

AIRPORT SYSTEMS MODELING AND SIMULATION



Following up our introduction of an expanded Simulation Modeling and Analysis core class in 2018 and the elective Airport Systems Planning and Design course in 2019, we have launched the second course in the Aviation focus track, Airport Systems Modeling and Simulation.

We are fortunate to have a faculty expert in airfield economics, Professor Nuno Ribeiro, to teach both the core simulation class and this new elective. Building on the core class in simulation, Professor Ribeiro lays out the challenges in airport design and management and leads students into the creation of realistic airport models and the techniques to answer fundamental design questions.

Professor Ribeiro's approach is to guide the class through building an airport capacity model from scratch. Students select an airport to study, gather data, and forecast traffic demand. With COVID-19 this year, students discovered the perilous uncertainty involved in aviation forecasts. Forging ahead, students develop a CAD representation of the airport layout using AutoCAD (Figure 1).

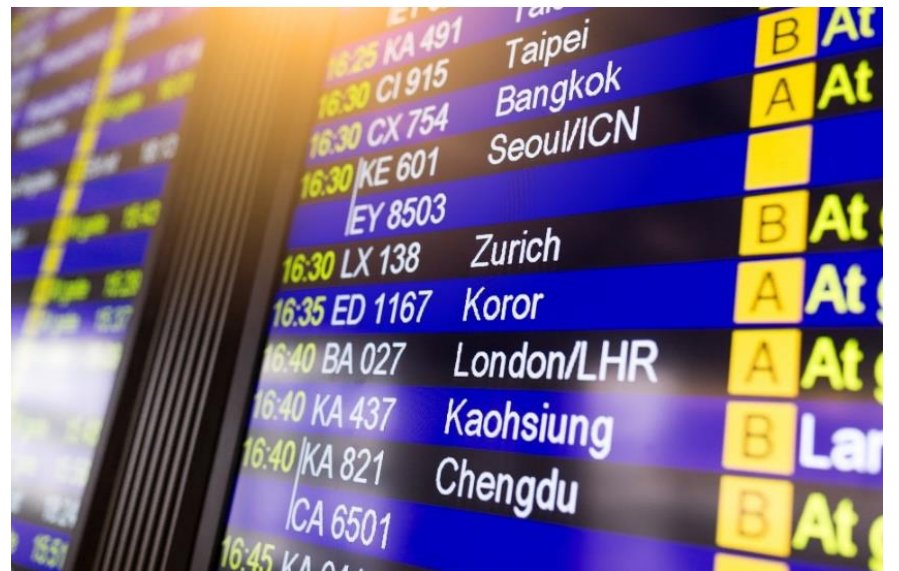


Figure 1. Satellite Photo and CAST Model of Bali Airport.
Courtesy of Chiang Aiting Faye and Jiang Youwen

We provide students with licenses to the commercial simulation software, CAST, used by airport planners around the world. Students import their CAD layouts into CAST, specify the airport operating rules, perform different simulation runs, and visualize the resulting outcomes. They are now in a position to ask fundamental questions:

- Is the airport under congestion at any point during the day?
- Where are the bottlenecks in the system?
- How does the airport behave under bad weather scenarios?
- What are the operating rules that overall lead to a better airport performance?

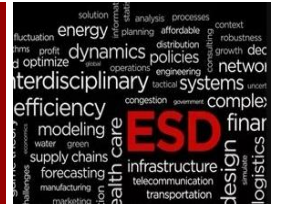
Students also learn how to apply optimization tools (such as AMPL software) to make decisions with respect to runway flight scheduling, aircraft gate assignment, and air traffic flow management. Professor Ribeiro believes that with this hands-on approach, students not only develop the ability to analyze the complexities of managing and operating an airport system, but they actually experience and visualize these complexities, driving them to learn more deeply, better preparing them for a career in systems analysis.



Airport Systems Modelling and Simulation by Nuno Ribeiro, Assistant Professor

“ In this course, you will learn how to apply systems engineering tools (such as optimization, simulation, and data analytics models) to make decisions in an airport environment. You will be introduced to software's such as CAST and AMPL that will allow you to develop a comprehensive study in airport capacity management.

By the end of this course, you should be able to provide insights to the these questions: Is the airport under congestion? What are the bottlenecks of the airport system? How does the airport operate under bad weather scenarios? What are the operating rules that overall lead to a better airport performance? Is there the need to build a new runway at the airport in the near future? ”



New ESD Programs

WHY AVIATION?

ESD launched its new Aviation focus track this year against the backdrop of steadily increasing demand for air travel. Growth in commercial air passenger travel in Asia Pacific was projected to grow at 3-4% per year, compounded. We were looking for air travel to double in magnitude over the next 15 years. What a difference a year makes! The COVID-19 crisis has devastated the airline industry worldwide, idling resources, and resulting in massive layoffs and bankruptcies. It would be reasonable now to ask “Why Aviation?”



Does the Aviation focus track still make sense? I believe it does, for several reasons. In the first place, it is simply an opportunity to learn and practice the ESD-style of thinking about a major engineering system. This is a skill that is easily transferable to other large-scale systems, such as manufacturing, hospitals, or logistics. I taught Manufacturing Systems at Cornell University for 25 years. It was a very popular course even though very few of our graduates actually took jobs in manufacturing. Most of them went to Wall Street or worked in consulting companies. But the alumni feedback was always that this course gave them a career advantage because of the thought-process they learned.

My rationale was that if you can wrap your thinking around something as complex as manufacturing with its multi-item, multi-stage, multi-time-frame dimensions, then you will not be intimidated by any other system you come into contact with.

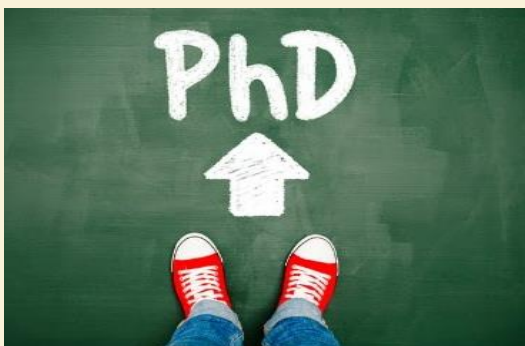
The same is true for Airport Systems because airports are truly systems of systems and if you cut your teeth on the types of problems faced in the design and operation of airports, you will have the confidence to take on many other similar challenges.

The second reason for choosing the Aviation focus track is precisely because the industry is in upheaval. As a career it may not be a safe choice, but so much is going to change in the industry in the next few years, that dramatic new career opportunities will emerge. For example, airlines will have to completely re-develop their route structures, pricing models, boarding processes, and more. Airports will have to institute standards for ultra-cleanliness, passenger screening, and workforce planning. Major new technologies will be adopted such as biometric identification systems, contact tracing, and collaborative decision-making. ESD graduates will be needed for all these challenges.

So, embrace the future. The aviation industry will come back and it will always have need for ESD engineers and analysts. Plus, airport systems courses are a great place to practice your ESD-mindset.



ESD Ph.D PROGRAM – GO DEEP



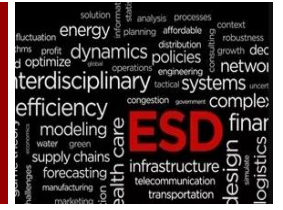
To our graduating seniors: Have you considered going deep? The ESD Undergraduate Curriculum has been great exposure to the world of data-driven decision making. Have you thought about how satisfying it would be to really become an expert in this area?

Why not discuss with our faculty members about some of the research areas and projects available for the pursuit of PhD studies after graduation. This is a world-class faculty with research interests covering Aviation, Transportation, Manufacturing, Quantitative Finance, Healthcare and more.

There is generous support to make the extended study affordable for you. Our premium scholarship for Singapore Citizens tops the list with free tuition, a S\$5,000/month allowance with CPF, and yearly support to attend conferences of S\$3,900. All successful applicants will be awarded scholarships based on competitive factors. More details can be found [here](#).

We have enjoyed working with you as undergraduates and would be delighted to continue working with you as graduate students. Think ESD PhD!





LAUNCH OF NEW ESD GAMES



In ESD, we exploit team-based games in our supply chain courses. Thrown into distance-learning mode, we have had to be creative in how we achieve this without access to our great Data Analytics Lab. This semester, Summer 2020, we pioneered the concept of using desktop cloud PCs in combination with Zoom breakout rooms for our Supply Chain Digitalisation and Design course.

With this set-up, Professor Ying Xu and Professor Peter Jackson organized a class of 33 students into teams and assigned them in pairs to different Zoom break-out rooms. We role-played the situation of company executives having to suddenly step in to control the supply chain for manufacturing an anti-viral drug during a pandemic crisis. This required ‘the executives’ to collaborate in a multi-player logistics simulation game hosted on a remote server. Using the desktop cloud PC, we were able to present each team with a common look and feel interface to the game (Figures 1 and 2) no matter what computer they had at home.



Figure 1. The Desktop Cloud PC Welcome Screen

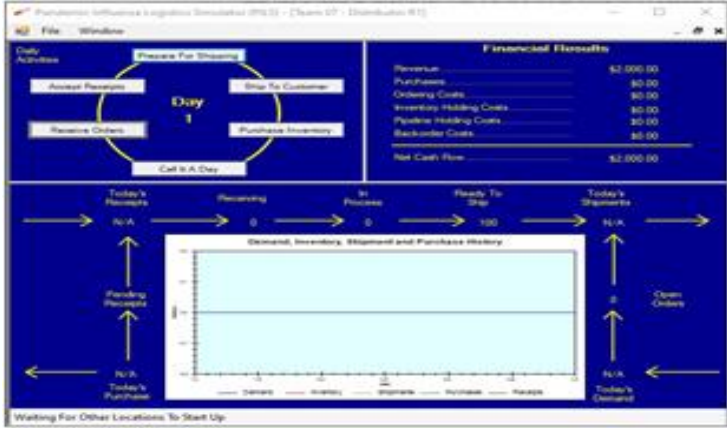


Figure 2. The Pandemic Influenza Logistics Simulator (PILS)

In ESD, we continue to explore different content and game management systems to enhance our students’ learning experience. This current experimentation with desktop cloud PCs and video conferencing is a step towards running highly interactive activities permitting a uniform experience for all participants from remote locations.

You can also check out other new ESD games [here](#).

CFA INSTITUTE RESEARCH CHALLENGE (Season 2019 – 2020)

The CFA Institute Research Challenge is a global competition that tests the equity research, valuation, investment report writing and presentation skills of university students. The Singapore Finals were held on 8th February 2020. The SUTD’s Team ‘R Capital’ won the Best Presentation Award, and student Fariha also won the Best Speaker Award. A big congratulations to the honored team - Fariha Ahsan, Hum Qing Ze and Muhammad Azmi Bin Zainudin.

On behalf of the team, Fariha said:- 'We never imagined that one day, we would be participating in an equity valuation competition while taking our very first equity valuation class! The growth we have experienced through this competition has been incredible. We are very grateful that we have been able to represent SUTD on a national stage and even happier that we won.'

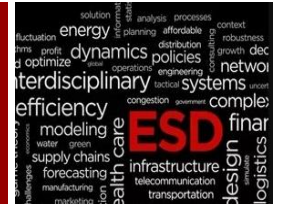
We couldn’t thank our mentors enough, Professor Rolph and Mr. Tan, for their guidance has been instrumental in our win. Besides developing our financial and valuation skills, they encouraged us to think critically about businesses and generate variant perceptions. The skills learnt through the competition are universal and applicable to academic, projects and careers. Finally, thanks to the CFA Institute for organising such an awesome competition!"

Congratulations to Team ‘R Capital’!



(L-R) Melwin Tan (Industry Mentor for SUTD), Fariha Ahsan (ESD Senior), Hum Qing Ze (ESD Senior), Muhammad Azmi Bin Zainudin (ESD Senior), Douglas Rolph (Faculty Adviser)





Student Achievements

Entrepreneurial Spirit Award - 2020 Student Achievements Award



Ku Wee Tiong, co-founder of a startup, Snap Labs,

At a time when data is the new gold and customer experience the new goal, SUTD's ESD students are well positioned to thrive.

Equipped with data science and analytics skills, systems design thinking and an understanding of business, we develop the ability to navigate the new economy as tech- and business-savvy

entrepreneurs. We spot overlooked problems, discover gaps, and find the key leverages to do more with less.

As a DDP Scholar, I take this edge further. From managing people to finances, stakeholders, partnerships, and beyond, systems thinking is essential everywhere. The world and its diverse interdependencies begin to make sense. A well-engineered solution cannot truly solve problems without a sustainable system. With a breadth, depth and perspective like no other, I believe I can live up to my dream of solving wicked problems that have plagued the humanitarian aid field for generations.

Meanwhile, I practice and hone my analytical and strategic skills as a co-founder and CFO of Snap Labs, a merged reality technology start-up currently incubating at the SUTD Entrepreneurial Centre. Having a business and systems view, I can effectively align the strengths of my multi-disciplinary, all-pillar team along paths to value.

Together we have won multiple startup competitions, visited the Taiwan start-up eco-system and represented Singapore at the Enactus World Cup held at Silicon Valley.

National Winner - 2019 James Dyson Award



Sarah Ong (ESD), Ang Wei Jie, Leong Kei Sheng, Keerthana Janmugam (ESD), Glenn Chia, Lim Wilson

Congratulations to ESD students, Keerthana Janmugam and Sarah Ong, Glenn Chia (ISTD student), Wilson Lim Wei Sheng (EPD student), Ang Wei Jie (EPD student) and Leong Kei Sheng (EPD student) as the 2019 National Winner of the James Dyson Award. This award is an international design award that celebrates, encourages and inspires the next generation of design engineers.

Against the backdrop of greener methods of mobility being encouraged in the country, the team of six inventors were struck by the common, everyday relatable problem of how difficult it is to maneuver a bicycle while carrying a grocery load in the front basket.



for carrying loads of up to 15kg, which can fit bicycle frames of various dimensions and with a volume capacity of 36L.

Their project "Wheelson" is a clever and versatile bicycle attachment that makes carrying heavy loads for cyclists safe and easy. It is a highly adaptable attachment



Announcement of New Faculty Members



Nuno Ribeiro
Assistant Professor
PhD, University of Coimbra



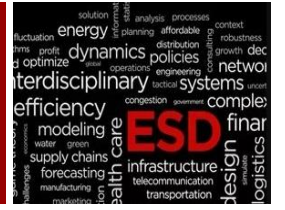
Antonios Varvitsiotis
Assistant Professor
PhD, Dutch National Research Institute for Mathematics and Computer Science (CWI)



Zhang Weiqi
Senior Lecturer
PhD, National University of Singapore



Keegan Kang
Lecturer
PhD, Cornell University



**Zhou Zhi, KTH Royal Institute of Technology
(Stockholm, Sweden)**

GEXP provides an opportunity to see and experience the world, to interact with and to be immersed in vastly different cultures.

Studying in a foreign country brings new perspectives into innovation and enables one to understand the need for empathy within other cultures, like realising the importance of a coffee break.



The journey lets you be independent and take full control of your actions on the path to developing your global outlook. You will never know how your perceptions of the world will change if you never take that first step.

Gao Yuze, Aalto University (Finland)

I would like to say GEXP is a wonderful and meaningful experiences for me. The exchange in Finland is an unforgettable memory in my university life. I got to be in touch with the unique Nordic culture and was immersed in the gorgeous Nordic scenery, the mountains, the lakes, and the snow. In Europe, you can easily make a trip by train to other countries and you will get to experience different European countries, north to south, east to west.



Finland offers me a sense of being alone, comfortable and peaceful, which is hard to catch in most of other modern cities. In their school, the education system and schedule are less hectic unlike in Asia, and this provides more time to me in focusing on the knowledge.

Thanks to SUTD that I get to this opportunity and I will always miss it there and hope to visit again.

Ng Jia Sheng Jason, Sung Kyun Kwan University (Korea)

The GEXP experience has opened new doors to new opportunities such as making friends with people from different cultural backgrounds. I have enjoyed my time in South Korea gaining new experiences I can't get anywhere else!

Joining such an overseas program in SUTD is a once-in-a-lifetime opportunity as you will able to live and study in your desired country for a long time. Through this, you will be able to immerse yourself in a very different culture and you will be able to meet many people from different countries. Having an international range of friends will widen your perspective of the world.

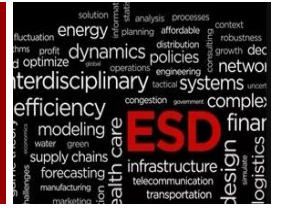
Many of the things I have learnt cannot be learnt from books or by staying in Singapore. By living in a different country by yourself with a language barrier, you learn to adapt and accept challenges you encounter quickly. As I was exposed to many different cultures, I have learnt to embrace them and be more accepting. It was fun adapting to the South Korean culture as well and I enjoyed every part of the experience. This is one big part of my university experience that I will never forget!



For all NEW ESD Students

Mark this date!
16 September 2020 (Wednesday)

More details will be shared nearer to event date.



ESD Course Projects



The ESD undergraduate program offers a client-facing curriculum. From day one, when you enter the ESD pillar, you are presented with real clients who bring you questions about how to improve their operations. Here are the examples of our course projects accomplished by our students:

Data and Business Analytic (DBA)

Working on our DBA project, “Text Classification with Graph Neural Networks from News Sources”, was fascinating as we got to explore the application of various machine learning concepts while solving a problem to create real business value.

We had the chance to experiment with Graphical Convolutional Networks (GCNs), which helped us facilitate a better understanding of the complex relationships involved in our unstructured data input. Through the process, we derived meaningful internal representations of documents and words, and used these to build a classification model with high accuracy.

Apart from gaining a better technical understanding of these machine learning techniques though, we were grateful to have experienced client-facing interaction throughout the project, and to have received invaluable feedback and insights from our industry mentors along the way.



Contributed by:

Tan Hui Min Grace, Wong Lai Men, Zenn Png Zhuang Yi, Gan Hui Ting and Wu Qi

Engineering Systems Architecture (ESA)



Team Cook Off designed a VR cooking simulation game that targets university students to teach them how to cook and get them familiar with kitchen equipment.

Using knowledge from the Engineering Systems Architecture course, we identified and fleshed out functional requirements we wanted for the game. These helped us to create the key elements of our game required to achieve our mission of teaching cooking.

Working on and presenting projects remotely amidst the Covid-19 situation was challenging but our teamwork allowed us to push through during this difficult time. Each member pulled through which allowed us to create a final product that we were all satisfied with.



Contributed by:

Martin Ho Zhengyi, Liu Jiajun, Yang Peng and Yip Weisheng Ryan

Simulation Modelling and Analysis (SMA)



The SMA project provided an opportunity for students to apply their knowledge with the flexibility of simulating virtually any event.

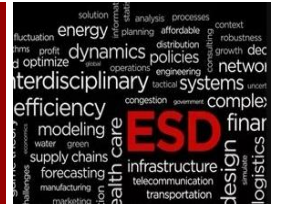
Due to the team’s financial background in the Financial Services focus track, we thought it would be intriguing to attempt to simulate the price fluctuations of a stock coupled with the investor decision making process.

Under the guidance of Professor Nuno Ribeiro for the creation of the simulation system and Professor Douglas Streeter Rolph for the technical financial aspects, the project was made possible. Numerous iterations to

improve the project were inevitable, as the team researched theories from sources such as the SUTD library that were useful to tune the simulation to practical standards.

Contributed by:

Justin Chung Zhi Xian, Lin Xinyi, Thiang Wan Terng and Teo Hong Jie Darryl



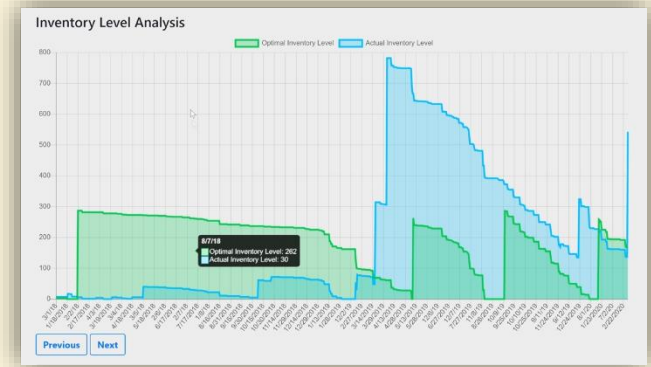
Manufacturing and Service Operations/ Statistics



Pharmaforte is a leading healthcare and pharmaceuticals distributor in Singapore. Due to the characteristics of the business, high inventories are held to shield against volatility, and the erratic demand patterns makes trends and product life cycles hard to track.

Nevertheless, probabilistic models could be adopted to quantify risks and optimize inventories. By modelling demand distributions and

employing the (Q,r) model for inventory management, total inventory costs could be reduced by 10%-30%* while maintaining an acceptable service rate. The concepts learnt in MSO helped us to better advise our client, deriving insights from data and giving recommendations to optimize Pharmaforte's inventory.



To facilitate the implementation of our model, our team developed an online dashboard to showcase the key visualizations and performance metrics for our client.

Contributed by:

Seah Ee Song, Tong Hui Kang, Aaron Reul Khoo Yi Xin, Yusnoveri Calvin, Ku Wee Tiong and Seow Xu Liang



UNDERGRADUATE RESEARCH OPPORTUNITIES PROGRAMME (UROP)

DRONE-ASSISTED LAST MILE LOGISTICS By Antonios Varvitsiotis, Assistant Professor

The transport of goods across logistic networks contributes decisively towards worldwide economic growth and adds significant societal value. Transportation systems used for the distribution of goods typically comprise of a vast network of trucks, cargo ships, and aircrafts, which need to coordinate across different countries and time zones. Each of these conventional modes of transport comes with its own set of advantages and disadvantages but at the high-level, they all share the same characteristics: They can carry a bulky cargo of diverse shapes and sizes over long distances but incur high operating costs and a significant ecological footprint. Complementing the characteristics of standard modes of transport, the use of unmanned aircraft systems (UAS) allows transporting light and uniformly shaped items over short distances at a low cost and with a minimal ecological footprint.

In alignment with its smart nation vision, Singapore has also been an early adopter of UAS technology, two important milestones being the designation of One-North as a drone

estate (2018) and the world's first shore-to-ship delivery in Marina South Pier (2019).

The amalgamation of conventional modes of transport with UAS has introduced a new paradigm in Last Mile Logistics, where a drone is deployed from a slow carrier (e.g. a truck or a ship) to fulfill the final step of the delivery process. This synergy of technologies effectively extends the drone's limited operating range and reduces the costs associated with last-mile deliveries, which can make up to 30% of the total cost. The goal of the proposed project is to design and analyze new models for truck-drone deliveries in dense urban environments such as Singapore. The design aspects will be addressed using a powerful class of models known as Mixed-Integer Linear Programs (MILP), which allow expressing linear dependencies between variables that can take either continuous (e.g. weight of a parcel) or discrete (e.g. the number of parcels) values.

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