MomenTUM

TUM ASIA EVENTS, HIGHLIGHTS
& ALUMNI STORIES

2021 | Edition 02

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PRESIDENT EMERITUS AND DIRECTOR'S MESSAGE

Guten Tag! The year 2021 has been extraordinary. If 2020 was the year of disruption where COVID-19 threw us off our tracks, then 2021 was the year of adaptation where we gradually gained our bearings as we carefully tread the murky waters of the pandemic. Despite the numerous challenges we faced throughout the year, we are heartened to know that the TUM Asia community have taken things in stride and remained steadfast in learning.

The pandemic has not stopped us from advancing our mission of honing the brightest minds globally to build the next generation of leaders. During this time, we have organised several virtual masterclasses aimed to ignite students' interest in a particular field of study while illuminating their understanding of a specific topic. In this newsletter, we feature Prof. Dr.-Ing Florian Holzapfel's interesting insights into the dynamic challenges of Electric-Vertical Take-Off-and-Landing (eVTOL) – a technology that could potentially revolutionise air transportation and solve some of the urban mobility challenges of today.

Technology has been instrumental in keeping our learning functional throughout this difficult time. However, we are also sensitive to the fact that the level of collaboration, sense of belonging, and the spirit of camaraderie, which shape the very essence of learning, cannot be cultivated via Zoom screens. As best as possible, we strive to deliver in-person learning experiences while adhering to safe management guidelines laid out by the authorities. Our Aerospace Engineering students were able to conduct different experiments in the field of structural mechanics at the laboratory of our partner, AeroHub@SP. Our Rail, Transport, and Logistics students have also had the rare opportunity to witness the technological prowess of autonomous vehicles operated on the roads of Singapore. Both experiences are relived in this issue by our student and faculty based on their keen observation. We were also able to glean some insights into one of our student internships, as Zhu Jiawei , a Master of Science in Industrial Chemistry student, shares his first-hand experience at Clariant in China.

In the wake of the pandemic, the world has managed to leave a legacy of change at the United Nations Climate Change Conference UK 2021 (COP26), with nearly 200 nations adopting the Glasgow Climate Pact. This pact aims to turn the 2020s into a decade of climate action and support to end the devastating effects of global warming. At TUM Asia, sustainability has always been at the heart of our work. The Memorandum of Understanding (MOU) signed with the Plastic Recycling Association of Singapore (PRAS) is a testament to our commitment to nurture more technology leaders to take on the mantle of leadership and drive the environmental outcomes that our planet sorely needs. Through collaborating and training in the mechanical recycling of high-volume plastic wastes, we hope to empower more individuals and organisations in Singapore to achieve a higher circularity of plastics. In the same vein, the TUM Asia community has organised a dialogue on the Future of Farming, sparking a round of active conversations on sustainable farming and the technologies revolved around it.

Lastly, let us not forget to celebrate the achievements and the indomitable spirits our students have valiantly shown all this while. In this issue, we share an inspiring story of the Best Student in Bachelor of Science in Electrical Engineering and Information Technology in 2020, Nicholas Leong, of how he navigated the challenges of the curriculum that prepared him for a career in defending the nation. Next, we shine the spotlight on our Best Thesis Student in Master of Science in Aerospace Engineering in 2020, Anubhav Gokhale, whose long and personal journey in realising his childhood dream of being an Aerospace Engineer culminated in the pursuit of a doctoral degree in Aerodynamics.

The Omicron variant may have cast a cloud of uncertainty over the endpoint of this prolonged pandemic and fuelled feelings of fatigue. Nonetheless, we have persevered through this unprecedented crisis of modern history. Thus, we are confident you will display equal measures of courage and passion even as 2022 presents a fresh new set of challenges. On this note, we wish you all the best. Stay safe and healthy.

Prof. Dr. Wolfgang A. Herrmann
President Emeritus, TUM
Academic Director, TUM Asia

Dr. Markus Wächter
Managing Director, TUM Asia

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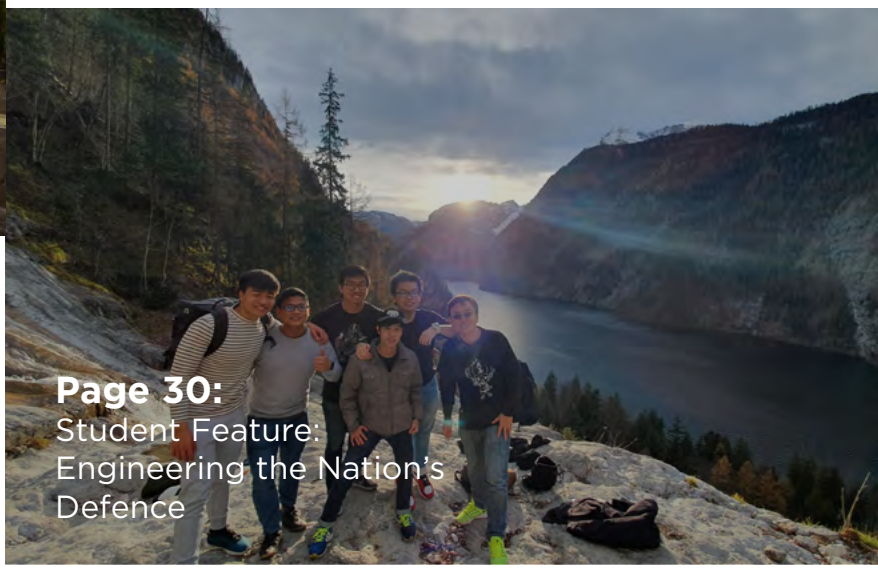

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AEROSPACE ENGINEERING VIRTUAL MASTERCLASS: DYNAMIC CHALLENGES OF EVTOL

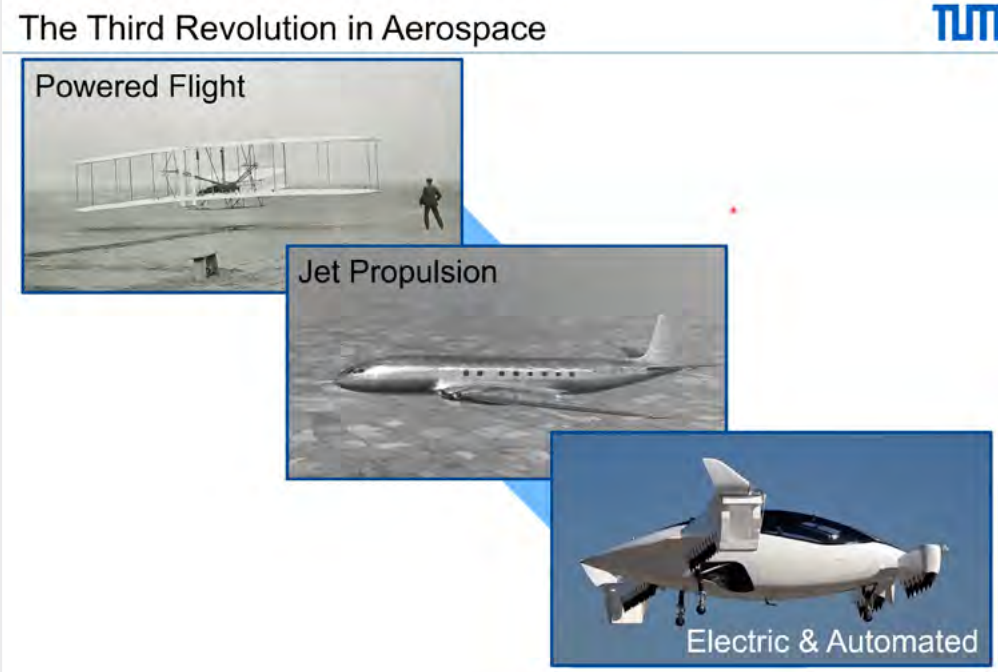
In one of the virtual masterclasses conducted, we had the privilege of inviting Prof. Dr.-Ing. Florian Holzapfel, Chair of the Institute of Flight System Dynamics at TUM, to share about the novel challenges surrounding electric vertical takeoff and landing (eVTOL) aircraft. Prof. Holzapfel is concurrently a Teaching Professor in TUM Asia's Master of Science in Aerospace Engineering programme.

Prof. Holzapfel commenced the masterclass with a discussion on today's rapid technical disruptions in the society being primarily driven by economic considerations. Propelled by the imperatives of clean energy, rise of automation and electrification, automated electromobility is rapidly emerging as a service in demand. Prof. Holzapfel explained that while the current cost of an electric engine is about US$4,000 and weighs about 12.3kg, a conventional combustion engine costs about US$40,000 and weighs about 85.2kg. Therefore, he highlighted that an electric engine is already 10 times as cheap and 7 times as light as a conventional engine. He noted that economies of scale will further drive down costs of electric engines by 2030.

Third revolution in aerospace engineering

Today's model-based development enables engineers to work in the problem domain rather

Propelled by the imperatives of clean energy, rise of automation and electrification, automated electromobility is rapidly emerging as a service in demand.



than the programming domain, while simulation provides a powerful tool that allows high level of realism and cost savings since simulation tools can reduce the necessity of building prototypes for testing. Prof. Holzapfel outlined the three main stages of aerospace engineering as powered flight, jet propulsion, and electric and automated flight, stressing that we are currently in the Third Revolution in Aerospace Engineering that focuses on flight automation. At TUM's Institute of Flight System Dynamics, the primary areas of focus are flight controls, flight control algorithms, ground test instrumentation, simulation modelling, redundancy management, and certification and safety aspects.

In addition, Prof. Holzapfel highlighted that if a person is on board the eVTOL aircraft, there is a need to ensure that he/she is fully able to handle the response behaviour of the system. In the event of engine failure or single battery failure, there must still be minimum manoeuvrability to allow the pilot to conduct the flight. In advanced stages of testing, prototype flight data can be used to update simulation models. Prof. Holzapfel also touched on Simplified Vehicle Operations enabling non-pilot trained people to drive eVTOL aircraft, as long as they pass a Handling Qualities Assessment test.

During the Question-and-Answer segment that followed, Prof. Holzapfel further substantiated that the future of flight systems will be electric. He explained that an electric motor already costs US$4,000 per motor. However, a turbine would cost at least half a million dollars, and require far more maintenance.

Another question posed was whether Prof. Holzapfel thinks eVTOL aircraft will be safer than other aircraft, specifically helicopters. Prof. Holzapfel stated that he expects that this will be the case when eVTOL aircraft become more widely utilised and deployed. He explained that this is because helicopters have just 1 main rotor. Nonetheless, current eVTOL regulations state that the complete failure of a single lift thrust unit or failure of a single battery must not lead

Because eVTOLs can take off vertically and move in any direction, they are ideal to manoeuvre around congested locations, allowing people to commute between two points in less time, which could potentially have a variety of applications in the future.

Prof. Dr.-Ing Holzapfel's research field is flight system dynamics. His key interests are flight control, trajectory optimisation, sensor technology, data fusion and navigation, modeling, simulation and parameter estimation, avionics and safety critical systems.

to a loss of vehicle. For current regulations on commercial aircraft, a failure event must require the aircraft to ensure that operation can continue until an emergency landing is successfully completed. Furthermore, safety parachutes can be added into eVTOL design too, in order to allow the safety parachute to safely eject the pilot in a failure event. Therefore, in the long run, Prof. Holzapfel expects that eVTOL vehicles will have a much higher safety level as compared to helicopters.

All participants of the session found the masterclass to be highly inspiring and relevant to the global trends surrounding the development of the new eVTOL industry. In particular, the session outlined the relevance of TUM Asia's Aerospace Engineering programme in grooming industry experts of tomorrow trained in such a groundbreaking area of research and industry. We look forward to more of such exciting masterclasses in the future!

The session outlined the relevance of TUM Asia's Aerospace Engineering programme in grooming industry experts of tomorrow trained in such a groundbreaking area of research and industry.

NOVEL CHALLENGES SURROUNDING ELECTRIC VERTICAL TAKEOFF AND LANDING (EVTOL) AIRCRAFT

BY: PROF. DR.-ING FLORIAN HOLZAPFEL

Need for effective regulatory environment

Prof. Holzapfel stated that there has been a shift from design-based safety assurance to performance-based safety assurance, as seen in how the FAA Regulations for aeroplanes have shortened from 131 pages to 33 pages, moving from Amendment 4 to Amendment 5. Also, a Special Condition for eVTOL Certification document was released by the European Union Aviation Safety Agency in July 2019, underscoring the importance of regulation in this new space.

Non-linearity of scaling factors

Prof. Holzapfel showed that an increase in vehicle scale requires far greater changes in considerations such as manoeuvring time constants, currents and loads to operate. As a result of the importance of the non-linearity in scaling factor considerations, Prof. Holzapfel stressed that to prove compliance, actual dynamics and loads must be known and tested.

Uncertainty modelling

It is important that probabilistic predictions are made only when uncertainty models are fully and correctly assumed. Hence, there is a need to define safe envelopes in different development stages, identify critical parameters, and employ highly efficient flight dynamics analysis tools. For example, failure considerations for manoeuvrability must be fully calculated and accounted for.

INTERVIEW WITH DR. ALSON CHNG: ON CHEMISTRY AND SUSTAINABILITY OF THE WORLD

Dr. Alson Chng begins to live his dream of nurturing the future generation of chemists at TUM Asia after attaining his PhD in Medicinal Chemistry.

With a PhD in Medicinal Chemistry conferred by National University of Singapore and more than five years of inter-disciplinary research experience in Medicinal and Organic Synthetic Chemistry under his belt, Dr. Alson Chng has chosen to dedicate his passion for science to nurturing the next generation of scientists at TUM Asia. He is now the Assistant Faculty Head of Chemistry and Project Liaison for TUM Asia. Let us find out more about him.

1. Can you share more about yourself (what did you study and where did you work previously?)

Hi! I graduated with a Doctor of Philosophy in Medicinal Chemistry from the NUS Graduate School for Integrative Sciences and Engineering, National University of Singapore (NUS), working on natural product synthesis and optimisation as well as drug treatment on wound healing and breast cancer. Prior to that, I graduated with a B.Sc. (Hons) in Chemistry, with a specialisation in Medicinal Chemistry as well as a Minor in Forensic Science from NUS in 2015.

I joined TUM Asia directly after graduating from my PhD, believing firmly in education as a cornerstone of improving the global quality of life. Moreover, educating bright young minds in the field of Chemistry has been my aim since I discovered my passion for Chemistry. As an outgoing extrovert who loves to talk to people and understand various matters from different points of view, it would not be difficult to imagine the joy of sharing a hobby or topic of interest to people with a similar passion. To anyone with

a similar interest in Chemistry or otherwise, do feel free to invite me for a cup of beverage to discuss more!

2. What inspired you to take on a lifelong career in Chemistry?

What inspired me for a lifelong career in Chemistry is the fact that Chemistry intrigues me as one of the fundamental sciences which makes us understand how things work. Ever wondered how your headache is miraculously cured with Panadol (Paracetamol)? Or have you ever wondered how new medicines or vaccines get discovered and developed to combat ever-changing diseases? Attempting to understand all these issues is like digging in a gold mine for treasure, moreover, it makes for a good story to tell over dinner! Be it teaching some aspects of Chemistry to the next generation of scientists/ engineers or as a scientist or chemist, it brings me joy that I can play an active role in providing more clarity in this world through the lens of Chemistry.

3. In your opinion, what are some of the most interesting aspects of Chemistry?

Of the 4 main branches of Chemistry, Organic and Inorganic Chemistry spark joy in me the most. From the understanding of elements to the discovery and synthesis of novel molecules

DR. ALSON CHNG

"What inspired me for a lifelong career in Chemistry is the fact that Chemistry intrigues me as one of the fundamental sciences which makes us understand how things work. Ever wondered how your headache is miraculously cured with Panadol (Paracetamol)? To make it even more interesting, ever wondered how new medicines or vaccines get discovered and developed to combat ever-changing diseases?"

and materials for various important applications such as medicine or energy, Organic and Inorganic Chemistry provide us the knowledge required to make a difference in this ever-changing world. In the physical world, it is not hard to find the need for Chemistry everywhere. My personal interest lies in Medicinal Chemistry, i.e. Chemistry for Medicine, in our attempt to improve human health globally. As we understand more about the many diseases, we find even more things that we do not understand—it will take generations of scientists to even get a glimpse of how diseases work as well as how we can attempt to tackle it. The need for novelty, innovation as well as to improve current processes present scientific challenges that work like a puzzle, in which solving each puzzle leads to a bigger piece of the puzzle which will eventually give us a nice overview of how we can solve all these challenges and help global health. Understanding Organic and Inorganic Chemistry is the pre-requisite to start solving this challenging puzzle.

4. Could you provide some tips for our students to prepare for their exams and a career in Chemistry?

My personal advice to students would be "Learn to Teach, Teach to Learn" for examinations. Find a few buddies, voice out, discuss and practice

"For a career in Chemistry, strong critical and analytical thinking, coupled with strong problem-solving skills, will be crucial since the fundamentals of Science are an attempt to solve problems and understand how to enhance current measures."

scientific concepts to understand them further. The more we do it, the easier it is to remember, not forgetting the fact that this process boosts personal confidence as well.

For a career in Chemistry, strong critical and analytical thinking, coupled with strong problem-solving skills, will be crucial since the fundamentals of Science are an attempt to solve problems and understand how to enhance current measures. Train yourself to think of problems like how you would search for a file saved in a remote folder in your computer: you look from the bigger picture and slowly zoom into the problem until you find the root source, ensuring you approach any problem systematically. On top of that, learning how to present yourself professionally and making sure that you communicate your thoughts in a clear and concise manner is a must for any profession. I wish the students all the best in their future endeavours.

5. What are some of the evolving challenges in today's landscape and how can future chemists help in solving some of today's challenges?

Sustainability in a fast-paced, ever-evolving landscape is very important on top of current trending challenges and technological advancements, ensuring that we continue to advance and improve human life as much as we can with as little resources as possible.

Sustainability can be addressed in many forms. Let's take the traditional method of optimising processes as an example. Fundamentally, we want to achieve the maximum output with minimum input, to put it simply, if we can exchange 1 candy for 10 chocolate bars that will be ideal. However, to achieve that, we need to investigate the optimal conditions to achieve more output or less input. As time passes, more and more resources will be depleted as input to these processes and if we do not find a replacement, eventually all usable resources will be depleted and impact human life negatively.

Another evolving challenge is the digitalisation of the world. We zoom into Chemistry and we look at how it impacts manufacturing for example. Manufacturing processes are slowly getting digitalised, improving the efficiency of processes and eliminating certain sources of human error. However, digitalisation also comes at a cost in terms of the large amount of energy it consumes, which also negatively impacts the resources remaining on our planet.

With all these being said, how can future chemists help in solving the challenges we are having now as well as the incoming challenges? Strong critical and analytical thinking, coupled with strong problem-solving skills, will be the key. Scientists from the past, present and future should be able to look at any problem, known or unknown, and attempt to solve it. We can look at process optimisation, energy generation and conservation, environmental preservation, sustainable medication and many more topics but it would not work if we do not possess any problem-solving skills.

6. On the side, what are some of your interests apart from delving into the scientific mysteries of the world?

I am someone with lots of interests and hobbies—science, photography, sports etc. I enjoy learning technical skills from these interests and I find that it takes my mind off stress and unhappiness when I dive deep into learning or attempting to perfect a certain skill. If I find that it can be applicable in other aspects of my life, it often brings me joy and happiness as well.

DIARY OF AN INTERN:
ZHU JIAWEI, MSc IN INDUSTRIAL CHEMISTRY

Jiawei's learning journey at TUM Asia has led him back to his home country, China, where he spent his three-month internship at Clariant.

We have the privilege of having Zhu Jiawei, Master of Science in Industrial Chemistry student, who is also a scholarship recipient of TUM Asia's Industry Scholarship (sponsored by Clariant) to share with us about his internship experience at Clariant. Here are his words.

Two years have passed in a blink of an eye, and I have completed my internship at Clariant a few months ago. As the world begins its recovery from the COVID-19 pandemic, I have also found my own set of rhythm.

My name is Jiawei. Born and raised in China, I had the opportunity to study in Singapore at the age of 16. After completing my four years of study in Singapore, I chose Canada as my next stop to pursue a Bachelor's degree in Chemistry. In my scientific pursuits, I have developed an appreciation for chemistry and its industrial applications.

Yet, in the most peculiar way ambition can take you, it landed me back in Singapore as I began to embark on the next phase of my learning journey, taking a joint Master of Science degree in Industrial Chemistry conferred by the Technical University of Munich (TUM) and the National University of Singapore (NUS).

The COVID-19 pandemic has been an omnipresent shadow, looming over every aspect of our lives, including our learning experience. Although most lessons were conducted virtually, the insights and perspectives I had gained from the lab sessions and interactions with the lab coordinators and professors were not compromised and were equally enlightening to me.

What truly brought a refreshing change to my learning journey was my internship with Clariant, which led me back to my home country, China.

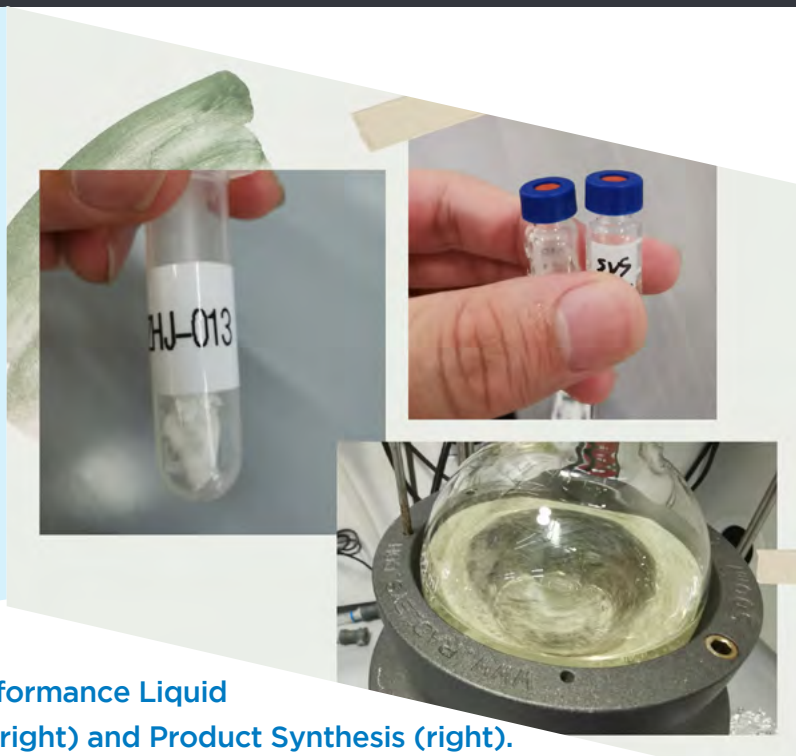
At Clariant, I was part of a new product development team. In my scope of work, I tried to synthesise various surfactants (or surface active agents) and examine different reaction temperatures, starting materials and other paraphernalia necessary to find the optimal set of conditions leading to our desired product.

As with almost all instances, the corporate world and school function in rather different ways.

At school, lab coordinators and technicians would set up the apparatus and prepare necessary chemicals in advance so that we can focus on the experiment itself. However, in the corporate world, it is a different

"At Clariant, I was part of a new product development team. In my scope of work, I tried to synthesise various surfactants (or surface active agents) and examine different reaction temperatures, starting materials and other paraphernalia necessary to find the optimal set of conditions leading to our desired product."

“We are responsible for searching for research papers to extract pieces of information relevant to our purposes. From this starting point, we can make decisions on the preliminary steps to take and optimise the conditions through subsequent experiments.”



Preparing samples for High Performance Liquid Chromatography Analysis (top right) and Product Synthesis (right).

story. Before performing an experiment, I need to make sure all starting materials and required apparatus are available. The preparation work could sometimes take up a couple of days before the experiment can take place, especially when some of the starting materials need to be sourced externally. Therefore, overall planning of tasks is essential to ensure each working day is spent in a productive manner.

In the university laboratory, the primary work of performing an experiment was to follow the manual closely, make observations and collect data according to the requirements stated on the manual. In the actual research and development process, there is nothing as a lab manual. We are responsible for searching for research papers to extract pieces of information relevant to our purposes. From this starting point, we can make decisions on the preliminary steps to take and optimise the conditions through subsequent experiments. Thus, every experiment is a new revelation of what was unknown beforehand.

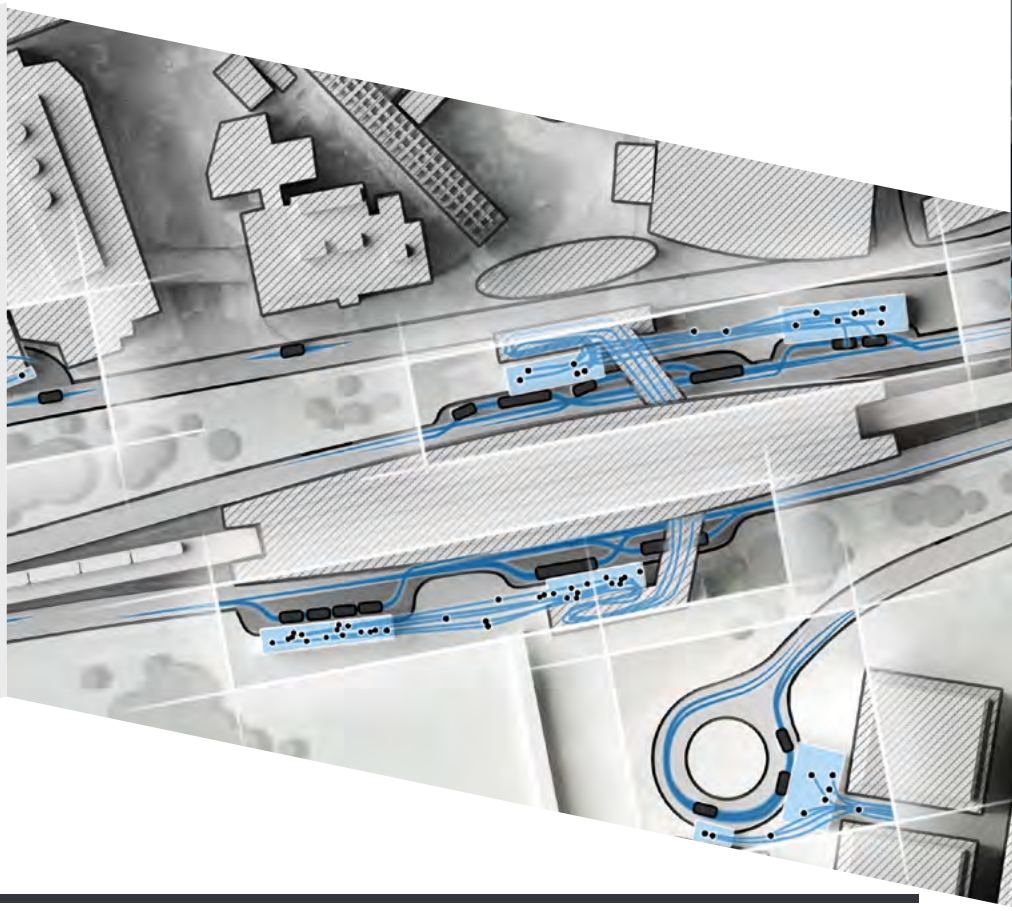
In retrospect, my time at Clariant provided a glimpse into the monumental challenges the industry faces today. For our lab lessons at school, an experiment was deemed a success when results met our expectations. In areas of industry, there is no simple definition for success. Multiple factors are taken into account, where the most important point falls on cost and profitability. Apart from that, environmental sustainability is also a matter of concern, especially as the world today is being confronted by a climate crisis. In the development of new products, we also hold ourselves responsible for minimising the impact on our environment.

The internship was indeed an experience of profound revelation where it widened my scientific knowledge and changed my attitude towards work and life. In the short span of three months, I have become a more independent researcher and learner.

Having gone through this memorable phase in my learning journey, I have further strengthened my beliefs that we must not accept something as it is. We may have repeated the same experiment many times in the course of work, but there is always something new to discover, and something insightful to glean. Let us not be restricted by our knowledge learnt at school. Open your minds and explore at your own pace and will. By doing so, you will find that there are many more doors of opportunity awaiting us in a way that we have never envisioned before.

2025 AND BEYOND:
RE-DEFINING PEOPLE-VEHICLE INTERACTION AND INFRASTRUCTURE FOR FUTURE MOBILITY IN SINGAPORE

As the first physical interface between passengers and the transport system, the pick-up/drop-off facility plays a major role in how people access future mobility services.



TUM Asia has been awarded a 2-year, S$2.38 million project under the LTA-URA Urban Mobility Grand Challenge to research the current and future design of Bus Stops, Taxi Stands and Pick-Up/Drop-Off points. The main goal of the project is to prepare these passenger pick-up/drop-off facilities (PUDOs) for the upcoming deployment of Autonomous Vehicles (AVs) and improve mobility experiences for all users.

The research project is led by TUM Asia in partnership with National University of Singapore, Nanyang Technological University and ST Engineering Autonomous Solutions. Motional Singapore Pte. Ltd., an autonomous vehicle (robotaxi) research and development company. Public bus operators SBS Transit and Tower Transit are also collaborating in the project to ensure relevant outcomes for all stakeholders.

In Singapore, there are standardised design specifications for bus stops, but they are not set up for receiving AVs yet. Other transport facilities such as pick-up/drop-off points and taxi stands do not have unified design specifications. To ensure the smooth deployment of AVs, revised and consistent design standards for all PUDO types will be necessary. Most PUDO facilities are complex environments, especially at peak hours. There can be many vehicles and passengers intermingling, waiting for, finding, boarding,

Inadequacies in PUDO design could impede the AVs' ability to navigate safely, and instead, create conflicts in traffic and commuter flows and interactions between pedestrians, human-driven vehicles, and AVs.

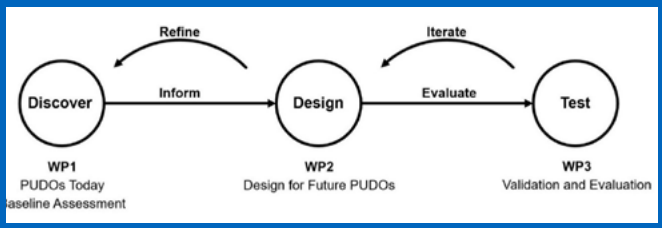
and alighting from buses, taxis, and private vehicles. Such inadequacies could impede the AVs' ability to safely navigate in PUDOs and create conflicts in traffic and commuter flows and interactions between pedestrians, human-driven vehicles, and AVs.

As the first physical interface between passengers and the transport system, the pick-up/drop-off facility plays a major role in how people access future mobility services. The transition is critical for ensuring safe integration of AVs with human-driven vehicles, a smooth learning curve for other road users and pedestrians, and minimal or positive impacts on traffic flows. To address the identified problems, our project consists of three main objectives:

1. **Determine the impacts of AV deployment on traffic demand and throughput at PUDOs**
2. **Propose new design and retrofitting concepts to future-proof and improve the user experience at PUDOs**
3. **Evaluate and validate the proposed design and retrofitting concepts**

We exercise a holistic, design-led and iterative strategy that synergises Design, Traffic Engineering, Sensing Technology and Prototyping. Our approach is closely supported by continuous user research, real-time contextual and operational data, and traffic simulations. Iterative prototyping and progressive testing lead to the final on-site pilot test and eventually, practical design recommendations and innovative ideas for future PUDOs. Infrastructure and human-machine interface elements are combined in one integrated concept to improve information dissemination and passenger/pedestrian and traffic flow in a mixed traffic environment with autonomous and human-driven traffic.

HOW IS THE PROJECT DONE?



Divided into three main work packages (WP), WP1 lays the foundation for the project and discovers the present context of PUDOs with the collection of baseline data and research into human interactions and behaviour in transport environments.

WP2 then builds on the outcomes and insights from WP1 to explore and develop solutions for future PUDOs designs in an iterative process.

In WP3, the impacts of AV activity on people and traffic flows as well as their interactions are evaluated to validate the proposed design recommendations.

MOU SIGNED BETWEEN TUM ASIA AND PRAS TO FIGHT PLASTIC WASTE

The MOU was signed by Dr. Markus Wächter, Managing Director of TUM Asia and Professor Seeram Ramakrishna, Chairman of PRCOE

The Technical University of Munich (TUM) Asia signed a Memorandum of Understanding (MOU) with Plastics Recycling Association Singapore (PRAS) to provide skills training and foster closer collaboration in the mechanical recycling of high-volume plastic wastes, the processability of quality recyclate pellets, and the achievement of a higher circularity of plastics.

The MOU was signed by Dr. Markus Wächter, Managing Director of TUM Asia and Professor Seeram Ramakrishna, President of Plastics Recycling Centre of Excellence (PRCOE), amidst the inauguration ceremony of PRAS. The signing was witnessed by Minister Grace Fu, Ministry of Sustainability and Environment (Singapore).

Deepening Singapore's capability in plastics recycling

In this memorandum, TUM Asia and TUM will support Singapore in its efforts to become a

SOURCE:
https://www.eco-business.com/news/singapores-recycling-rate-falls-to-10-year-low/
https://www.nea.gov.sg/our-services/waste-management/waste-statistics-and-overall-recycling
https://www.towardszerowaste.gov.sg/zero-waste-nation/

MARKUS WÄCHTER MANAGING DIRECTOR, TUM ASIA

"The MOU will make a significant contribution in bridging the skills and knowledge gap needed to accelerate the plastic recycling rate. The partnership will foster closer collaboration between academia and the waste and recycling industry to achieve circular economy goals through developing a skilled workforce."

technology pioneer in the field of environmental protection for Southeast Asia by deepening Singapore's capability in plastics recycling.

On the occasion of the signing, Dr. Markus Wächter, Managing Director of TUM Asia, said, "The MOU will make a significant contribution in bridging the skills and knowledge gap needed to accelerate the plastic recycling rate. The partnership will foster closer collaboration between academia and the waste and recycling industry to achieve circular economy goals through developing a skilled workforce."

Locking away unwanted emissions

In Singapore, a lack of recycling ethos, coupled with a rise in consumption, has driven the recycling rate to a 10-year low of 52 per cent, a decrease from 59 per cent in 2019. With online shopping and home-delivered food gaining dominance during the COVID-19 pandemic, the recycling rate of solid waste has consequently dropped from 17 per cent to 13 per cent. The recycling rate of plastic was only at 4 per cent.

With the use of disposable products growing at an alarming rate, Singapore is facing an impending waste crisis as its one and only landfill is projected to reach capacity by 2035 or earlier.

Singapore has been adopting a waste-to-energy initiative to incinerate 79 per cent of its domestic waste in Singapore. Although such a method reduces the amount of waste to 10 per cent while generating useful energy, it releases heat-trapping greenhouse gases into the atmosphere. The low recycling rate of plastics has also come to the fore as one of the biggest environmental challenges in Singapore, given its deeply entrenched throwaway culture, which contributes to its chronic plastic use and wastage problem.

AUTONOMOUS VEHICLES: ON THE ROADS OF SINGAPORE

▶ The engineer from ITS gave a detailed explanation of the technologies revolving around autonomous vehcles as the students of MSc in Rail, Transport and Logistics listened attentively.

With all the buzz surrounding autonomous driving and cars, have you ever wondered how different it would be from manual driving? Given the string of news that put a negative light on autonomous driving, how safe is it? The students of Master of Science in Rail, Transport & Logistics had the opportunity to find out!

Written by: Chen Qi, MSc in Rail, Transport and Logistics student, TUM Asia

Not long ago, the Intelligent Transportation Society (ITS) Singapore organised a visit for TUM Asia's students, in which they had a first-hand experience of taking an autonomous vehicle.

What are Autonomous Vehicles (AVs)?
As the name suggests, AVs are equipped with technologies that enable them to sense their environment and operate without human involvement.

Set to transform land transport in Singapore, AVs are progressively introduced on Singapore's roads in a bid to battle the manpower crunch and traffic accidents caused by human error.

Categorised into six levels, the Levels of Vehicle Autonomy range from Level 0 (fully manual)

SOURCE:
https://www.counterpointresearch.com/new-entrants-autonomous-vehicle-solutions-will-drive-market-coming-decade/
https://www.synopsys.com/automotive/autonomous-driving-levels.html

Although the Auto Rider can be operated autonomously, it still allows for drivers to take control at any one time.

to Level 5 (fully autonomous). Currently, most mainstream autonomous vehicles are at Level 2. At this level, vehicles are equipped with advanced driver assistance systems to control both steering and accelerating / decelerating. However, automation still falls short of self-driving because a human can sit in the driver's seat and take control of the car anytime. Cars like Tesla Autopilot and Cadillac (General Motor) are currently defined as Level 2.

Auto Rider - autonomous shuttle service at Gardens by the Bay

Their first stop was at Gardens by the Bay, where students first met the Auto Rider – an autonomous shuttle service shuttling between Bayfront Plaza and the Flower Dome with no intermediate stops. To determine the vehicle's precise position at any one point, the AV employs a technology known as the Global Navigation Satellite Systems Antenna to communicate between the GPS sensor and a base station. To detect obstacles accurately, the AV is equipped with LIDAR (Light Detection and Ranging) Senros to provide 2D and 3D perceptions maps of the environment.

In addition, the Auto Rider incorporates light effects and project artistic images onto the windows, which was a nice touch to the visitor experience.

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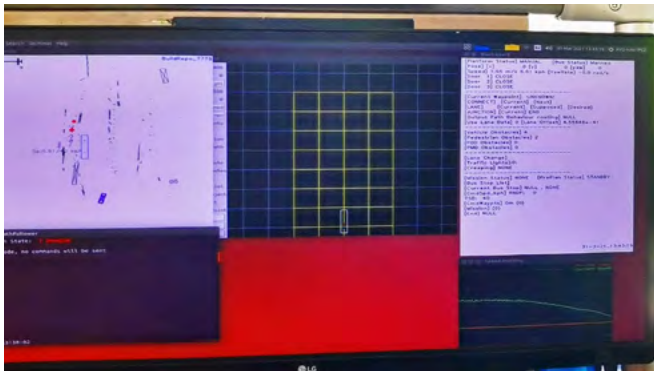


The autonomous bus is manned by a safety driver trained to take over of the vehicle should the need arise. In addition, the buses use electronic signs to signal that they are operating autonomously for easy recognition by road users and pedestrians.

Although the auto body parts were imported from overseas, the software used to operate the vehicle autonomously was designed by the ITS engineers through numerous rounds of improvisations and modifications. Also, even though the Auto Rider can be operated autonomously, it still allows for drivers to take control at any one time. Its symmetrical design also allows for the vehicle to be driven back or forth with ease.

Following their visit at Gardens by the Bay, students headed over to Jurong Island, where they enjoyed a unique joy ride around the island in an autonomous bus. In contrast to the Auto Rider, the autonomous bus is manned by a safety driver trained to take over of the vehicle should the need arise. It plies a fixed route between Jurong Island's amenities centre and Sakra Road, covering 10 stops. In addition, the buses use electronic signs to signal that they are operating autonomously for easy recognition by road users and pedestrians.

Using the software designed by ITS, the autonomous bus was already operating on public roads as part of a three-month trial.

The future of autonomous vehicles

Autonomous vehicles have come a long way since General Motors' first self-driving car model was introduced at the 1939 World's Fair. In 2019, there were some 31 million vehicles with varying levels of automation globally, and this number is expected to surpass 54 million in 2024. Although Tesla has pioneered a beta of its Full-Self Driving in the marketing with selected car owners, fully autonomous cars have yet to gain confidence and traction worldwide. Fully autonomous vehicles may not come soon, but it would not be too far from the future where we get to see more autonomous vehicles beyond Level 2 on our roads.

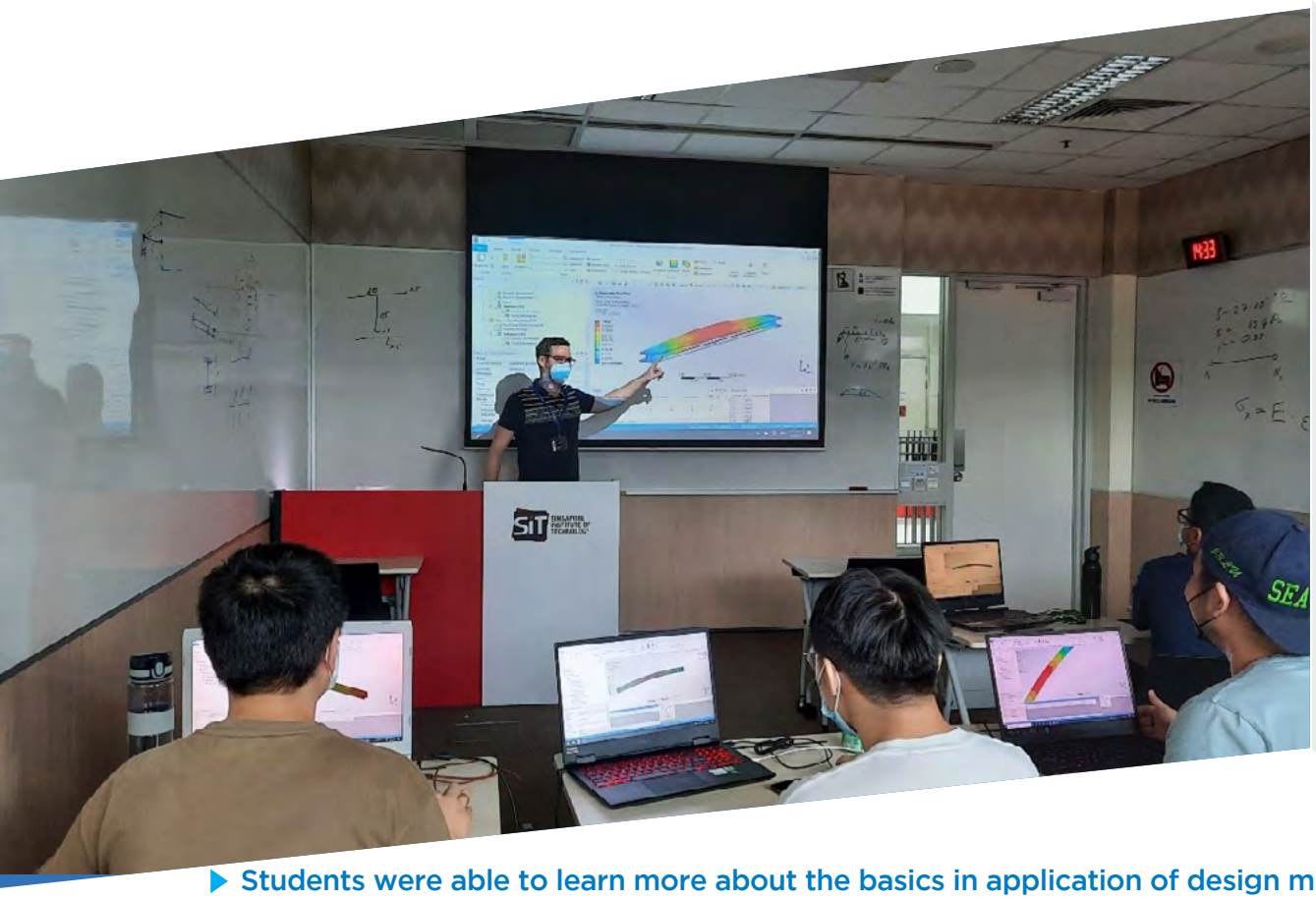
MSc IN AEROSPACE ENGINEERING: NEW FEM-LAB AT TUM ASIA, SINGAPORE CAMPUS

Mr Andreas Hermanutz, together with the MSc in Aerospace Engineering students, were able try out different experiments in person despite the challenging circumstances.

Written by: Andreas Hermanutz, Assistant Faculty Head of Aerospace Engineering, TUM Asia

For another semester, teaching and lectures at the Asian campus of Technical University of Munich, TUM Asia, were held under the restrictions caused by the pandemic. While adhering to strict safety measures, we were nevertheless welcome a small group of students in our newly launched Aerospace Lab.

Southwest of the city centre is the TUM Asia campus. Together with our campus partners, Singapore Polytechnic (SP) and Singapore Institute of Technology (SIT), we form a long-standing partnership in teaching and training young talented scientists and engineers. Similarly at the TUM campus in Munich, the Coronavirus pandemic has caused restrictions



Students were able to learn more about the basics in application of design methods, which are important for aerospace engineers, and understood the limits for simulation.

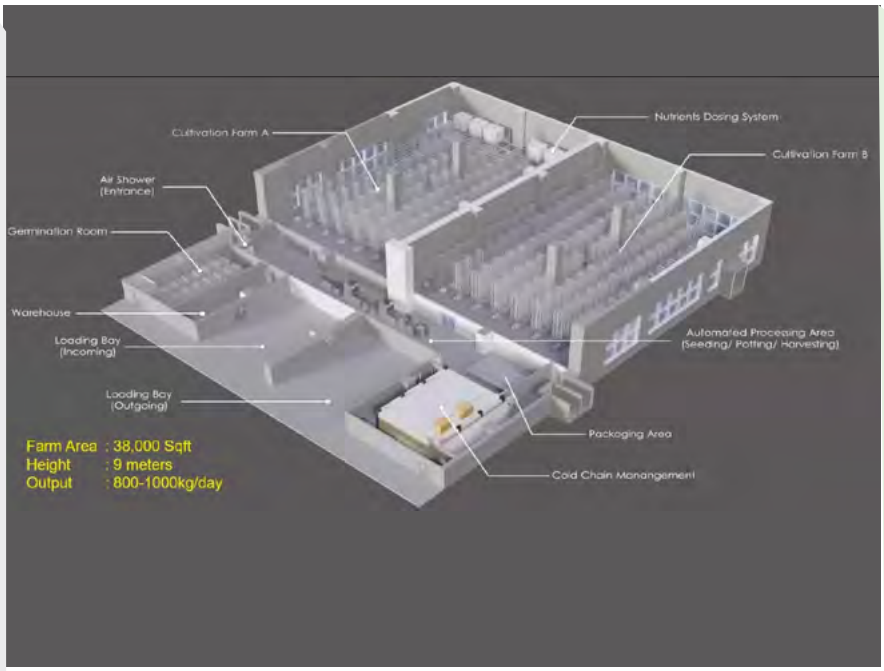
on face-to-face teaching and studying. The campus is therefore only sparsely visited, which allowed the indigenous flora and fauna to recapture their original terrain back – a silver lining in the midst of the pandemic.

Despite challenging circumstances, we were able to launch our Aerospace Lab as planned with a small group of students. Organised in a morning and afternoon session, the students started in the laboratory of our campus partner, AeroHub@SP, with different experiments in the field of structural mechanics. With well-chosen experiments, the students collected measurement data from static and dynamic experiments. After an introduction to the finite element method, the students started to compare experiments through simulations. Not only were the basics in application of design methods, which are important for aerospace engineers, discussed, the students also got further to know where the limits for both simulations and experiments. Based on the positive feedback, further steps were envisaged to deepen and expand the practice-oriented training in the laboratory.

We are especially looking forward to welcoming another strong cohort of motivated aerospace students, coming from across the world, and look confidently ahead that normal campus life will return to us soon.

The presence of students in the Singapore campus of TUM was dearly missed during this COVID-19 period.

TUM GLOBAL WEEK: PLANTING THE SEEDS FOR THE FUTURE OF FARMING



Aside from dedicating his time at his vertical farm, Mr Alfred Tham also teaches at Republic Polytechnic for Continuing Education and Training under the School of Applied Science for Urban Agricultural Technology.

As one of the event highlights for TUM Global Week, we had the privilege of inviting Mr Alfred Tham, CEO and Co-Founder of Indoor Farm Factory Innovation (IFFI), to talk about the novel challenges surrounding Singapore's innovations and efforts to raise food self-production levels.

Mr Tham set up Singapore's first licensed vertical indoor farm in 2014, which is certified by Singapore Food Agency and acquired the first Hazard Analysis Critical Control Point (HACCP) certification awarded to such a facility. He also set up a salad processing facility for Panasonic, which acquired a food processing license that allowed Panasonic to launch ready-to-eat salads under the brand Veggie Life into the retail market. Mr Tham went on to establish IFFI in 2019.

Dr. Jesmond Hong from TUM Asia opened this session, by outlining Singapore's efforts to improve food sustainability and resilience. Dr. Hong highlighted that Singapore adopts a three-pronged approach by diversifying food imports, growing food locally and growing food overseas, in order to ensure continuing food security. The 2019 Global Food Security Index affirmed Singapore as the most food secure country in the world, as Singapore keeps food prices affordable relative to household incomes, upholds high food safety standards and maintains reliable supply chains from diverse countries.

'30 by 30' Initiative

However, in 2019, the Singapore Parliament proposed to raise food self-production levels

Using modular, vertical trays in indoor climate-controlled conditions, coupled with algorithms and other technology to optimise light and growing conditions, often in urban environments, crops are produced with higher yield with less land and water.

from 10% of total food needs to 30% of total food needs by 2030, also known as the '30 by 30' initiative. The rationale behind this is that Singapore needs to import 90% of all food, which puts it at the mercy of food exporting countries. Even though Singapore diversifies its food imports from over 170 countries, the 30% self-production target by 2030 would provide a much-needed buffer in times of disruptions, which would reduce our vulnerability and achieve greater stability in Singapore's supply of food.

As the COVID-19 situation underscores the importance of local food production as part of Singapore's strategy to ensure food security, the Singapore Food Agency rolled out a "30 by 30 Express grant" in April 2020 to further strengthen food security, as part of its goal to meet the '30 by 30' target. Under this initiative, 9 farms, including IFFI, were awarded almost S$40 million in grants to increase local food production. The grant award could be used to defray costs of expanding production capacity within the next 6 to 24 months, which in turn creates more jobs in the agri-food industry and helps local SMEs.

Mr Tham continued by touching on the increasing importance of the agri-food sector in ensuring adequate food supply for Singapore as well as Asia and the world at large. He highlighted Singapore's vegetable consumption statistics: as Singapore's annual vegetable consumption stands at 90,524 tons and the current annual product is 12,698 tons, Singapore is 14,459 tons short of meeting its '30 by 30' target.

Harnessing innovative technology

Mr Tham went on to talk about his company's efforts to manage indoor farming, as well as to harness innovative and automated smart urban farming solutions, to support Singapore's food security efforts. He touched on the strong government support received to drive company efforts to ensure sustainable food supply through farming, solutions to support farm operations, F&B and retail concepts to create awareness and demand, as well as IFFI's initiatives to educate the next generation.

Through the webinar, participants had the rare opportunity to witness the technology used to drive IFFI's indoor vertical plant factories, including high performance growth lights, water treatment systems, recycled carbon dioxide technology, artificial intelligence and robotics, ergonomics growth racks, farm automation and positioning systems, crop recipe and farming methodology and cultivation systems. He also showed them images of IFFI's modular growing trays.

In order to enhance plant quality, IFFI implements bacteria control to effectively use plant microbes and water treatment for enhanced growth and stress resistance. Lighting control enables factory workers to use wavelength and

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intensity variations to improve crop flavours. Nutrient control allows factory workers to identify the right nutrient mix for respective plant species and develop customised nutrient recipes for vitamin and antioxidant rich plants. Environmental control enables workers to implement temperature, humidity and carbon dioxide concentration control for higher yields and quality.

Lastly, Mr Tham touched on the current major project of IFFI, namely the IFFI Mega Indoor Farm, which is currently undergoing construction and will be ready by end-2021. The goals of this project are to ramp up vegetable production capacity in Singapore for local consumption, develop a highly productive farming system based upon indoor precision farming techniques, and create a training facility to also equip the next generation with skillsets to manage indoor farm operations.

During the Question-and-Answer segment that followed, fellow Co-Founder of IFFI, Mr Nelson Lim, shared that the vertical farming method deployed at the IFFI Mega Indoor Farm allows the farm facility to be effectively compacted. This entails that the headcount required at this farm can be decreased from the estimated 120 people required to run the farm under conventional farming methods to the 40 people required using vertical farming.

All participants of the session found the event to be highly enriching and relevant to food security and technology, which are highly pertinent issues of Singapore. In particular, the session outlined the efforts Singapore and IFFI are taking to reduce import reliance and enhance food security. We look forward to more of such exciting sharing sessions in the future to deepen our knowledge.

Vertical farming has enabled IFFI to deploy its manpower more efficiently with just 40 people to run its operations in contrast to conventional farming, which requires at least 120 people to run the operations.

CREATING A SUSTAINABLE WORLD

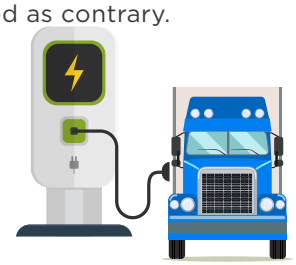
For nearly three decades, the United Kingdom has been bringing countries together to battle climate change. With the climate reaching an irreversible state, nations began to adopt a more proactive approach to end the devastating effects of climate change. The 2021 United National Climate Change Conference (COP26) marks a watershed moment for nations to act and make climate change a priority. Find out more about how Technical University of Munich (TUM) and TUM Asia has risen to this challenge through research, teaching and entrepreneurial action across multiple disciplines spanning the natural sciences, life sciences, engineering, the humanities, social sciences, economics and medicine.

Integrating Wild Animal Needs into Urban Planning

An interdisciplinary scientific team led by Prof. Dr. Wolfgang Weisser, Professor of Terrestrial Ecology at TUM, has developed a method to integrate the needs of wild animals into urban planning. This enables an integrated consideration of housing construction and nature conservation and combines these issues that are often viewed as contrary.

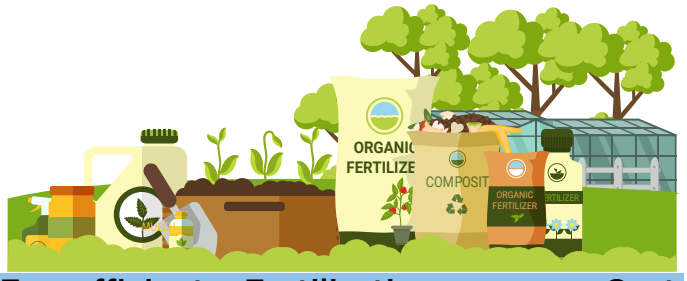
Faster, More Sustainable and Smarter Travel

The Department of Aerospace and Geodesy is developing the Hyperloop, a climate-neutral, ground-based transportation technology for ultrafast links between mobility centers. In the initial phase of the programme, a 24-meter demonstrator will be built with a matching passenger capsule.



Electric Trucks: Ultra-Fast Charging in the Megawatt Range

To enable a long-distance truck to cover 500 kilometers or more per day, its battery would have to be charged rapidly and frequently - big change for drivers as they only have to refuel once every five days. In the NEFTON project, which is funded by the Federal Ministry of Economics, researchers at TUM are working with partners from industry and research are developing the prototype of an electric truck and a corresponding charging station.



Eco-efficient Fertilisation as a Cost Effective Protective Measure

A team of TUM researchers from the Department of Plant Nutrition has now developed a concept to calculate the societal and environmental benefits of using urease inhibitors. They calculate a benefit of urea emission reduction for ecosystems and human health of 17.5 euros per kilogram of urea emission on average while only increasing the cost of urea fertiliser by about 10 percent, which equates to less than 10 cents per kilogram of nitrogen.

DID YOU KNOW?

416 PARTS PER MILLION

The concentration of CO_2 in our atmosphere is the highest (July 2021) recorded.

0.98°C WARMER

Average global temperatures in 2020 was 0.98°C warmer than the 20th century average — second-hottest year on record.

50% SPECIES LOSS

Climate change could cause some animals in Africa to decline by as much as 50% by the end of the century, and up to 90% of coral reefs in the Pacific Ocean may bleach or degrade by 2050.

21-24cm SEA LEVEL

Global sea level has risen about 21–24 cm since 1880 - a third of it coming from the past 25 years.

800 MILLION PEOPLE

11% of the world's population is currently vulnerable to climate change impacts such as floods, heat waves, extreme weather events and sea-level rise.

SOURCE:
https://www.tum.de/die-tum/die-universitaet/nachhaltigkeit
https://www.conservation.org/stories/11-climate-change-facts-you-need-to-know
https://www.scientificamerican.com/article/climate-change-is-becoming-a-top-threat-to-biodiversity/

TUM Coordinates Future Laboratory for Green Hydrogen

Hydrogen from climate-neutral sources is regarded as one of the most important energy sources of the future. Accordingly, TUM is opening an international Future Lab with researchers from 13 countries to coordinate the research on Green Hydrogen as an alternative fuel produced with renewable energies. The German Federal Ministry of Education and Research will provide as much as five million euros for sustainability research.

TUM Asia to Nurture More Technology Leaders Specialising in Sustainable Food

More than a third—34%—of man-made greenhouse gas emissions come solely from food systems globally, which generates an average of 2 tonnes of CO2 per year. Thus the need to establish a sustainable global food system is critical in producing enough food for a growing world population while mitigating the effects of climate change. In light of this, TUM Asia is planning to launch a sustainable food programme to increase the global talent pool, specifically in Singapore, to specialise in the global food system and sustainability. This programme in Sustainable Food will provide advanced scientific knowledge in Food Technology, Food Safety and Food Science, and bridge the connection between fundamental knowledge, while incorporating sustainability in industrial applications to address the research and practice gaps in the food industry.

Microalgae-Based Alternatives to Combat Overfishing

The demand for fish is increasing worldwide, with most stocks already being overfished and aquaculture often polluting the environment. The Koralo team, a student team from TUM, has created a microalgae-based alternative that mimics the taste and texture of fish. To do this, they have expanded a traditional fermentation technique that is not only cheaper than fish products, but one that is rich in healthy nutrients. It will be integrated in the TUM Venture Lab Food / Agro / Biotech in the future.

TUM Asia to Provide Skills Training in the Mechanical Recycling of High-Volume Plastic Waste

As part of TUM Asia's commitment to sustainability, the campus is organising a complimentary two-day online workshop to empower more individuals and organisations in Singapore in the mechanical recycling of high-volume plastic wastes to achieve a higher circularity of plastics. TUM is also supporting Singapore in its efforts to become a technology pioneer in the field of environmental protection for Southeast Asia. Specialising in closed loop recycling management, the CirculaTUM, a research alliance that consolidates expertise in the field of Circular Economy throughout the entire university and across discipline and site boundaries, will work together with the Plastics Recycling Association Singapore (PRAS) to drive progress in plastics.

COP26 : MAKING CHANGE FOR OUR PLANET

LIMIT GLOBAL AVERAGE TEMPERATURE INCREASE TO 1.5°C - 2°C

Countries reaffirmed the Paris Agreement goal of limiting the increase in the global average temperature to below 2°C above pre-industrial levels and pursuing efforts to limit it to 1.5 °C.

45% CO_2 EMISSION

Carbon dioxide emissions must be reduced by 45% to reach net zero around 2050.

30% METHANE EMISSION

103 countries, pledged to limit methane emissions by 30% by 2030,

FOSSIL FUEL

Countries ultimately agreed to a provision calling for a phase-down of coal power and a phase-out of "inefficient" fossil fuel subsidies.

FOREST

137 countries commited to halt and reverse forest loss and land degradation by 2030.

CARS

Over 30 countries, vehicle manufacturers and other contributors, strive for new car and van sales to be zero-emission vehicles by 2040.

SOURCE:
https://www.fao.org/news/story/en/item/1379373/icode/
https://www.un.org/en/climatechange/cop26

ENGINEERING THE NATION'S DEFENCE

Nicholas Leong Wei Jun, Best Student, BSc in Electrical Engineering and Information Technology in 2020

For many youths, the future can be rather daunting. Spoilt with a plethora of career choices and opportunities, it does take insurmountable courage and leaps of faith to choose a path that determines their future career trajectory. But for Nicholas Leong Wei Jun, Best Student, BSc in Electrical Engineering and Information Technology in 2020, his goal and vision were clear.

Having enlisted as part of the mandatory national military service for all eligible Singaporean males, Nicholas had the opportunity to witness the prowess of Singapore's military and gain a profound appreciation for well-established national security.

Now at the prime of his life, twenty-seven-year-old Nicholas has become the pride of any nation. Guided by an unwavering belief in his nation and the righteousness of securing the nation's defence, Nicholas has since charted a career path that would bring him to play a central role in securing the nation's defence.

Mandatory conscription is a rite of passage that all Singaporean males undergo when they turn 18 years old. For many, it is a mere stint in life, but for Nicholas, it became his life's mission to serve his country.

Having attained a scholarship with the Singapore Armed Forces with his exemplary results, he enjoyed a wealth of choices that would propel him forward in his career. For most local students, local universities would naturally come to mind. For Nicholas however, he decided to take an unconventional path and pursue a bachelor's degree in Electrical Engineering and Information Technology conferred by the Technical University of Munich (TUM).

"The excellence of German Engineering is well known in the engineering arena. There is science towards technology, but I believe there are some

forms of art in them as well. The artistic approach that the Germans take towards its technology is admirable. There is the global perspective I have gleaned from my learning journey at TUM Asia, and it is an attribute I could bring across the table where I work," said Nicholas.

Readiness – a lesson well learnt

On 5 July 1950, a group of American soldiers, known as the Task Force Smith, were left to their own devices. With some leftover Bazookas, the battalion hobbled a crude defence against the advancing army. Against the fully armoured North Koreans in T-34s and tanks, it was butchery. Within four hours, more than 40 per cent of Task Force Smith were decimated. The episode continues to ring as a painful reminder of the devastating consequences at the cost of casualties when a country is caught off guard.

Technology and innovations in peacetime

Since then, the defence sector has invested heavily in research and development to be a step ahead of its adversary and gain first-mover advantage. Consequently, technology has effectively disrupted modern warfare, giving rise to a new war paradigm. Departing traditional forms of military power and engagement in open confrontation, warfare in modern times leverages revolutionary technologies such as unmanned drones that may push the involvement of humans down to the bare minimum.

Using a combination of robotics and precision mapping, unmanned aerial vehicles can be deployed to strike buildings or individuals. The use of fly-by-wire systems has been pivotal in enabling safer and more efficient flight by replacing manual flight controls with an electronic interface that uses signals generated by a computer and transmitted by wires to move control mechanisms.

Underpinning these magnificent technologies lay the irreplaceable building block of data.

With new war paradigms, rules of modern warfare upended in the evolving landscape, the conception that national defence relies on monumental efforts in coordinating legions of armies may soon be obsolete. This is the future of defence. And Nicholas could see how his skills and knowledge gleaned from his learning journey at TUM Asia would address the dynamic landscape of national security and how it could contribute to the nation's defence. The learnings that he has gleaned from his education at TUM Asia has enabled him to achieve strategic agility and readiness at his work and enabled him to support the operation of modern military.

Beyond his work, it was the memories of hunkering together with his classmates he cherished most.

"The TUM's curriculum can be quite rigorous. I believe it truly brought us together. I remember vividly how our lecturers warned us about an impending test where the failure rate was more than 50%. My course mates and I encouraged each other and studied hard for the examinations. In a remarkable turn of events, we had passed the test. What has nested deeply in me is the close-knit bond and camaraderie that I've stitched with my course mates - something that I will truly cherish."

NICHOLAS LEONG WEI JUN

"What has nested deeply in me is the close-knit bond and camaraderie that I've stitched with my course mates - something that I will truly cherish."

CARVING A NICHE IN AERODYNAMICS

Anubhav Gokhale, MSc in Aerospace Engineering Graduate

The roots of aerospace engineering can be traced back to the early days of mechanical engineering, with earliest sightings of sketches of flight vehicles drawn by Leonardo da Vinci. For Anubhav Gokhale, a Master of Science in Aerospace Engineering graduate, his interest in aerospace engineering could be traced all the way back to his childhood. For him, it was a dream come true.

Bearing a quiet and composed demeanour, Anubhav spoke in measured cadence, yet it was apparent when the topic of aerodynamics came up, he spoke with much gusto that each utterance was brimming with passion.

Chartering a path to a dream come true

Knowing what he likes at a tender age certainly gives him an edge in life. Yet life was never an easy path to walk, never knowing where it would lead one to. Despite knowing what he wants to pursue in his career, Aerospace Engineering was not a common course of programme in India. “There aren’t many institutes focusing on Aerospace Engineering in India, so I studied Mechanical Engineering with a mind to further my studies in Aerospace Engineering in future,” explained Anubhav.

Taking a leap of faith

With a steely resolve to carve a niche for himself, he flew across thousands of miles to Singapore to pursue Aerospace Engineering at some of the leading learning institutions – Technical University of Munich (TUM) Asia and Nanyang Technological University (NTU) – in the world. It was the first step into the life he envisioned himself. This passion also gave him the courage to traverse across the globe – Germany – where he is currently pursuing his PhD in Aeorodynamics at Institut für Flugantriebe und Strömungsmaschinen (IFAS), a part of TU Braunchweig.

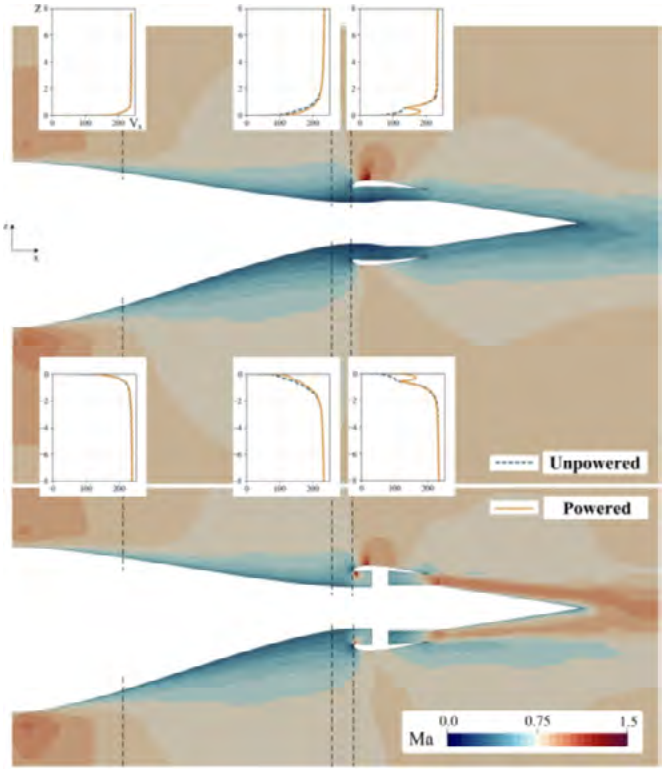
Starting out at TUM Asia was a flurry of unfocused activity where he did not exactly know how these random pieces would fit nicely together.

"Aerospace engineering is a very diverse field of study. From designing the wing of an aircraft, designing components to optimising the air flow – which can be employed in turbines or even for a conventional household fan – the basic theory is the same. The only thing that changes is the design process, and that's what I love to do," explained Anubhav.

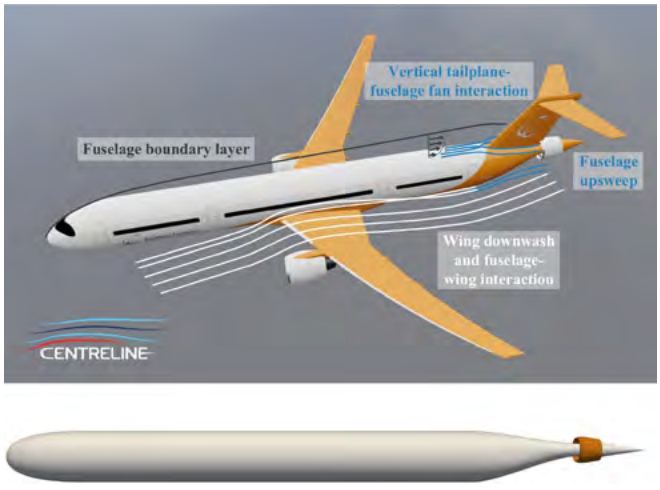
"The overall structure has provided a base knowledge and the application of the entire aerospace industry. In the first semester, we learn about modular structure that provides details or specialised understanding of the structure of an aircraft, and its limitations. The base knowledge is very important and forms the foundation of our specialisation in aerospace engineering," Anubhav elaborated.

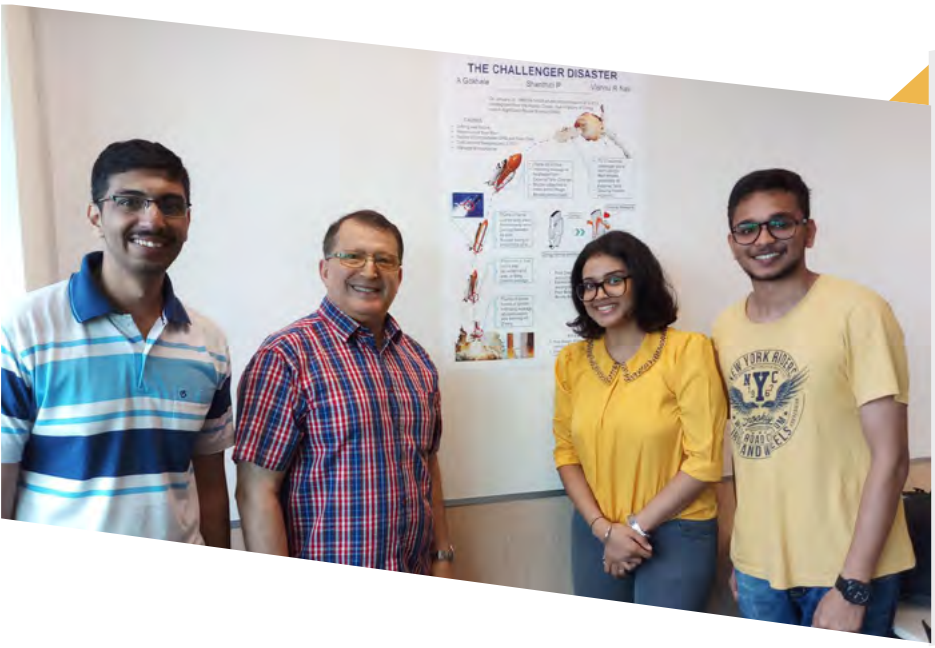
The amazing memories Anubhav have had with his classmates at TUM Asia will continue to be with him wherever he is.

With so much to learn, anyone would probably be at a loss not knowing where and how to begin. He then began to approach several professors, hoping it would bring a spark of inspiration for his thesis. It was through his conversations with professors like Apl. Prof. Dr.-Ing. habil. Christian Breitsamter, and Prof. Dr.-Ing. Mirko Hornung, where he found his calling in the research on Boundary Layer Ingestion – a method in reducing fuel consumption in aircraft.



In Anubhav's thesis, he explored the different geometric profiles of the boundary layer ingestions and ran a series of simulations to discover the most optimal geometric profile that would improve the performance of the Boundary Layer Ingestion.





Studying at TUM Asia has not only offered him a real glimpse into the dream he envisaged himself in, but also perhaps, the first step into the life he has been working so hard for.

Reducing fuel consumption in aircraft

The current placement of the engine on an aircraft is designed under the wing or near the tail of the aircraft, which minimises the aircraft from ingesting the layer of slower airflow that develops along the aircraft's surfaces, also known as the boundary layer. In recent years, a new promising method has surfaced, known as the Boundary Layer Ingestion, where the engine is situated at the back of the fuselage. This enables the aircraft to ingest the slower boundary layer air flow, to generate the thrust needed to propel the aircraft through its mission.

It might seem a cosmetic change, yet airflow is highly varied and can greatly affect the performance of the engine.

In Anubhav's thesis, he explored the different geometric profiles of the boundary layer ingestions and ran a series of simulations to discover the most optimal geometric profile that would improve the performance of the Boundary Layer Ingestion.

"There were challenges in writing the thesis but that is a natural part and parcel of any research. Besides, this was something that I had not done before. For example, developing a new code for boundary layer ingestion took me some time to get used to," quipped Anubhav.

Studying at TUM Asia has not only offered him a real glimpse into the dream he envisaged himself in, but also perhaps, the first step into the life he has been working so hard for. Shortly after his study stint with TUM Asia, he continued his learning journey in Germany with IFAS. Currently, he is continuing his PhD at the Department of Aerospace at TU Delft in the Netherlands.

The future of aerospace engineering

While the aerospace engineering landscape may have altered dramatically since the onset of COVID-19 pandemic, Anubhav still has high hopes for the industry.

"The research arm of aerospace engineering is impacted as we are not sure if we could continue designing aircraft in the same way as before. As precarious as the situation can be, the answers will probably surface in the next few years. We could potentially design to build segregation to minimise risks of infections. This could be the new normal, yet it provides some glimmers of hope for the future of air travel," explained Anubhav.

Leaving India that has been his hometown for more than 20 years was not an easy decision to make, let alone carving a niche for himself in a foreign land without a clear vision of how the future would pan out. Yet Anubav was undaunted. With a heart full of hope and courage to forge ahead, he is ready to take on the challenge no matter what life has thrown along his way.

"I'm quite set on spending the next 10 years in Europe to do what I like to do and gain as much experience as I can. The aerospace engineering industry in India is still in its nascent stage, but no one can say for certain of the future. Thus, I am keeping an open mind about that," explained Anubhav.

THE JOURNEY TOWARDS INDUSTRY 4.0 TRANSFORMATION:

TranZplus ENGINEERING

How Singapore's small and medium enterprises (SMEs) became one of the early adopters of Industry 4.0

The manufacturing sector has suffered much disruption during the pandemic. With such disruptions as supply and demand shocks, growing dominance of e-commerce, and increasing complexity in supply chains, SMEs are hard-hit by setbacks after setbacks. In the face of an uncertain future, companies are gearing up for digital transformation to keep up with emerging customer demands and gain a better edge in an increasingly competitive landscape. While the integration of Industry 4.0 technologies has proven to be effective vehicles for long-term organisational resilience, for SME such as TranZplus Engineering, the degree of success in their transformation are matters of life and death of a company.

But what does it take for companies to achieve Industry 4.0 success? What are some of the more significant barriers and potential pit holes that companies who are intending to embark on their own Industry 4.0 journey could avoid? Let us find out more about the digital transformation journey of TranZplus Engineering.

From a mechanical components distributor to a comprehensive solution provider

Established in 2000, TranZplus Engineering began as a distributor for mechanical components.

"We kept our communication channels open and strived to be transparent. We shared these findings with our employees and elaborated how the transformation would boost our productivity and efficiency, provide flexibility, and increase profitability through delivering an exceptional customer experience."

- Mr Nelson Lim
Chief Executive Officer,
TranZplus Engineering

It grew to become a comprehensive engineering solutions provider, providing manufacturing components that undergo extensive multi-process engineering for its customers.

In light of the growing competition, TranZplus Engineering recognised the need to transform digitally to develop resilience and agility. When they engaged an external consultant to evaluate their processes and technologies, the findings were unexpected. There were several pain points, such as inaccurate inventory management, logistics and supply chain issues and a long lead time of 17 days which led to a low on-time delivery of 63 per cent. The insights jolted them to immediate action. Together with the consultant, they established a six-month transformation roadmap and embarked on their Industry 4.0 journey.

Embrace the change: attaining universal buy-in

Any integration of new systems and technologies will always be preceded by a series of teething issues such as application compatibility, and tweaking of settings for maximum performance. But the bigger block to successful transformations is changing people's mindsets. Naturally, employees who were comfortable with the traditional ways of working resisted the change initially. "We spoke to our employees at all levels about the need for transform digitally. We kept our communication channels open and strived to be transparent. We shared these findings with our employees and elaborated how the transformation would boost our productivity and efficiency, provide flexibility, and increase profitability through delivering an exceptional customer experience." said Mr Nelson Lim, CEO of TranZplus Engineering.

Building capabilities: Industry 4.0 training

To bring the organisation through this Itransformation, TranZplus Engineering needed the necessary capabilities to operate the digital technologies and cultivate a digital-ready and agile culture. Over three months, employees underwent the essential training required to build the capabilities and know-how to navigate the new processes, technologies, and systems. Employees were also taught how to employ the Lean methodology, an approach that aims to handle work in a lean way by focusing on providing high levels of customer value through the continuous improvement of business processes.

"Work with an external consultant and select one or two domains that are most suitable to implement based on the insights and findings revealed."

- Mr Nelson Lim
Chief Executive Officer,
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(Photo Credit: zaobao.sg)

Small wins, big success

To boost employee morale and drive the change throughout all departments, employees began making regular, incremental improvements to every aspect of their operations. Employees from administration, human resources, and sales departments worked together in teams to increase productivity by implementing the methodologies learnt. Overall, processes such as assembly, gained an improvement of 40 – 60% in productivity. The employees were ecstatic and were greatly motivated by how these slight changes could greatly boost their productivity and efficiency.

Incorporating Industry 4.0 domains into the factory floor

For a company to be considered as Industry 4.0 ready, the following domains are required to be incorporated into its factory floor: Data Computational Power and Connectivity; Human-Machine Interaction; and Analytics and Intelligence. Understandably, the cost to implement all domains would be too astronomical and overwhelming to execute. In counter to this issue, Mr Lim advised, "Work with an external consultant and select one or two domains that are most suitable to implement based on the insights and findings revealed." For TranZplus Engineering, they eventually went with Industrial Internet of Things (IoT) and Industrial Human-Robotics Collaboration that eventually led to a high on-time delivery of 91%.

Implementing Industrial IoT

To cater to customers' needs in precision parts fabrications, TranZplus Engineering boasts a wide array of precision machining and quality control capabilities to ensure the parts are fabricated to the tee. However, these machines were operating at a utilisation rate of 30 – 40%. Naturally, this impacts its efficiency.

By creating a remote machine monitoring service with IoT sensors installed on their machines, the machines were able to operate at a higher utilisation rate, which raised their efficiency and cut back on necessary operations when needed. Machine usage data were first gathered from its machinery and equipment and displayed on a simple graphical interface. Through the implementation of a monitoring system, employees can grasp insights and knowledge quickly in real-time of any production processes' efficiency and possible bottlenecks, which enabled them to recalibrate quickly to optimise utilisation of the machines.

Since the implementation of the production monitoring system, the utilisation rate of the machines increased to 50 – 60%.

Implementing a production monitoring system as the foundation of a "smart factory", is essentially a radical departure from traditional working methods. For TranZplus Engineering,

where employees were used to working in traditional silos, would complete their job without being fully aware of the overall product's status. This posed a problem when asked for an update or required the parts to be sent urgently. Employees would have to knock on all doors to find out the status and expedite its fabrication process. With a production monitoring system located at the machine, the status is updated in real-time. Supervisors were able to provide timely interventions and adapt daily plans to meet customer demands, improve labour productivity and operational efficiency – all remotely.

Transformation is a continuous journey fraught with unexpected complications. Executives and employees can be discouraged by the astronomical upfront costs or teething issues. For change to happen, leaders must stay convinced about the value of the digital transformations and committed to leading the pack through this extraordinary yet worthwhile Industry 4.0 journey.

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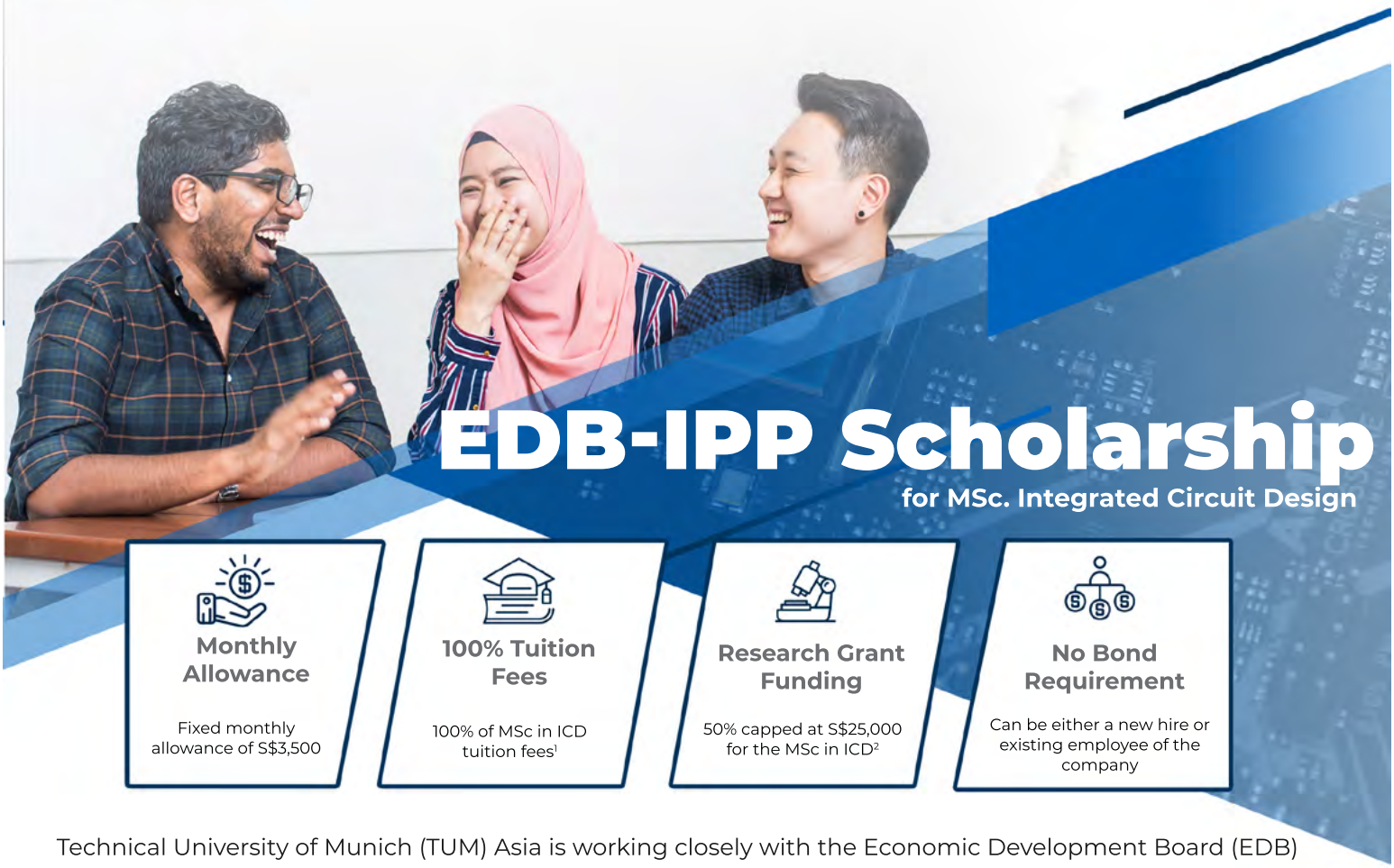
TUM Asia



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for MSc. Integrated Circuit Design

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Fixed monthly allowance of S$3,500

100% Tuition Fees

100% of MSc in ICD tuition fees[1]

Research Grant Funding

50% capped at S$25,000 for the MSc in ICD[2]

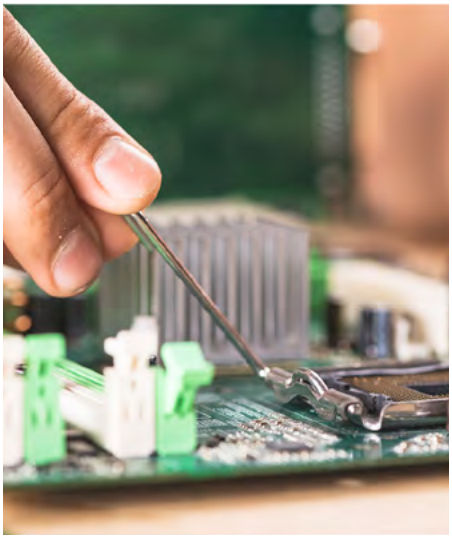
No Bond Requirement

Can be either a new hire or existing employee of the company

Technical University of Munich (TUM) Asia is working closely with the Economic Development Board (EDB) and Singapore Semiconductor Industry Association (SSIA) to provide postgraduate students with industry relevant training in the area of Integrated Circuit Design. With the EDB-IPP Grant, students have the opportunity to take on Research & Development (R&D) roles in the industry while companies are able to attract talent to fulfil their R&D roles. TUM Asia is committed to support training positions which provide postgraduate training to eligible candidates, and to prepare students for research-intensive roles with strong industry relevance and focus.

Trainee Eligibility

- The trainee must be a Singapore Citizen or Permanent Resident.
- The trainee must not be receiving concurrent funding under any EDB grant schemes, or, regardless of the awarding body, any bursaries or scholarships.
- The trainee must meet the prevailing admission criteria for the MSc in Integrated Circuit Design (MSc in ICD).
- There is no bond requirement. The trainee can be either a new hire or existing employee of the company.
- Each trainee will be placed under an ICD training position, in which he/she will be enrolled for the MSc in ICD, while undertaking a research project under their company's supervision for the purposes of completion of the Master's thesis.



Interested applicants please write in to **admission@tum-asia.edu.sg**

[1] Items which may be claimed under this grant component include: tuition fees, examination registration fees, and fees for other mandatory academic activities. All taxes, including but not limited to GST, are not claimable.

[2] Items which may be claimed under this grant component must be related to the Project, and include: (i) funds paid to University for usage of lab equipment/consumables at the University R&D laboratory, or software procured for the completion of the academic degree; (ii) funds paid to University to cover overhead charges incurred at the University R&D laboratory; and (iii) funds paid to University and Trainee for publication of research work and participation in research conferences (including the overseas travel expense incurred for such conferences, such as travel insurance, accommodation, meals, local transportation). All taxes, including but not limited to GST, are not claimable.

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Office of Marketing Communications

SIT@SP Building

510 Dover Road #05-01

Singapore 139660

Tel: +65 6777 7407 | **Email:** events@tum-asia.edu.sg

Website: www.tum-asia.edu.sg | **Facebook:** www.facebook.com/tumasia

German Institute of Science & Technology - TUM Asia Pte Ltd

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