VORTEX
Publication of the Singapore Institute of Aerospace Engineers
MCI(P)079/01/2021 | Jan-Mar 2021 | Volume 8

The Beginning of eVTOL Aircraft & Urban Air Mobility – *an autobiography*

Professor James Wang
Director of eVTOL Research and Innovation Centre
NTU

© Brandlab / Skyports / Volocopter / GRAFT

Allow me to rewind the clock back ten years. Back in 2010 when I was the Vice President of Research and Development at AgustaWestland Helicopters (renamed Leonardo Helicopters in 2017), one of my responsibilities was to manage the technology strategy for the company. The other responsibilities were to innovate and lead cutting edge research to leap-frog competitions.

My technology strategy comprised three stages; short term, medium term and long term. The short term projects looked at what we can do to improve the current helicopter products. Research projects for the medium terms included looking at Version 2.0 of the current helicopters. Long term strategic projects explored blue sky ideas and disruptive innovations, for example, future vertical lift aircraft configurations. Through brainstorming sessions in 2010, I came up with the idea of Vertical Takeoff & Landing (VTOL) aircraft powered by electric or hybrid-electric energy sources.

Back then no one in the world has done an electric VTOL aircraft (eVTOL) because the idea did not exist. With management approval, I pulled together a team to develop the world first eVTOL - Project Zero. The project goal was to investigate electric propulsion and build a technology demonstrator to validate eVTOL. The R&D project was a success – we created a disruptive vehicle configuration with individual blade control and validated the electric power architecture all within 6 months and flew it in 2011. Project Zero was unveiled at the 2013 Paris Airshow! Even though the maximum endurance was only 10 minutes using 170 Wh/kg lithium batteries, it created a worldwide curiosity and interest in eVTOL.

From then on, many groups from around the world started exploring eVTOL. eVTOL potentially could be greener, simpler, and less expensive to operate than conventional helicopters. In 2016, the on-demand car service company, Uber proposed an air taxi service and fuelled the race for eVTOL development. This concept is known as Urban Air Mobility (UAM). The dream was to have eVTOLs operating from many vertiports in urban cities like Los Angeles, Paris, Melbourne, Dubai, and many others and an ambitious target to move 10,000 passengers per hour per vertiport. If we multiply that by 20 vertiports per city, it would mean that 200,000 people would be traveling on eVTOL per hour per city. If each eVTOL, or air taxi, can only carry 4 passengers, it would require tremendous number of eVTOLs. This is why so many startups are exploring eVTOL. Realistically, such scenario would possibly not be achieved till 2035 to 2040. By 2025, we might start seeing some cities commence air taxi operations using eVTOL on a limited scale. For example, Singapore is already planning to start operating eVTOL for sight-seeing purpose around 2023. Paris is targeting to operate eVTOL flights during their 2024 Olympics in Paris.

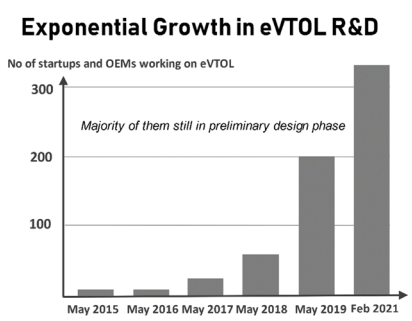
Contents

The SIAE Newsletter is published quarterly by the Singapore Institute of Aerospace Engineers.

For enquiries, please email aero@siae.org.sg or Whatsapp SIAE @ (65) 8227 5291, ATTC @ (65) 8494 8180. Website: siae.org.sg

Project Zero at the 2013 Paris Airshow

As of March 2021, the Vertical Flight Society has catalogued, on its ***website***, more than 300 electric and hybrid-electric VTOL aircraft. However, none of them has yet become a true product. The challenges include their short flight endurance, and the regulation for how to incorporate them into civil airspace for commercial use is still being explored. Despite there are couple billions of US dollars invested in eVTOL development today, majority of these startups will not survive because there are not enough experienced rotorcraft designers and the funding is still insufficient to support 300+ companies and groups working on eVTOL design. It is foreseeable that by 2030, we may see about 20+ eVTOL groups thrive far above the rest.



In 2011, the Project Zero eVTOL that I designed could only fly for 10 minutes if we drain the battery completely. To make eVTOL viable, the specific energy must improve to become 400-500 Wh/kg by 2025 and to 600 - 800 Wh/kg by 2030. With endurance of about an hour, only then it would become a reality for UAM.

Packing tremendous energy into a compact volume requires extreme care in handling. Lithium cells could ignite due to a short, puncture, high internal temperature, faulty charging procedure, and many other reasons. Once a rechargeable lithium cell ignites, the fire is difficult to stop. Rechargeable batteries must be used with extreme care when deployed. This is also what's learned by the automotive industry.

The technological and financial outlook for Urban Air Mobility (UAM) and Advanced Air Mobility (AAM) for the next 20 years is promising. We are researching and developing the next disruptive eVTOL aircraft, and I welcome companies to work with us.

Editor's Message

Greetings to a new workyear! With the easing of the COVID-19 restrictions, we began to see a slow but steady pick-up of international air travels, especially for business trips; some countries in our region are already planning to open borders for leisure trips. It is hoped that recovery would be further accelerated with the IATA travel passes.

SIAE conducted its 45th AGM and concluded the 5th series of the Aviation Safety Competition (ASC) in the last months. Gearing up to the travel revival, we have commenced the planning with RSAF for the next Singapore Airshow scheduled in Feb 2022. Despite the pandemic and disruption of Airshow 2020, the in-road of Urban Air Mobility (UAM) into the transport ecosystem of the city has continued with concrete roadmaps.

In this issue, we continued to provide updates on SIAE activities, key technological topics and changes in aviation which would be of interest to aviation professionals. An elaborate discussion and **outlook** of UAM was also included.

Till the next issue, enjoy the articles.

SIAE 45th AGM

Darrel Chua
Hon Secretary SIAE
Ivan Ong
M.SIAE

SIAE 45th AGM was conducted on 13 Apr 2021 in a hybrid setting. It was delayed by almost a year due to various factors, including delays in getting information from our former subsidiary company to complete the financial report. Working within COVID-19 restrictions, five members of the ExCo hosted the AGM at Flightech Systems Pte Ltd. thirty members attended AGM via Zoom.

SIAE President Prof Lim Yeow Khee opened the meeting by thanking members for their participation and continued support. Prof Lim, currently in his 4th term as President, highlighted the urgent need to find suitable candidates for the next SIAE President.

Annual Report and Financial Report

Hon Secretary Darrel Chua reported that membership had remained relatively stable, with 119 Individual Members and 6 Corporate Members as at Mar 2020. The year also saw the 15th Café Aeronautique being held at Nanyang Polytechnic's Aerospace Lab, where Prof Lim led the discussion on the topic of "Can we trust computers to fly aircraft?". The Aviation Safety Competition (ASC) for Cat A (students under 16 years) was completed in 2020. That was the 5th ASC to be held since its inauguration in 2015.

It was unfortunate that Singapore Aerospace Technology and Engineering Conference (SATEC) 2020 had to be cancelled. Despite the setback, SIAE continued to reach out to our members and next generation aviation professionals (NGAP) via the Vortex publication. Four issues of Vortex were published from Apr 2019 to Mar 2020. We have suspended hard copies circulation and all past issues are now available for download on SIAE's ***website***.

Presenting the financial report, Hon Sec Darrel explained that the net loss of SGD 8,889.48 was mainly attributed to the cancellation of SATEC 2020.

Prof Lim thanked our Hon Internal Auditors, Mr Ivan Wong and Mr Lloyd Lazaro for their hard work during these difficult years. The AGM elected Mr Chandran Sanmugan and Mr Fung Yee Tik as the new Hon Internal Auditors.

Issues Raised by Members

Hon Fellow Michael Loong asked about SIAE Consultant's activities citing potentials for SIAE members' expertise and experience to be put to good use. Hon Sec Darrel shared that SIAE Consultancy was deeply involved in the divestment of ATTC, searching for suitable investors to help us transform ATTC to higher value-added services to manage the high overhead cost of the hangar. Several interested parties went through rigorous due diligence facilitated by SIAE Consultant. Vaayu Group, a global company providing aviation services and aircraft maintenance training was recommended and accepted by the ExCo.

Member Chan Sig Yam asked whether we continue to carry liability for ATTC's financial commitments before the transfer of ownership. Darrel replied that Vaayu has agreed to take over all of ATTC's debts and business losses.

Student member Muhammed Ashik asked about Student Group activities in SIAE. ExCo member Kelvin Ong explained that plans are underway for a Student Chapter in various IHLs. Student Members can benefit by actively organising and participating in On-Line activities which are being planned for the coming year. Vortex Editor-in-chief, Lim Chui Ping further extended her invitation to all student members to join the Vortex Team to contribute articles and share their thoughts.

President Lim rounded up the AGM with a positive note of the impending recovery of aviation. We are currently forming the SATEC 2022 Committee and creating new activities. *"It is through taking on challenging tasks, like chairing a sub-committee that members can benefit most. You get to be involved with people from all sectors of aviation and experience first-hand working in the aviation culture"* said Prof Lim.

Undercarriage Design

Foong Zhi Yu
Aeronautical Engineering Undergraduate, Imperial College London

70 Elephants - *a whooping 280,000kg!*

That is the equivalent maximum take-off weight (MTOW) of the Airbus A350 XWB! What's amazing is that this entire weight, is only supported by three oleo-struts in a tricycle configuration. Further, in the event of extreme conditions of crosswind landing, a single main undercarriage assembly may have to withstand the entire landing impact! Because of this stringent requirement, most commercial aircraft utilises multi-bogie wheels for each undercarriage as it distributes the load evenly such that in the event of a burst tyre, there are multiple redundancies.

Airbus A350 XWB Undercarriage © Adrien Daste / Safran

The undercarriages are classified accordingly to configurations – Single Main, Taildragger, Quadricycle, Bicycle, Tricycle and Multi-Bogey. Majority of commercial aircraft have a tricycle configuration due to their huge advantages for pilot visibility, ease of loading and unloading as the fuselage is kept horizontal, allowing stronger application of brakes without the risk of nosing over and preventing ground looping. The undercarriage is typically positioned such that the nose gear will withstand 8-15% MTOW[1] while the main gear withstands the rest. The nose gear enables easy steering on the ground. This configuration, h owever, has a weight and drag penalty due to the nosewheel strut and thus reduces the aircraft payload.

[1] *MTOW is defined as the maximum weight of an aircraft allowed for it to take-off taking into consideration its structural and regulatory constraints.*

When in flight, the undercarriage needs to be retracted to reduce unnecessary drag. For the main gear, this can be achieved in a variety of ways such as retracting into the wing or wing-fuselage junction. The nose gear however is usually configured to retract forwards into the fuselage such that in the event of hydraulics failure in flight, the gears can still be deployed by air loads, allowing for a safer landing.

On a related note, did you know that aircraft cannot just land at any airport or runway? The ICAO requires the use of the Aircraft Classification Number-Pavement Classification Number (ACN-PCN) method as the only acceptable method for reporting runway strength and aircraft suitability for aircraft with apron mass greater than 5700kg. Aircraft can only land at the runway if its ACN is smaller than or equal to the runway's PCN. This ensures that the aircraft landing does not cause any structural damage to both the runway and the aircraft itself. Aircraft designers typically use the user-friendly Federal Aviation Administration's COMFAA code to determine an aircraft ACN from its undercarriage.

The main complexity of the undercarriage design lies with integrating the undercarriage to the entire aircraft. Aircraft typically have a range of centre of gravity (CG) positions that needed to be closely guarded to prevent aerodynamic instability or even the danger of overturn or tip back (the tail of the aircraft hits the ground). Placement of the undercarriage affects the entire CG of the aircraft, which would potentially incur aerodynamic instability or structural problems. A comprehensive CG analysis is mandatory for every iteration of the aircraft design process. Constraints during the design process such as available space for undercarriage retraction during flight or even structural restrictions resulting in limited positions where the undercarriage can be mounted under the wing, which affect factors such as wing position and engine placement are complex interdependencies. This iterative process of optimising the undercarriage placement demands that a multi-disciplinary team from various functional groups work together with effective communication to ensure that the aircraft designed fulfils airworthiness regulations.

Thus, next time when you board an aircraft and admire its beauty, be sure to also grab a look at the undercarriage flexing its might as it withstands those large amounts of forces and loads, made possible with many hours of engineering expertise and design.

Image from www.hydro.aero

Aircraft Painting

Andrew Connelly
Operations Manager – Singapore, SATYS

An aircraft overall colour and design is usually the first impression that customers have on the airline or aircraft operator/ owner. It is a statement about the aircraft/ airline and the owner of the aircraft/ airline.

However, from the technical and engineering perspective, aircraft painting is an important part of aircraft maintenance as painting an aircraft prevents corrosion. Typically, each painting could last about 6 years on a jet and up to 8 years on a turboprop.

The repainting of aircraft is a complicated and a skilled process requiring trained operators and the best advanced equipment. Repainting involved first stripping of old paint before any new paint can be applied, as existing paint will add weight to the aircraft. There are basically 3 layers of paint used – the primer, base coat, and top coat. The equipment used to paint the aircraft is an electrostatic paint system that also reduces waste and cost, as the aircraft is grounded to earth with the electrostatic guns providing the paint with a positive charge so that the paint is attracted to the aircraft using 95% of sprayed paint due to reduced over-spray and better wrap-around.

Bombardier's Singapore Service Centre has partnered with Satys Service, a French group which is active in aircraft painting, sealing and manufacturing interiors for aerospace and rail sectors, on a paint facility in Singapore. This facility will be opening for production in middle of this year. The new paint facility at Seletar will be to paint Bombardier Business jets but also able to paint larger commercial aircraft like the B737 A319. At this facility, all operators are trained by Satys instructors. The operators not only are required to be highly skilled painters, but must possess the required technical knowledge to be able to apply their know-how appropriately to meet any livery a customer may request.

By looking at the facility setup is already testament to the complexity in aircraft painting. The facility has two bays - one for preparation and one for painting. The bays are temperature and humidity controlled with down draft extraction. Workshops and paint component booth, as well as a water treatment plant to remove all volatile organic components (VOC) for a clean functional facility are critical infra requirements. Besides client rooms and offices to support all customers' needs, the facility had included a small graphics room and store room to support paint mixing scheme to be able to match all customers' needs for aircraft livery's.

Artist impression of the new facility

"We are very pleased to be working with Satys to provide impeccable paint capabilities at the Singapore Service Centre, offering enhanced service and support options for our Asia-Pacific based customers," said Jean-Christophe Gallagher, Vice President and General Manager, Customer Experience, Bombardier Business Aircraft. "Customer satisfaction is always a top priority at Bombardier and this key partnership will enhance reliability and expectations, further strengthening our support to our customers."

Aircraft painting to many is an art for the eyes but it is an essential aircraft maintenance technology that impacts safety and aircraft durability.

Aviation Safety Competition 2019/2020

The Aviation Safety Competition (ASC) 2019/2020 was recently concluded on a high note with the online presentation by Category B finalists. Another successful event by SIAE!

Lim Chui Ping
Vortex Editor-in-Chief, E.SIAE
Ivan Ong
M.SIAE

The presentations by ASC Category B finalists (selected from over 20 participating teams!) were grandly carried out on 30 Jan 2021, and for the first time, online. ASC is a competition aimed at generating interest in aviation and reaching out to students from secondary schools, polytechnics, colleges and universities to build a strong aviation culture for our Next Generation of Aviation Professionals.

This year marked the 5th iteration of the competition with the theme "Flying with Computers". We kicked off ASC 2019/2020 in Aug 2019 for Category A participants (students in Secondary academic levels) and in Sep 2020 for Category B participants (students in Tertiary academic levels).

In ASC competition, each participating team submitted an essay on their research on how computer systems have improved flight safety and how else can computer systems further improve flight safety. Prior to the essay submission, the teams were given lectures covering the use of computer systems in various aviation domains ranging from Airport operations, Aircraft maintenance and Aircraft on-board systems (Avionics). We were fortunate to have experienced aviation professionals as lecturers of these topics, providing great insights and conducting open discussions with the participants:

- **Prof Lim Yeow Khee**, Associate Professor (Adjunct), Nanyang Technological University
- **Michael Daniel**, Managing Director, Aviation Insight
- **Victor Lee**, Principal Regulator (CNS Regulation), Civil Aviation Authority of Singapore (CAAS)
- **Tan Chu Hiang**, Managing Director & CEO, Heavy Maintenance Singapore Services

Lectures and presentation by finalists of Category A competition were conducted as physical events at Singapore Polytechnic. That was before the COVID-19 pandemic. Due to COVID-19, the Category B competition was held online. The quality of the online lectures and discussions were as captivating and engaging.

To read more about ASC Category A in 2019, click on the icon to visit our previous publication.

Click on the icon to watch a video recording of the ASC 2021 Finals.

(From Top) Lecture on Avionics; CAT A Participants; Lecture on Airport Ops

For both Category A and B, a total of 5 teams were selected to present in the finals. Finalists delivered their final presentations using all the resources they had, highlighting their findings and solutions with videos and well-crafted presentations.

We congratulate the top 3 teams in each category. They have all demonstrated their understanding of the topic and abilities to articulate their ideas and technologies they foresee that would play a major role in the future of aviation safety.

Winners of Category A	Winners of Category B
Team Gryhons	NTU Aerosoc
Team Night Riders	SIMP Aero
Team Night Riders	NTU Engineers

The active participation in both Cat A and Cat B competitions is testament to the students' enthusiasm in aviation and their alignment to the importance of safety in the aviation industry. The SIAE Exco and ASC organising committee had enjoyed each of the journey and are encouraged by the prospects of our next generation aviation professionals. We look forward to next year's Aviation Safety Competition and hope that more students could participate and benefit from the events.

(Top Left) ASC Organising Committee; (Top Right) ASC Judges; (Below) ASC Finalist

MANY THANKS TO

Our sponsors, without whom the competition cannot happen:

- **SIA Engineering Company**
- **Aerospec Supplies Pte Ltd**
- **Diamond Aviation Pte Ltd**
- **PJE Group Pte Ltd,** for their extensive assistance in organising and facilitating this competition.

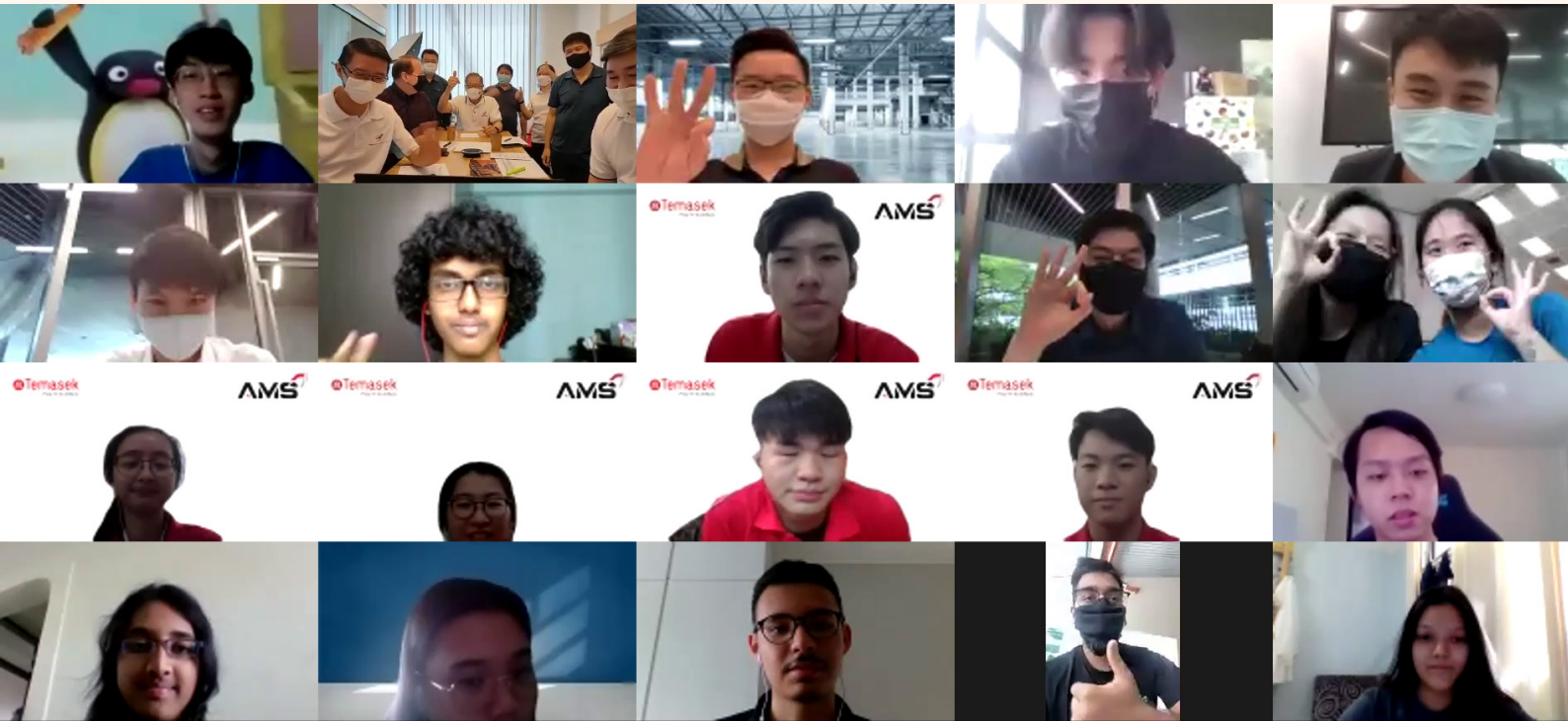
Our panel of judges for taking time out on a Saturday morning to assist in evaluating the presentations and provide great sharing opportunities with the finalists during the Q&A sessions.

Category A Judges:

- **LTC Danny Koh,** *Safety Inspectorate, HQ RSAF*
- **Victor Lee,** *Principal Regulator (CNS Regulation), Civil Aviation Authority of Singapore (CAAS)*
- **Kelvin Ong,** *Singapore Polytechnic (Aviation Academia)*

Category B Judges:

- **Mr. Chua Hock Hai,** *SVPHR, SIA Engineering Company*
- **Michael Daniel,** *MD, Aviation Insight*
- **ME7 Tay Gek Peng,** *Dy Head Air Engineering and Logistics, HQ RSAF*



Impact of Brexit on Aviation Regulations

Mr. Michael Daniel
SIAE Vice President

Brexit is a term familiar to many, and refers to the withdrawal of United Kingdom (UK) from the European Union (EU) at the end of 31 Jan 2020. After many months of negotiations, the UK and EU finally agreed on a deal that came into effect on 31 Dec 2020. We are sharing on the impact to the aviation industry.

UK-EU Aviation Safety Governance Transition

Now that the UK and EU are decoupled, there will be an impact on the UK safety governance. For the immediate, many countries depended on UK parts and materials in the aviation industry. In some instances, even the MROs are dependent on UK 's support for the products and type design that MROs are responsible for.

The UK-EU trade deal, announced on 24 December 2020, had included agreements on air transport and aviation safety which had come into effect at 23.00 GMT on 31 December 2020 when the UK ceases to take part in the EU Aviation Safety Agency (EASA) and other EU institutions.

While the agreements involve some elements of continuity, they do not constitute a replication of the UK's regulatory arrangements as part of the EASA/EU framework. Many sections of the aviation and aerospace industries will face changes after 31 December, as this microsite sets out.

If you are one of the many entities dependent on the UK aircraft/engine product design and certification, you can catch up on the latest news in the link below until full transition is achieved.

Visit CAA Website

Singapore, UK Sign Safety, MRO Agreements

The Civil Aviation Authority of Singapore (CAAS) and the UK Civil Aviation Authority (UK CAA) have signed two agreements on safety, security and training, as well as on aviation maintenance.

The first is a wide-ranging memorandum of understanding covering areas such as aviation safety and training, as well as emerging issues facing the aviation industry, such as cybersecurity and safeguarding public health amid the coronavirus outbreak.

In addition, Singapore and the UK have signed an agreement covering areas such as public health while travelling. "Under the MOU, a bilateral aviation steering committee will be established to drive the collaboration," CAAS states.

In the area of MRO, CAAS and the UK CAA have signed a technical arrangement on aviation maintenance, which will "facilitate the reciprocal acceptance of approvals" pertaining to MRO and aircraft components by both agencies.

The agreement also hoped to reduce regulatory compliance costs for MROs in Singapore and the UK, streamline audits, while maintaining safety standards. It is expected to benefit 70 MROs in Singapore and the UK.

At the EU end, in early December, CAAS and the European Union Aviation Safety Agency updated their bilateral working agreement, allowing Singapore aviation companies get speedier approval to use new and emerging technologies, such as electric-vertical take-off and landing aircraft.

For more information, you can check out Flight Global via the link below.

Visit Flight Global

Image created using content from freevectormaps.com

Design of eVTOL

Professor James Wang
Director of eVTOL Research and Innovation Centre
NTU

Nearly all eVTOLs designs currently being studied or evaluated derived their lifting and propulsive thrust from spinning rotors. Unlike traditional helicopters which use one or two large diameter main rotors, nearly all eVTOLs use multiple, smaller diameter rotors. A multi-rotor design is ideal for eVTOLs because multiple small electric motors can be used, and the propeller is usually driven directly by the motor without a gear reduction transmission. Multiple rotors also provide flight safety through redundancy. For example, the German Volocopter's eVTOL aircraft design called the Velocity, uses 18 separate rotors. The Velocity is like a very big drone.

Using 18 rotors certainly helps provide some mechanical redundancy, but also increases the vehicle's drag, and without a wing to provide lift, the Velocity can only fly for around 20 minutes. This is why Project Zero and many recent eVTOL designs have added wings to provide forward flight efficiency. The beauty of electric power is that it has opened a whole new door to allow designers to be creative and place motors at where they deemed fit. This moment is truly a great epoch for aerospace engineers.

Modern electric motors can develop as much as 5 kilowatts of power per kilogram of motor weight. This puts the electric motors at just shy of the power per kilogram as turbine engines. What makes an eVTOL not as competitive as using turbine engine is the battery specific energy. Fossil fuel by far out-performs rechargeable batteries in energy density and specific energy. To lengthen flight time, more batteries must be carried onboard, which necessitate a more powerful motor propulsion to carry the additional weight; this becomes a vicious cycle. With liquid fuel, as fuel is consumed, the aircraft becomes lighter. With electric power, the battery weigh remains constant even as energy is drained.

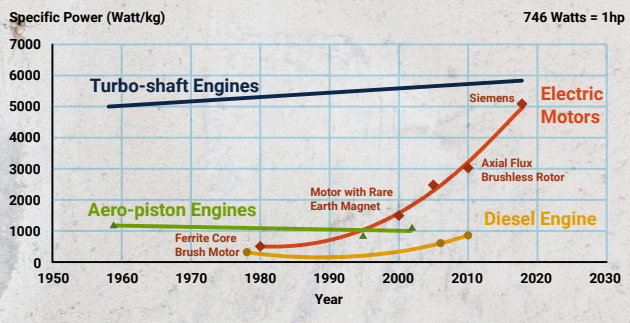


Figure 1: Propulsion Specific Power Trend

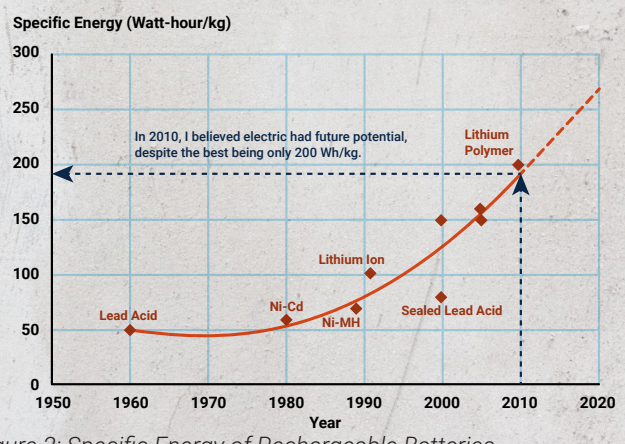
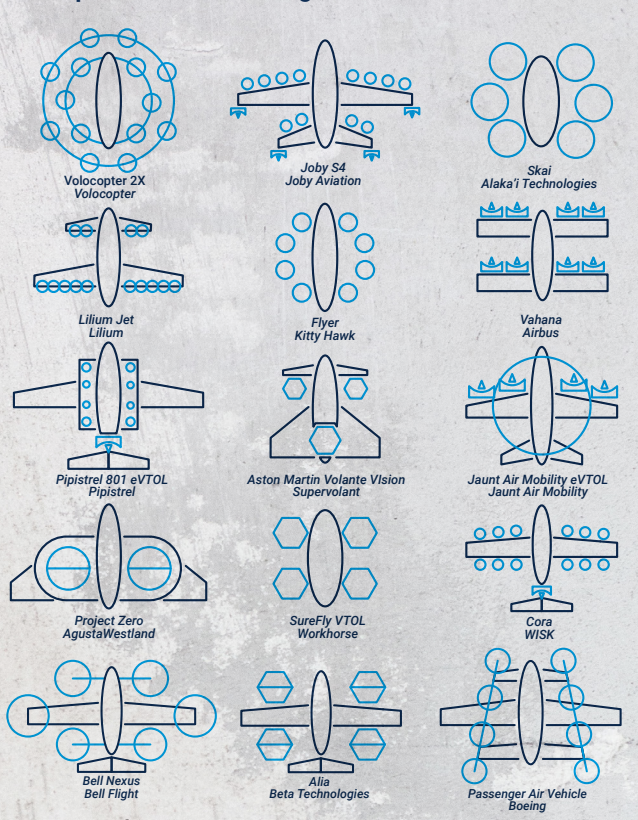


Figure 2: Specific Energy of Rechargeable Batteries.

Examples of some exisiting eVTOL aircraft architecture



Fuel cell may pack higher specific energy, but fuel cell cannot disperse current fast enough to meet the need of electric propulsion. For example, if a particular eVTOL aircraft requires 1,000 horsepower to hover (1,000 hp = 746 kilowatts), and its flight battery is at 750 volts, then the energy source must be capable of supplying 1000 amps. Hydrogen powered fuel cell cannot provide such high current draw. Hydrid-electric could be an interim solution until higher energy density rechargeable batteries are developed.

Figure 1 compares the Specific Power of turbine engines, piston engines, diesel engines and electric motors. The specific power for electric motors has improved tremendously since 1960. The old fashion brushed, ferrite motors have been replaced by modern brushless motors that use rare earth magnets like samarium cobalt or neodymium.

Figure 2 shows the improvement in rechargeable battery technology since 1950. In 2010, the best rechargeable lithium battery used in Project Zero, had a specific energy of 200 Wh/kg at the cell level. Today, the state-of-the-art, commercially available rechargeable batteries, like the Panasonic 18650 lithium cells used in Tesla Model S electric cars, have almost 250 Wh/kg of energy density at the cell level. Even after the cells are packaged into battery packs, coolant lines are added, and safety BMS (battery management system) are added, the energy density at the completed battery pack level for a Tesla Model S car is still a respectable 160 Wh/kg.

Passion for Flight

Noor Muhammad Khalid
M.SIAE
Lim Chui Ping
Vortex Editor-in-Chief

Yeo Kheng Meng, an Internet-Of-Things (IOT) engineer, attained his Private Pilot License (PPL) in the US in 2018. He appeared in a Mothership.sg article, "How a S'porean engineer became a private pilot so he could fly a plane by himself" (published 3 January 2021), where he shared his experiences in attaining the PPL. Vortex Magazine is fortunate to bring him for an interview and to share his experiences and further insights in General Aviation (GA).

Vortex (VM): *In the Mothership.sg article, you mentioned that your interest to take to the sky was rekindled after your friend Roger brought you us in his Socata TB-10 in Malaysia. Thereafter, you did extensive research on how one can secure a PPL. Are you able to share what exactly that triggered you to take it so seriously after that experience? Could you elaborate the 'push' that see you through all the trainings from ground school to taking flight in the US?*

Yeo Kheng Meng (KM): After this experience, I realised it was something an ordinary person could accomplish too and not totally out of reach.

I was starting out my career as well and I soon realised time may not be on my side if I wanted to go ahead with this major endeavour. I foresaw that as I proceeded in my career and job responsibilities, it would be increasingly more difficult to take extended time off without incurring high opportunity costs. So, it was pretty much now or never unless I want to wait until retirement or something.

Images courtesy of Yeo Kheng Meng

VM: *You have flown in the US, over Malaysia and now in Singapore, even at night. Can you highlight and share on the differences?*

KM: In terms of General Aviation (GA), flying in the US is no doubt the best. Airspaces are huge, air routes are less stringent with plenty of airports to explore and lots of beautiful scenery to appreciate.

In contrast, GA flying in Singapore and Malaysia are a lot more regulated. Given the size constraint of Singapore, one is only allowed to fly within a tiny Light Aircraft Training Area (LATA) in the northern part of Singapore. There are also additional administrative hurdles when it comes to planning of aircraft departures and bringing in visitors which do not exist in the US or Malaysia.

Visual night flights are only limited to directly above Seletar Airport whereas it is entirely normal to do visual night cross-country flights in the US.

Malaysia is slightly better in this regard given their relatively larger airspace. However, cross-country flying is still limited to selected routes formed by pre-defined waypoints between airports. Altitudes for cross-country GA flying in Malaysia are also relatively low usually less than 5000 feet. Even so, there are lots of nice scenery to appreciate.

In terms of cost, it may come as a surprise that the US has the lowest cost of flying probably due to their economies of scale followed by Malaysia and Singapore. Landings in US are also generally free unlike in Seletar Airport which charges not a trivial amount per landing.

VM: *Now that you are a qualified PPL pilot, what is your next goal? How would you or have you intended to spread this passion? In school's NCC (Air)? Youth Flying Club (YFC) or Singapore Flying Club (SFC)?*

KM: Flying is an expensive hobby and attaining additional certificates beyond the PPL may not financially prudent in the short term unless one is certain to make it a longer-term career in the aviation industry to recover the costs. In the longer term, I do hope to be a part-time flight instructor in a decade or so.

Right now, given the demands of my full-time job, I have limited time outside of work.

I still take fellow pilots, friends and acquaintances on flights and share those videos publicly to help raise awareness of our tiny local General Aviation Scene. Occasionally, I write aviation-related blog posts to spread aviation knowledge online.

VM: *If you had a chance to start all over again from Secondary School as an NCC (Air) cadet, what would you have done differently?*

KM: I would have no doubt applied to join the YFC as they fully sponsor the training. Otherwise, there is little deviation from the current path as earning the necessary funds to engage in flight training would have been difficult while I was still schooling.

VM: *We wish you all the best and looking forward to seeing more of your blog posts to spread the passion online.*

Difference between an UA Pilot and Pilot

UA pilot has to maintain good situational awareness and "Fly Ahead of Your Aircraft"

Isaac Ng
M.SIAE

FEEL

Pilots are trained to feel the aircraft. For instance, when an aircraft is entering into a stall there are symptoms where the pilot could observe and feel. Controls will feel sluggish, presence of a stall warning, high nose attitude, and control buffeting. On the other hand, a UA pilot has to rely on telemetry data or maintain visual line of sight to determine the performance of the UA and to assess when the UA is entering into an undesirable aircraft state.

The obvious difference is UA pilots operate the aircraft externally while the conventional pilot operates within the aircraft. What makes an UA challenging to fly is the lack of visual references and feel.

With commercial drones paving the way for conducting visual inspections for high rise structures, land surveys, photography and videography, airspace is tight. CAAS has recently mandated that anyone who operates an UA exceeding 7kg for recreational, educational, and commercial purposes are required to obtain an Unmanned Aircraft Pilot License (UAPL).

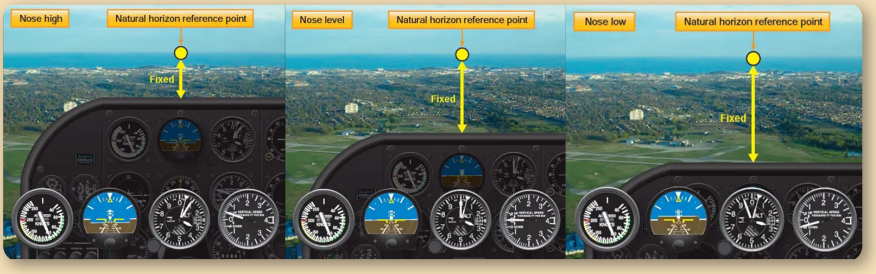
To conclude, besides the differences in the aircraft control, a UA pilot has the same responsibility in ensuring safety to the public, property, and other airspace users; especially critical in our local tight airspace.

VISUAL REFERENCES

A pilot determines the attitude of the aircraft through the reference of a horizon. From the top figure, nose above the horizon would mean a pitch up attitude, while a nose below the horizon would mean a pitch down attitude.

How the horizon cuts the dashboard indicates the angle of bank during a turn, as shown in the bottom figure.

Continuous visual checks of outside references and immediate corrections made by the pilot minimises the chance for the aircraft to deviate from the desired heading altitude and flightpath. However, flying a UA manually, a pilot relies on the perspective of the aircraft's attitude on ground and is required to remain coordinated while flying.



FLIGHT OPERATIONS

The 3 stages of flight operations of a drone is similar to flying an aircraft; pilots have to ensure Pre-Flight, Flight, and Post Flight are being planned and executed safely.

Pre-Flight

During Pre-Flight we can use the acronym PAVE, which stands for Pilot, Aircraft, enVironment and External pressure.

Pilot: Self-assessment which can be broken down into IMSAFE (Illness, Medication, Stress, Alcohol, Fatigue, Emotions), assess if a pilot is physically and mentally sound to operate the drone. Apart from the self-assessment the pilot has to ensure that his license is valid, and he is proficient in his emergency procedures.

Aircraft: Pilot has to ensure that aircraft is serviceable and fit for flight through pre-flight checks.

Environment: Pilot has to check if the prevailing weather during the time of flight would affect the flight operations of the drone. For instance, in a setting where the drone is exposed to a constant headwind, the battery would run out sooner than anticipated. Or what are the dangers of operating the drone under a CB cloud. Visibility plays a big difference in drone operations, as drone pilots always has to maintain an unobstructed line of sight of their drones. Differences in air pressure would also hamper drone performance. Apart from weather the pilot must ensure that if the area of drone operation is approved or operating within the confines of the permit issued. If operating in a restricted area, a permit must be issued.

External Pressures: Pilots also have to include external pressures like deadlines into consideration. This is to prevent pilots to be "Missionitis" so that safety will not be compromised for the completion of the mission or task.

Flight

Staying ahead of the aircraft is a mental discipline besides having to continually receive and digest new information as the flight progress. Similar to flying an aircraft, the pilot has the responsibility to make sound aeronautical decisions to ensure that safety isn't compromised. The UA PIC also utilise CRM (Crew Resource Management) amongst people involved in the flight operation, so that he is not limited to his own knowledge and ability, should an emergency arises.

Post Flight

Chuck Yeager once said "If you can walk away from a landing, it's a good landing. If you use the aircraft the next day, it's an outstanding landing." An aviator does not clock out after landing, post flight is also considered part of flying operations, where proper documentation of the flight including post flight debrief are essential. The debrief examines lapses that has occurred, ensuring mistakes are not re-learned.

Getting the Right Mood with Ambient Music

Reproduced with permission from Tutti

It seems paradoxical to compose music to not be listened to – what else should we do with it? Yet the idea that music can reach us without being the centre of our attention is widespread. From the haunting Gregorian chants of Middle Age Christendom, to clanging cymbals in Taoist funeral rites, we have always depended on music as an accompaniment to something else.

"The Mozart effect" which claims that listening to Mozart's music can increase your general intelligence had fueled a mini-industry of "smart baby" products and developmental toys. There were indeed reports that patients enjoy improved outcomes after listening to Mozart. But it has also been shown that people experience similar outcomes if they listened to other music or engaged in some other pleasurable activities.

Could a horror movie be suspenseful without a buildup by squeaking violins? Would a professional wrestler make an entrance without a rousing anthem announcing his appearance? Like a side dish to a main course, unnoticed but indispensable, background music has the power to set the tone, mood, and atmosphere, even when we aren't listening.

The idea behind ambient music is ancient, but it was only in 1917 that French composer Erik Satie coined the name musique d'ameublement, now known as furniture music, to describe music explicitly intended to create a background atmosphere, without being the focus of attention. Furniture music would blend into the environment but serves an important purpose – filling moments of silence in conversation, softening the clinking of dinner cutlery, or masking street noises.

In the 1940s and 1950s, music production company Muzak LLC would scale this idea to industrial proportions. Now most famous for its unobtrusive 'lift music' played in offices, airports and shops, Muzak took the suggestive power of background music to unsettling degrees with its patented 'Stimulus Progression' approach – factory productivity could be increased by blaring faster, more stimulating music, subconsciously prodding employees to work faster.

In 1978, English musician Brian Eno created Ambient 1: Music for Airports. The timing was no accident. The decade saw a revolution in musical technology, with new instruments and production techniques allowing musicians to concoct and combine new sounds as never before.

In the liner notes of Ambient 1, Eno explained the idea behind ambient music. Muzak's pieces were 'familiar tunes arranged and orchestrated in a lightweight and derivative manner', causing many composers and listeners to dismiss environmental music entirely.

Previous 'canned music' pieces sought to homogenize their environments by 'blanketing their acoustic and atmospheric idiosyncrasies', while 'brightening' the environment by adding stimulus to it. In contrast, Ambient 1 would enhance the unique features of each environment – in this case, an airport. It also sought to 'induce calm and a space to think'. Eno summarized in a well-known closing: 'Ambient Music must be able to accommodate many levels of listening attention without enforcing one in particular; it must be as ignorable as it is interesting'.

Meanwhile, ambient music has continued to develop into numerous derivative genres, such as ambient pop, ambient house and ambient techno. From the 1980s, many musicians became involved in the contemporaneous New Age movement, focusing on the healing and therapeutic potential of environmental music.

The Internet era of the new millennium has also allowed ambient music to reach ever wider audiences. Youtube and Spotify contain channels and playlists of countless ambience music tracks for a wide range of purposes, from meditation and study, to relaxation pieces incorporating forest or beach sounds.

Set your mood right. Whether you are studying or struggling with the budgets or working on your next marketing strategy, play some background music. In time, you will know which music is suitable for each of your tasks. You will be surprised with the result.

Building your Professional Capital

Prof Lim Yeow Khee, BBM
Hon F.SIAE, FRAeS, A/Prof (Adj) NTU, Adult Education Fellow IAL
President SIAE

To engineer is human - we began when human started to make tools. Our ability to make tools, sets us distinctly apart from other species. We now live in a complex world where technology defines every aspect of life on earth to the point where we are in danger of destroying it, if decisions are not well-thought through.

The fundamentals of our engineering knowledge come from science and with mathematics as our tool, we were able to muster the forces of nature to achieve great things. Understanding nature and overcoming it is one thing, getting people to adopt our innovation is a different story. Nature is largely predictable, but people are not.

There was a story of 4 people who were marooned on a deserted island discussing over a can of baked beans. Among them, the scientist proclaimed that it will need a pressure of 1kPa to break the can. The Mathematicians chipped in that the probability of finding that force on the island before starving to death is 50%. The Economist then tried to breakdown the problem at hand, "assuming we have a can opener…".

The Engineer appeared with a branch and a sharp piece of stone and proceed to punch a hole in the can, and they ate the can of beans.

Four people from different backgrounds; each reacted reflecting their training and professional mission. In this case, the engineer responded appropriately. Each of their reaction is understandable and would yield desirable result if presented in a different situation.

Today, engineers need to embrace all of the thought processes presented in the story. In summary, an engineer is now expected to present a solution with an estimate of required resources with due consideration of timeliness of securing such resources, basing on justifiable assumptions. Can an engineer learn all these in school?

Quite a challenge. While Physics and Maths can be acquired, the ability to use justifiable assumptions for resource planning, could take many years to develop. For an experienced engineer, it would be relatively easy task.

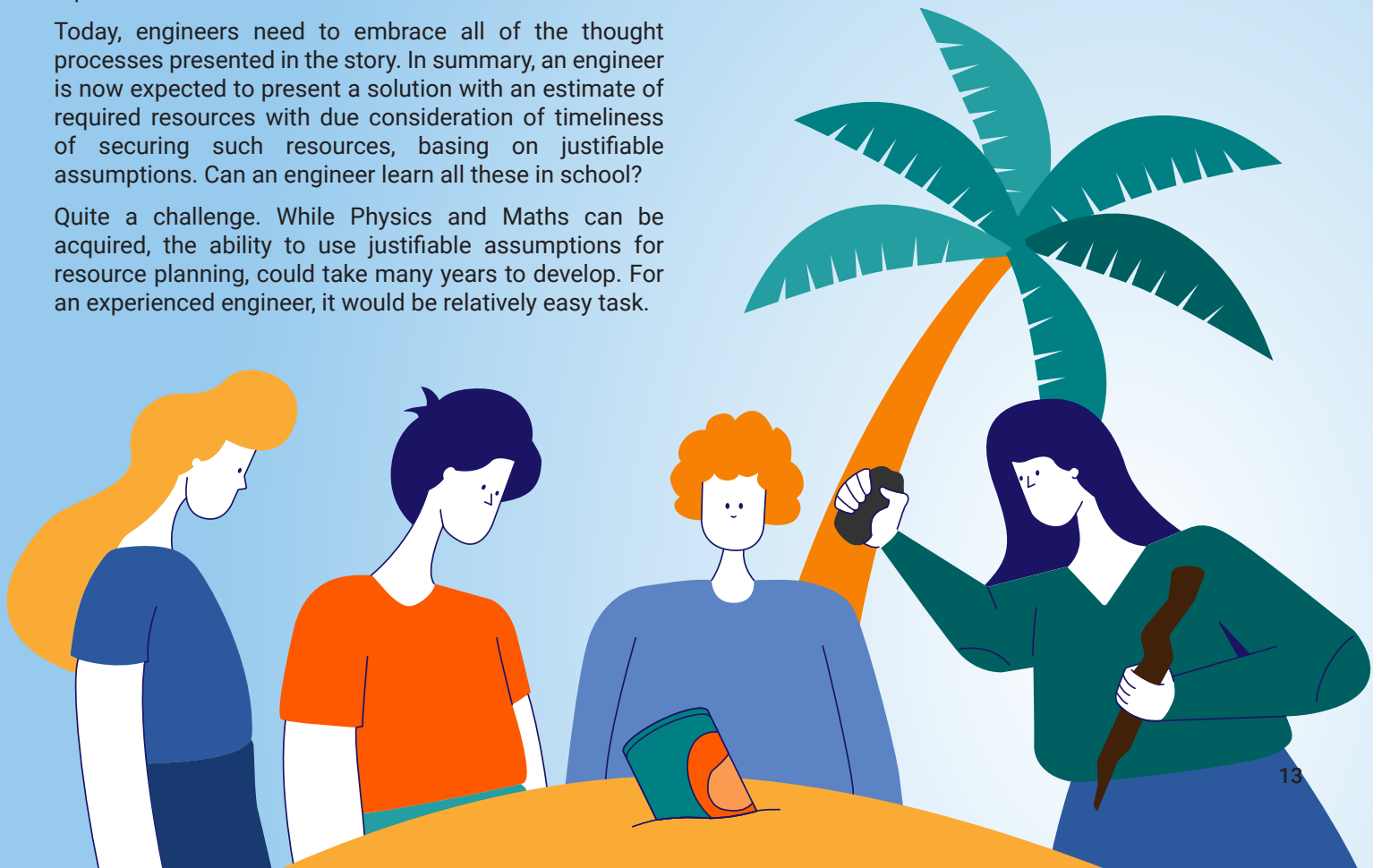
One way to accelerate learning of such skills is through exposure. Learning during casual gatherings and with formal contacts in seminars and professional meetings can be useful.

For students, they can also get engaged in the culture, learning the jargons and norms of the industry, through these sessions. Students must also find opportunity to organise activities and participate in competitions organised by these professional societies.

I have students who came to see me for advice on jobs and I noted that very few are active in activities organized by the professional societies. Some potential employers asked for letter of recommendation which educational institutions can only provide your grades and confirmation of your attendance. Professional societies can provide better referrals based on your membership and engagement with working professionals in the industry.

As a fresh graduate, your contacts in the professional society could be the first step to build your professional capital. There will be situations where a professional advice from your senior can help resolve situation which could develop to grave consequences, if not handled properly.

Listening to war stories and anecdotes can help understand the complexity of working with scarce resources, tight deadlines and natural conflicts arising from working with people and different cultures. Building your professional capital along with social and political capitals is a long and tedious road. Start on the right foot with the professional societies of your industry.



Preparing Aerospace Engineers for a Digital Age (Beyond COVID-19)

SINGAPORE INSTITUTE OF TECHNOLOGY

University of Glasgow

The role of Aerospace Engineers is dramatically changing. COVID-19 was a trigger, showing that future Engineers need to be multitasking superheroes, grappling with know-how and joggling tools related to simulation-driven design, data analytics and programming of unmanned systems, just to name a few.

The **SIT-UofG BEng in Aerospace Engineering** programme provides the multidisciplinary playground to prepare future Engineers with the skillsets needed for a Digital Engineering Revolution. The programme blends the use of **Unmanned Aerial Vehicles (UAVs), Virtual Reality (VR) and Internet of Things (IoT)** to mimic real industry problems of the future. At SIT, students combine all these technologies and work on various UAV projects to gain hands-on experience in our UAV Laboratory.

Industry involvement is key to educating industry-ready Engineers at SIT. Through an **eight-month Integrated Work Study Programme**, companies can work with our students to leverage on new technologies for their projects. Ever wondered how UAVs can be used to speed up your processes? Or if Computer Vision can be used to automate Visual Inspection Processes? Our students can help to provide the answers and solutions.

Visit SIT Website

Curriculum Highlights

- Aircraft Performance and Propulsion
- Aerodynamics and Computational Fluid Dynamics (CFD) Aircraft Structures and Composite Materials
- Capstone Project
- UAS Design and Build Projects Flight Systems and Avionics
- Eight-month Integrated Work Study Programme (IWSP) Overseas Immersion Programme (OIP)

Career Opportunities Graduates can look forward to careers in these areas:

- Unmanned Aerial Systems (UAS)
- Defense Contractor Aircraft Engine Design and Servicing
- Air Traffic Control
- Design Engineer (Avionics Production and Maintainability) Airworthiness and Quality Specialist