go through a secondary process to bend or modify an implant to fit a particular patient. That is the beauty of metal 3D printers," said Dr. Rosdi.

However, the precision advantage comes with a higher price tag. As such, the next step is to figure out how to make this patient-specific procedure more affordable. One of the key factors that could influence its price tag is the choice of materials. Currently, there are three materials that are widely used in metal 3D printing: stainless steel, cobalt chrome and titanium.

"Titanium and cobalt chrome are the most expensive materials among those three because they are lighter and have better osseointegration properties to allow the bone cells to attach and grow more easily to the metal implant," Dr. Rosdi explained.

The unique properties of the materials make them suitable for different needs and goals. For one, because implant expenses are borne by patients, those with a larger budget may be interested in titanium because of its lightweight properties, while those with a smaller budget may prefer stainless steel. For example, for oral or maxillofacial surgeries due to an accident, a patient may have four or five broken bones and needs between five and ten implants. Titanium implants may cost a thousand Ringgit Malaysia or more, but stainless steel implants may cost only a few hundred Ringgit Malaysia.

With *patient-specific implants*, surgeons will not have to go through a secondary process to bend or modify an implant to fit a particular patient. That is the *beauty of metal 3D printers*.

RISING POPULARITY

"At the initial stage when 3D printers were just introduced in Malaysia, many people were sceptical of metal 3D printers. At that time, polymers were the only known material used in 3D printers," reflected Dr. Rosdi.

SIRIM took the initiative to host a Symposium and Exhibition on Additive Manufacturing (SEAM) in 2016 to introduce the technology to academic and industrial communities. Since then, the Ministry of International Trade and Industry (MITI) has also allocated an additional RM1 million to SIRIM following a successful project for patient implants using metal 3D printers.

With the popularity of additive manufacturing on the rise across the globe, the number of 3D printer manufacturers has also been increasing. While previously Europe and the US were the primary makers of 3D printers, presently, Taiwan, Korea and China are among the new players producing 3D printers, which has consequently lowered the cost of metal implants.

"Implants for patients in Malaysia used to be printed overseas in countries like Belgium, the UK and US. Previously, no manufacturer in Malaysia could print medical items since the ISO 13485 certification was required. When we received the MITI funding, there were no Malaysian companies that possessed metal 3D printers with ISO 13485 certification," revealed Dr. Rosdi.

Fast-forward to the present day and five Malaysian companies now have metal 3D printer. One of them is the ISO 13485-certified 3D Gens Sdn Bhd, with which SIRIM has collaborated since the 11th Malaysia Plan.

"Once a company is certified with ISO 13485, it can manufacture medical products, including implants for patients," he said, before adding that local hospitals providing implant procedures include Pusat Perubatan Universiti Malaya (PPUM), Hospital Tunku Ampuan Afzan Kuantan, Hospital Sultan Aminah Johor Bahru and Hospital Melaka.

Today, Malaysia possesses the complete ecosystem, with SIRIM having the technology and capabilities to conduct the scanning, convert the data to STL files, model and print. This means that the entire patient-specific implant production process can now be done in the country.

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> Once a company is certified with ISO 13485, it can *manufacture medical products, including implants for patients*.

MYRIAD CAPABILITIES

Most recently, the ICI in Biomedical secured RM7.6 million in funding under the current 12th Malaysia Plan, allowing it to obtain 3D colour printers for polymers. "Before this, the colouring had to be done manually. As the only organisation in the country with 3D colour printers, we have been receiving many enquiries for polymer 3D printing," explained Dr. Rosdi.

Backed by vast expertise in 3D printers and implant design, SIRIM is also able to print various dental, cranial, maxillofacial, hip and knee implant designs. ICI in Biomedical also has an ISO 17025-accredited laboratory and testing capabilities in five areas, i.e. physical, chemical, biology, thermal and mechanical.

As such, small and medium enterprises (SMEs) can send in samples to conduct multiple tests at one go. For example, following printing, SIRIM has two heat treatment facilities to increase the product's malleability and strength. Chemical testing services can also be conducted here to determine if there was any contamination of the metal.

3D printers are also increasing in popularity in other fields, especially the aerospace and automotive industries. With their usage expected to keep growing with time, SIRIM is committed to doing its level best to continue expanding its capabilities and offerings to support the needs of SMEs, academia, associations, stakeholders and the government in this area.

Technological advancements have resulted in a proliferation of smaller and more sophisticated innovations. This, in turn, has necessitated the evolution of precision machines. The smaller the size of the product, the higher the accuracy needed. This is especially important in order to reap the benefits of Industry 4.0 innovations and beyond to meet current and future demands.

Enter intelligent precision machines. "These machines are equipped with a combination of descriptive, predictive and prescriptive capabilities with very high precision levels. They adopt Industry 4.0 technologies such as Industrial Internet of Things (IIoT), system integration, big data analytics, cloud computing and AI technologies," explained Ir. Rohaizat Omar, the Head of Machine Design Section, Machinery Technology Centre at SIRIM Industrial Research.

According to Rohaizat, the evolution of a precision machine is based on the achieved total machining accuracy. Just two to three decades ago, we were using normal machining equipment and processes with 1µm accuracy. Today, precision machining provides better precision with 0.01µm accuracy. Meanwhile, the next few years will pave the way for ultra-precision machining with 0.001µm accuracy.

> In addition to the software, we are hopeful to introduce ***self-diagnostic features***, which are an essential component of Industry 4.0. Eventually, five to seven years down the road, we look forward to introducing the ***super ultra-precision tools***, which will be very high precision and accuracy with self-repair and self-optimisation capabilities.

ADVANCING INTELLIGENT PRECISION MACHINERY

SIRIM is currently in the midst of a seven-year game plan to advance intelligent precision machinery.

During the first phase, which is the micro-precision phase, SIRIM is incorporating cyber physical systems (CPS) into existing machines. In the second phase, they will move on to ultra-precision machining, which has higher accuracy and will see the machine being connected to Enterprise Resource Planning (ERP) or Manufacturing Execution Systems (MES) software.

With progress, gadgets are becoming faster, easier and more efficient. In tandem with this, the machines that are used to produce these gadgets have to keep up. They, too, need to increase in accuracy, productivity and overall performance.

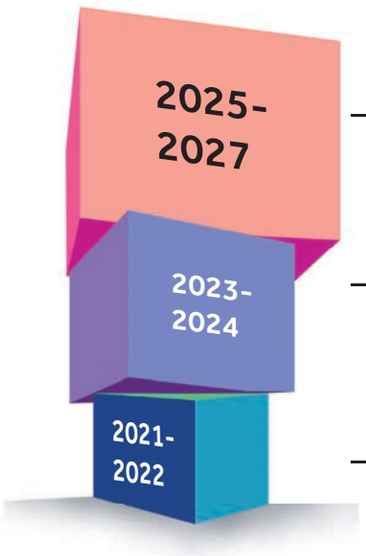
Ir. Rohaizat Omar
Head of Machine Design Section, Machinery Technology Centre, SIRIM Industrial Research

Rise of the Machines

Ever-Evolving Excellence

Precision machines typically employ a dedicated numerical control (NC) system, which is integrated with computational capabilities. Called Computerised Numerical Control (CNC), it evolved to include closed loop feedback and automated process control. In the near future, the CNC system will incorporate Artificial Intelligence, in addition to being networked to other systems internally and externally.

"In addition to the software, we are hopeful to introduce self-diagnostic features, which are an essential component of Industry 4.0. Eventually, five to seven years down the road, we look forward to introducing the super ultra-precision machine tools, which will be very high precision and accuracy with self-repair and self-optimisation capabilities," said Rohaizat excitedly.



→ Super Ultra-precision Machine Tools, Intelligence Machinery Self-repair and Self-optimisation

→ Ultra-precision Machine Tools, Connected Manufacturing Execution System (MES)/ Enterprise Resource Planning (ERP) to Automated Machines, Machinery Self-diagnostic

→ Micro-precision Machine Tools, Cyber Physical System (CPS)-ready Automated Machinery, Networked Machinery

Breaking Barriers

There are numerous reasons why smaller local companies are not adopting frontier technologies like intelligent precision machines. These include:

- → *Old production machines are still working well*
- → *Comfortable with old operations method*
- → *Lack of talent to operate the advanced machines*
- → *Company operations are too small*
- → *Lack of time to deal with production data*
- → *Lack of drive to transform the company*

THE BACKBONE OF MALAYSIA'S MANUFACTURING

Precision machines are used in just about any manufacturing industry, including electrical & electronic (E&E), mechanical, machinery & equipment (M&E), optic, microelectronics and semiconductor sectors.

Rohaizat affirms that the usage of intelligent precision machineries is picking up across sectors, and attributes it largely to the COVID-19 pandemic. "When everything closed down due to the movement control orders, there was a heightened awareness of the importance of incorporating Industry 4.0 features into machines to minimise disruptions and be able to keep up with production demands," he said.

However, many local industry players, especially small and medium enterprises (SMEs) still face hurdles in adopting this technology. A main factor is lack of financial capacity. Because of this, they might not be able to invest in new machinery, particularly if their current production machinery still functions properly. As many of them are operating on a smaller scale, they may also not see a need for expanding and upgrading their machines.

Another issue is a lack of talent to operate the newer, more advanced machines. "The younger generations may not be willing to work in current manufacturing environments, while the older workers may not be comfortable with adopting new technologies. Furthermore, certain features like data collection will be wasted if the company does not place importance on how they can use the data accumulated. Perhaps even the owner themselves lack the aspiration to transform and upgrade the company," shared Rohaizat.

A HELPING HAND

One of the Machine Design Section's roles is to assist local businesses in improving and upgrading their machine technology capabilities. In facilitating their adoption of intelligent precision machinery, the technical team employs a step-by-step approach:

conduct a technical assessment to get a better gauge of the company's current capabilities and pain points

propose technical solutions on how to improve the production processes using machinery, especially precision machinery

develop working prototypes of the precision machinery needed

provide technical advisory and consultancy, including engineering analysis, production setup and technical training

According to Rohaizat, two of the Machine Design Section's main activities are machinery development and engineering services. For the former, SIRIM designs and develops customised precision machinery and CNC machines. Among those that it has developed are the 5-axis CNC Optical Dicing Machine, 4-axis 3-spindles Filament Winding Machine and 3-axis Vertical Machining Centre. These machines can be developed for in-house usage, whereby they belong to SIRIM, or third-party usage – for the various industry players.

Its engineering services, on the other hand, include precision machining services using the CNC Double Column Machining Centre, CNC Horizontal Machining Centre, CNC Vertical Machining Centre, CNC Laser Cutting Machine and Coordinate Measuring Machine.

With prospects for predictive and prescriptive intelligent features on a sharp incline, SIRIM is committed to creating an ideal ecosystem to allow for the advancement of intelligent precision machines and increase its adoption among local players.

"To do this, we look forward to forging collaborative efforts with the government, industry and academia as well as gaining support from the local engineering support industry in particular," he concluded.

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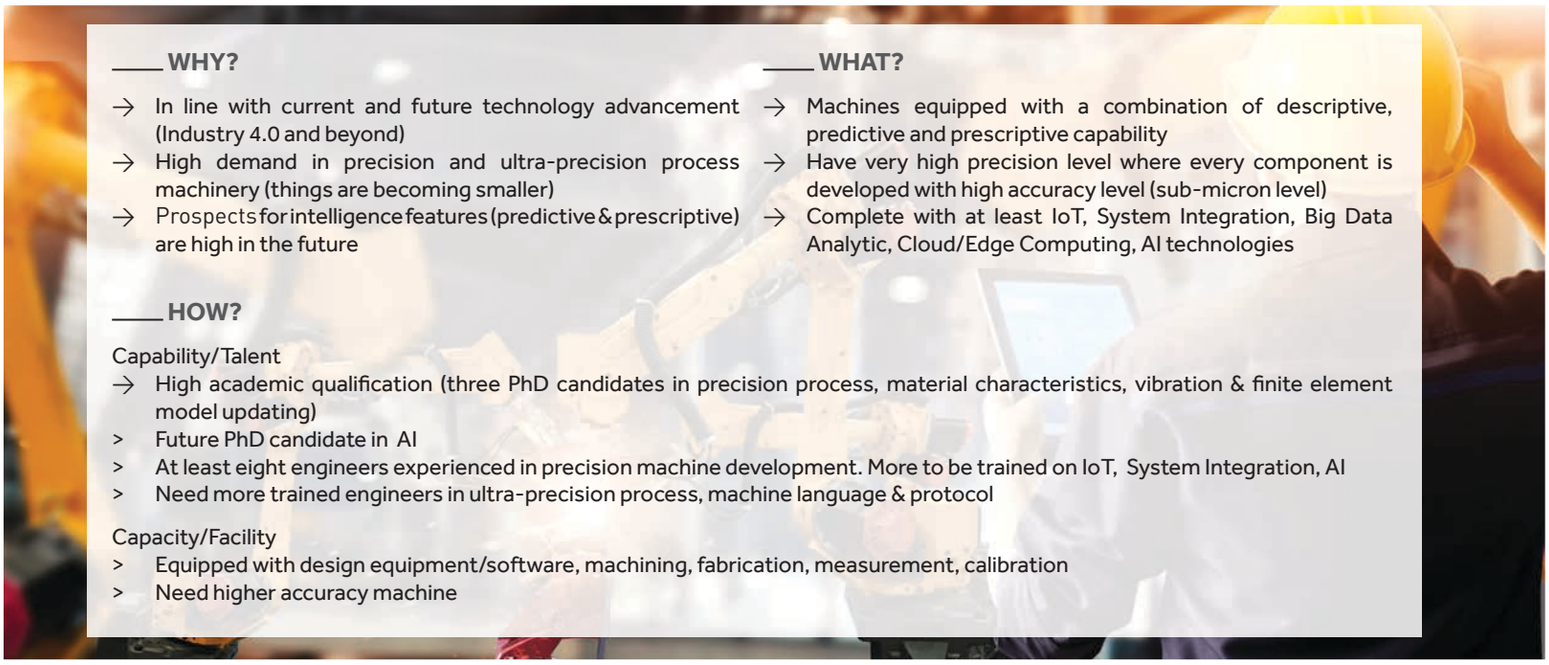

WHY?

- → In line with current and future technology advancement (Industry 4.0 and beyond)
- → High demand in precision and ultra-precision process machinery (things are becoming smaller)
- → Prospects for intelligence features (predictive & prescriptive) are high in the future

WHAT?

- → Machines equipped with a combination of descriptive, predictive and prescriptive capability
- → Have very high precision level where every component is developed with high accuracy level (sub-micron level)
- → Complete with at least IoT, System Integration, Big Data Analytic, Cloud/Edge Computing, AI technologies

HOW?

Capability/Talent

- → High academic qualification (three PhD candidates in precision process, material characteristics, vibration & finite element model updating)
- > Future PhD candidate in AI
- > At least eight engineers experienced in precision machine development. More to be trained on IoT, System Integration, AI
- > Need more trained engineers in ultra-precision process, machine language & protocol

Capacity/Facility

- > Equipped with design equipment/software, machining, fabrication, measurement, calibration
- > Need higher accuracy machine

Going Green with Hydrogen

In a world that's bursting at its seams due to an increasing population and overconsumption, the urgency for finding reliable sources of renewable energy is undeniable. SIRIM is ready to take the reins to lead Malaysia down a more sustainable path.

Azhar Abdul Raof
Director, Industrial Centre of Innovation in Renewable Energy, SIRIM Industrial Research

Renewable fuels are made from resources that are neither finite nor exhaustible. SIRIM has been honing its expertise in this area for around three decades, beginning with biogas. With knowledge gained from its involvement in biogas, it soon embarked on purifiying the biogas to refine its quality so that it is similar to natural gas. This led to the production of bio natural gas (BioNG), which paved the way for harnessing green hydrogen.

Many plants in Malaysia harvesting hydrogen are still using water electrolysis and fossil fuel-based natural gas. This is where SIRIM differs from them. "There are a lot of potential sources of biogas – palm oil, landfills and even food waste are some of them. We can use these waste products to produce biogas, which can be converted to hydrogen," said Azhar Abdul Raof, Director, Industrial Centre of Innovation (ICI) in Renewable Energy, SIRIM Industrial Research.

FACILITATING SUSTAINABILITY

Green hydrogen is 100% sustainable as it does not emit any polluting gases whether during the combustion or production process. "From the organic waste, we produce biogas, which goes through a purifying system so we can extract methane and split it further into hydrogen. This way, we don't have to depend on fossil fuels at any point," shared Azhar.

Hydrogen also has several traits that make it a favourable renewable fuel. These include its storability, versatility and portability. However, there are also several hurdles that need to be overcome. For one, the technology can be costly. This is exacerbated by the current situation in the country.

"Harnessing green hydrogen can be cost prohibitive. Furthermore, there are no incentives allocated for industry players, plus it needs to compete with subsidised fuel prices!" explained Azhar.

Besides that, logistics is also a challenge as biogas sources in the country can be scattered and remote. Nevertheless, with fuel prices getting higher and higher globally, there is a good chance that the popularity of green hydrogen will increase with time.

> There are a lot of *potential sources of biogas* – palm oil, landfills and even food waste are some of them. We can use these waste products to produce biogas, which can be *converted to hydrogen*.

"It is important to establish a proper ecosystem for green hydrogen. SIRIM is able to facilitate this and close the gaps in the industry. In building the ecosystem, besides the production aspect, we have to look at how to distribute the gas efficiently," Azhar advised.

FORGING AHEAD

In supporting the hydrogen economy, SIRIM is currently focused on the storage aspect. "Fuel storage is very critical. In 2018, we set up a BioNG processing plant in Tawau, Sabah. At that time, we also came up with a lightweight cylinder to contain the gas. This gave us the foundation needed to develop a cylinder that can be used to store green hydrogen," elaborated Azhar.

Besides that, SIRIM can also play an instrumental role in the development of standards as well as the necessary testing, training and certification services.

"At SIRIM, we are able to develop an industry guideline for the production of hydrogen to determine the minimum specifications and requirements for setting up a safe hydrogen plant alongside a safer logistics system and quality standards," he said.

As this is a relatively new industry, he advocates setting up a demo plant that will allow all relevant stakeholders to observe and collect relevant data towards ascertaining the viability of harvesting green hydrogen.

"With the demo plant, we will be able to learn a lot of things that can help to pave the way for the development of other aspects so we can mould a complete ecosystem. It also becomes a concrete example that allows potential investors and other stakeholders to understand, appreciate and support the technology and the potentials it offers. We want to show all interested parties that harnessing green hydrogen is doable!" he shared.

Evolving Expertise

SIRIM's recent success stories in renewable fuels include:

2012

Pilot-scale production of BioNG from palm oil mill effluent (POME) at Pulau Carey, Selangor

2018

Successful design, construction and operations of BioNG processing plant with a daily capacity of 6,000m³ per day in Tawau, Sabah

2019

Development of the world's first Sago Mill Biogas Plant in Mukah, Sarawak

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Did You Know?

Biogas is produced from organic waste that, if thrown away, can generate methane gas, which is not good for the environment. Putting this organic waste to good use will not only help the planet but also facilitate the creation of renewable fuels.

Materials are at the heart of our daily life, and they are constantly advancing to keep up with our ever-evolving needs. Boosting the nation's capabilities in advanced materials is instrumental in the development of frontier technologies.

Dr. Suriani Shamsudin
Senior Researcher,
Industrial Centre of Innovation in Biomedical,
SIRIM Industrial Research

Progressing with Advanced Materials

Day and night, we are all surrounded by technologies that are made possible due to advances in materials. While most advanced materials have been around for decades, the full potential of their uses is still being explored and discovered today. In fact, advanced materials may be key to solving many of the world's challenges.

One advanced material that is fast increasing in popularity is carbon fibre. A type of polymer that is also known as graphite fibre, carbon fibre is well-known for its immense strength and lightweight properties.

"Carbon fibre is a type of fibre that has a diameter of around 10 microns. Consisting primarily of carbon atoms, it possesses high stiffness, tensile strength and chemical strength as well as low thermal expansion characteristics," explained Dr. Suriani Shamsudin, Senior Researcher of the Industrial Centre of Innovation (ICI) in Biomedical in SIRIM.

When compared to steel, carbon fibre is five times stronger and twice as stiff. As it is significantly lighter, it has become a favoured material among manufacturing engineers and designers, particularly in the electronics, energy, robotics, architectural, medical and automotive industries.

"Carbon fibre is typically used as a reinforcement in a polymer matrix to produce a high-strength and lightweight composite. This carbon fibre reinforced polymer has vast applications in a myriad of industries. It has tremendously transformed human civilisation with its ability to replace traditionally low-strength and heavy metals in advanced applications," added Dr. Suriani.

Carbon fibre has many advantages over traditional materials like steel, wood and plastics. Among others, it is:

- stiffer and stronger, allowing it to handle more pressure
- lightweight, requiring a smaller workforce to deliver and complete a project, thus making it a more cost-effective option
- more resistant to corrosion, chemicals and fatigue, which makes it more durable in severe environmental conditions like humidity, rainfall or chemical exposure, and less likely to crack under repeated pressure

> *Carbon fibre* is a type of fibre that has a diameter of around 10 microns. Consisting primarily of carbon atoms, it possesses *high stiffness, tensile strength* and *chemical strength* as well as *low thermal expansion characteristics*.

Advantage of Advanced Materials

Advanced materials are specifically engineered to possess enhanced properties, giving them higher performance compared to conventional materials. Examples include light metals like titanium and aluminium, and composites like carbon fibre.

Did You Know?

No. 1
Carbon fibre can potentially replace steel and is popular for specialised, high-performance products like aircrafts, race cars and sporting equipment

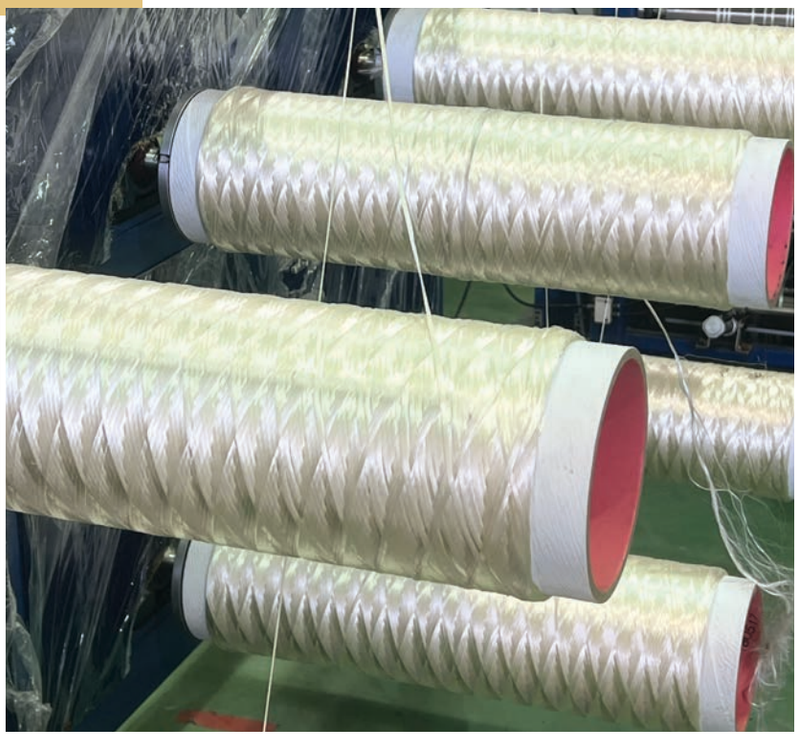
No. 2
Carbon fibre was first invented in 1958, but it was only five years later that its strength potential was realised

No. 3
The most common raw material used to make carbon fibres (also known as carbon fibre precursors) is polyacrylonitrile (PAN)

No. 4
Other precursor options for carbon fibre include plastic and wood byproducts

No. 5
Next-generation carbon fibre composites could potentially reduce passenger car weight by 50% and improve fuel efficiency by 35%

> With our ***own production capabilities***, Malaysia will have a very bright future. We'll be able to have our own carbon fibre facilities that can support other industries. Just look at our ***aerospace industry***, which is a key highlight in our current 12th Malaysia Plan. We already have prominent companies ***supplying composite products*** and ***subassemblies*** to the global aerospace market that stand to gain from this.



HONING CAPABILITIES

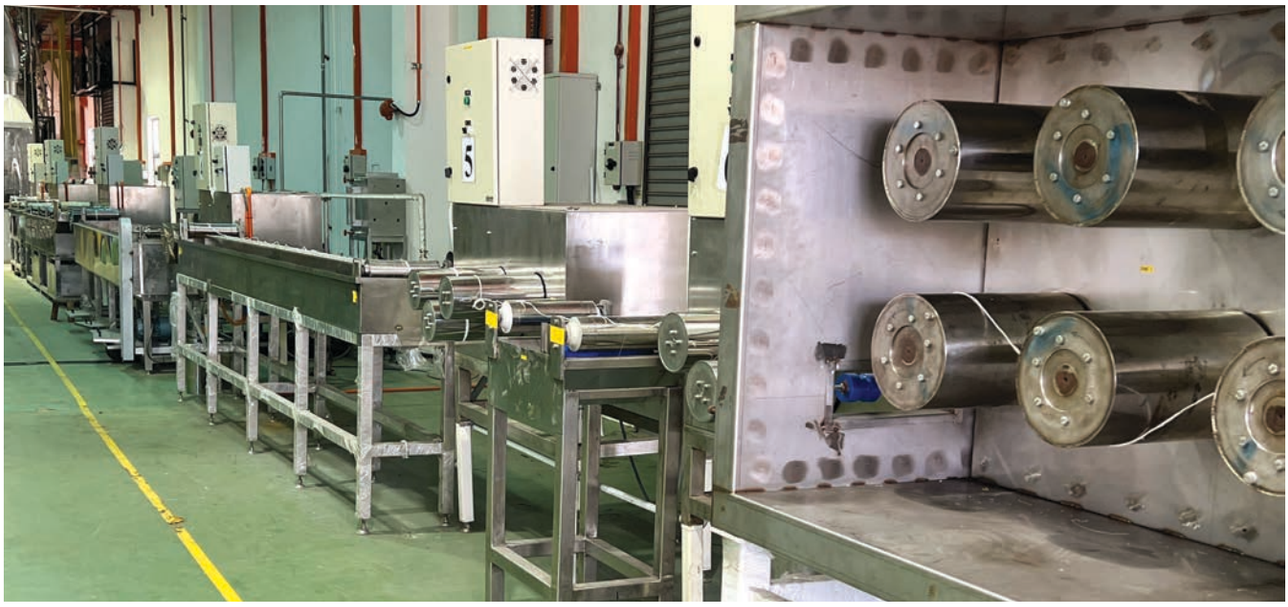
According to Dr. Suriani, Malaysia could look into growing its capabilities in the manufacturing of carbon fibre to serve the country's many industries. "With our own production capabilities, Malaysia will have a very bright future. We'll be able to have our own carbon fibre facilities that can support other industries. Just look at our aerospace industry, which is a key highlight in our current 12th Malaysia Plan. We already have prominent companies supplying composite products and subassemblies to the global aerospace market that stand to gain from this."

SIRIM has been steadily developing its expertise on the production of carbon fibre for the past five years and has a pilot plant in Kulim for this purpose. The carbon fibre is made from a polyacrylonitrile (PAN) precursor employing a wet jet spinning technique.

First, the solution is made and mixed for 24 hours before it is placed in a holding tank to get rid of bubbles. This is essential to ensure that voids are not formed in the carbon fibre as that could weaken its structure. Thereafter, the solution is channelled to the supply tank and pump before it is extruded and passed through a spinner rack to form 1,500 fibres.

The fibres then undergo a coagulation process and a washing process thereafter to remove access chemicals. Subsequently, they are heated, dried and collected at the spooling station, ready to be used for PAN fibre applications.

The PAN fibres will undergo a heat treatment process in an oxidation oven at a temperature range of 100°C to 300°C before going through carbonisation at 400°C to 1,500°C. Next is the graphitisation process where the fibres are heated until 3,000°C. Lastly, the finishing process encompasses surface treatment and sizing before the fibres are wound right at the end.



> With our varied expertise in diverse technologies in the medical and nanotechnology sectors, for example, we are *well-equipped* to harness the potential of the different kinds of advanced materials *to catalyse the progression and development of our industries*.

"Thanks to its fire-retardant characteristics, the white carbon fibre is typically used for aerospace, firefighter clothing or fire-proof furniture applications. The black carbon fibre, on the other hand, can be used as part of a composite for aircraft wings due to its lightweight properties," added Dr. Suriani.

Additionally, SIRIM has also honed capabilities in advanced material characterisation using state-of-the-art equipment such as the scanning electron microscope, viscometer, tensile machine and atomic force microscope.

"With our varied expertise in diverse technologies in the medical and nanotechnology sectors, for example, we are well-equipped to harness the potential of the different kinds of advanced materials to catalyse the progression and development of our industries," shared Dr. Suriani.

Rising Stars

Some other advanced materials that are gaining popularity in current times include:

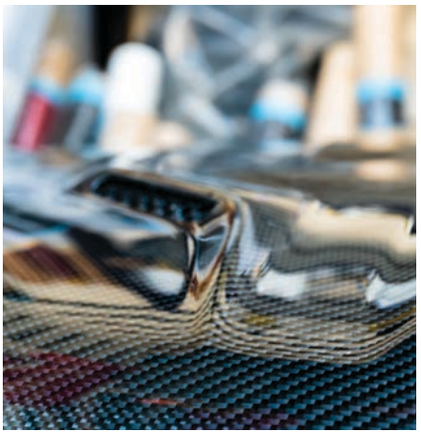
Graphene consists of a single layer of atoms in a two-dimensional honeycomb lattice nanostructure. It holds a lot of potential for diverse applications including anti-corrosion coatings and paints, sensors, electronics, solar panels, DNA sequencing and medicine delivery.

Nanotubes comprise single sheets of graphite with honeycomb structures that are wound into long, thin tubes. The strongest known fibres, they are ideal for applications that require high strength, durability, electrical and thermal conductivity and lightweight properties.

Quantum dots semiconductor particles that measure a few nanometres. These are instrumental in nanotechnology and can be injected into cells or attached to proteins to track, label or identify biomolecules.

Biomaterials a natural or synthetic substance engineered to interact with biological systems, and is typically used for medical purposes. As a science, it has roots that can be traced all the way back to when ancient Egyptians used sutures from animal sinew.

Nanofibre a one-dimensional nanomaterial with a diameter measuring from tens to hundreds of nanometres. It holds many possibilities for technological and commercial applications, including tissue engineering, medicine delivery, cancer diagnosis, optical sensors and air filtration.



ENHANCING THE SOCIOECONOMIC LANDSCAPE

The expansion of technologies in advanced materials will be a significant indicator towards the elevation of our wellbeing and the betterment of the nation in general.

"New technologies arising from carbon fibre reinforced composite materials in particular will contribute to the establishment of more advanced and modern industries, such as in aerospace, automotive and structural applications. This will directly propel Malaysia closer to higher income nation status," stated Dr. Suriani.

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ADVERTISEMENT RATES (RM)

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	1	2	3	4
ROP	3,500	3,000	2,500	2,000
Back Cover (A4)	5,000	4,500	4,000	3,500
Inside Front Cover (A4)	4,500	4,000	3,500	3,000
Inside Back Cover (A4)	4,000	3,500	3,000	2,500
Specified Positions (A4)	4,000	3,500	3,000	2,500
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