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## Evolving the ESD Curriculum

By Peter L. Jackson, Head of Pillar, ESD

### New Courses

ESD has continued to roll out a new, updated curriculum for the Classes of 2019 and beyond. Since September 2018, we have added four courses to the curriculum (one core class and three electives) and refreshed the content of four other courses as new instructors have stepped in.

Simulation Modeling and Analysis is a new core T6 course introduced in Fall 2018. It builds on but replaces the previous half-semester course in simulation analysis by adding a half-semester focus on different simulation modeling approaches: system dynamics, agent-based modeling, discrete-event simulation, process simulation, and physics-based simulation. The course features a student-initiated project which must use one of the modeling approaches and apply statistical techniques to rank at least two different system designs. There was exciting variety and complexity in the projects students designed. Students in Capstone have expressed appreciation that they learned javascript as part of this course. Javascript is a browser-friendly scripting language with a host of useful libraries.

Statistical and Machine Learning is a new elective T7 course which overlaps some of the material in the ISTD Machine Learning course but replaces material ESD students have already seen in the Analytics Edge course with material in deep learning and other topics that have been less accessible to ESD students. Students have valued the coding aspect to the course and asked for increased attention to this in subsequent editions.

Airport Systems Planning and Design is a new elective course which will be the introductory course for a new focus track in Aviation within ESD. It adapts a graduate course from MIT for our senior level students. We were fortunate to have the support of the MIT course creators, Prof.'s Richard de Neufville and Amedeo Odoni, in sharing their course materials with us. Prof. de Neufville also gave a guest lecture. We have also been fortunate in hiring an industry expert, Michael Portier, Deputy Director of Aviation at Surbana Jurong, to teach the class. Students have been enthusiastic about the passion for the topic Mr.

Portier brings to the classroom. In order to feed into future courses in the Aviation track we will be moving this elective to T6 beginning Fall 2019. We have plans to introduce a course in Airport Systems Modeling and Simulation in 2020.

Supply Chain Digitalization and Design is a new elective T8 course in the Supply Chain and Logistics focus track. This course has several novel features. The first half of the course, taught by Prof. Ying Xu, uses a case-based, experiential learning format to describe an approach to digitalizing supply chains. A series of cases describe the evolution of a fictitious multi-national corporation, the NOVA Corporation, and a multi-player computer game is used to illustrate the current state of the company's supply chain. Students use market data analysis and simulation models to articulate a strategy for the company and develop a value proposition for the implementation of selected supply chain initiatives. In the second half of the course, taught by Dr. Kaushik Ghatak, we use case-studies of real companies to hone student skills in developing value propositions for supply chain improvements and for managing their successful implementation.

### Refreshed Courses

In addition to offering four new courses, we have moved new instructors into existing courses and refreshed the material in the process. The Analytics Edge has been a popular elective in ESD for many years. With the SUTD President's initiative to ensure every student is exposed to data analytics, we moved Analytics Edge to T6 and made it a core ESD course. Prof. Stefano Galelli co-taught it with Prof. Karthik Natarajan this past year and they introduced a new project requirement.



*ESD launched the Airport Systems Planning and Design course in Jan 2019*

Energy Systems and Management (T8, 2019), ongoing now, had not been offered since 2016 but we identified a passionate instructor, Mr. Niles Jadhav, whose expertise is in clean energy. The content of this course is being refreshed to include that perspective. Investment Science (T6, 2018) as well as Derivative Pricing and Risk Management (T7,

2019) were refreshed with our hire of Prof. Douglas Rolph. He brings decades of both practical and academic experience to the goal of uniquely positioning ESD graduates for successful asset management careers. Students have appreciated his coaching on professional skills in addition to the technical content delivery.

## New ESD Courses Launched in 2018–2019



*Lim Nengli*

### Statistical and Machine Learning

“ If you're wondering what the latest craze in deep learning and AI is all about, or want to learn how is it that computers can classify images or recognize speech better than humans now, this is the course for you. Most importantly, in this course you will apply the math and programming skills you have acquired to teach machines to solve a wide range of complex problems. ”

### Airport Systems Planning and Design

“ Everyone has ever been to an airport in his/her life. If you are curious about the airport operational processes beyond everything you see, then you need to follow this course. In Singapore, the aviation sector contributes 6 percent to Singapore's GDP and you will learn about the airport operations and technology that boost the air transport industry. ”



” *Michael Portier*



*Ying Xu*

### Supply Chain Digitalization and Design

“ In this course you will engage in experiential learning through various games, simulations and case studies to learn how to quantify the value proposition for investments in digitalization projects and to apply design principles for strategic and tactical decisions within supply chains. ”



**For all new ESD students**

18th Sept (Wed), 1.30pm - 4.00pm, MPH

## Global Exchange Opportunities

In 2018, 19 ESD students embarked on the Global Exchange Programme (GEXP) to live and study in another country. Read some of their experiences below.

### **Kevan Tan Tian Jun (Lehigh University)**

"In term 6, I was at Lehigh University for an exchange program. The campus is located in a town called Bethlehem, and was a quiet and conducive place for learning, with a variety of food options nearby. The systems engineering skills that were taught in Terms 4 and 5 definitely came in handy when I worked on projects and hackathons with the students there and allowed me to contribute effectively in a group of computer science and business students. It also helped that the students, staff and faculty were warm and accepting which made me feel very welcomed there. I thoroughly enjoyed my time at Lehigh!"



*Kevan Tan (L)*

### **Tan Chuan Onn Nicholas, Sungkyunkwan University**

I went to Sungkyunkwan University (Seoul, Korea) during the Fall'18 semester. During my time there, I climbed mountains and even cycled from Seoul to Busan! I will never forget the beautiful nature scenery I witnessed in Korea. I also interacted with people from different societies and obtained a wider perspective in the various challenges people face. This exchange has also allowed me to be exposed to experiences out of my comfort zone on a firsthand basis, as well as make many new friends, to which I am grateful for.

### **Bai Xue Fei, City University of Hong Kong**

As one of the most dynamic metropolis in the world, Hong Kong has offered me so many fun and positive experiences during my Global Exchange. I had the privilege to explore courses in a comprehensive university, experience hall life with local students and, most importantly, have a blast exploring the city with good friends from all over the world. Global Exchange has been such an invaluable learning opportunity that I will cherish forever.



*Tan Chuan Onn Nicholas*



*Bai Xue Fei*

### **Daphne Goh Wen Hui, Hanyang University**

"GEXP gave me the opportunity to experience learning in a new academic environment thus gaining exposure in international education. In addition, I was able to travel around Seoul and other parts of Korea such as Busan and Jeju. In my travel adventures, I was deeply immersed in both Korea's traditional and pop culture. I understand the importance of building a global mindset to have strong self-awareness to avoid making judgmental perspectives on differences."



### Ang Yang Kai Justin, *University of Twente*

"I had a wonderful time at the University of Twente. The autumn/winter experience was fantastic, and it was a truly eye-opening to live in a country with a very different culture. GEXP provided me with a good exposure to a different learning environment and teaching style. I also thoroughly love the biking culture there!"



*Ang Yang Kai Justin*

## Student Competitions

In 2018, ESD students participated in 2 global competitions – the CFA Institute Research Challenge, and the Industrial and Systems Engineering Competition (ISEEC).

**The CFA Institute Research Challenge** is an annual global equity research competition that provides university students with hands-on mentoring and intensive training in financial analysis. Working in teams, students gain real-world experience as they assume the role of research analysts and are judged on their ability to value a stock, write a research report, and present their recommendations. After an internal selection round, team "The Quants" were the SUTD champions and they represented SUTD in the local finals against NUS, NTU, SMU, SIT, SIM Global, SUSS and Yale-NUS. Team Quants said "It was definitely a blast to have the opportunity to compete with universities around Singapore in their area of expertise. It is amazing to see concepts in engineering mesh well with concepts in business, it was tons of fun and very challenging, we'll absolutely do it again when given a chance."

**The Industrial and Systems Engineering Competition (ISEEC)** is an annual competition specifically designed for undergraduate industrial engineering and related courses students to hone and apply their skillset in solving real-world problems. This year's theme of 'Optimizing Jakarta's Urban Transportation System to Resolve Traffic Congestion' served as a valuable platform for participants to practice their problem-solving skills in the context of strategic management. Three ESD students, Cheow Yi Jian, Jeremia Juanputra, and Yuan Yongxi travelled to Jakarta to represent ESD in the competition. They said "It has been insightful to observe the differences in the management of urban transportation in Jakarta and Singapore. We are also grateful for the opportunity to assess the challenges faced by Grab and offer solutions for them"



(L-R) Douglas Rolph, Faculty Adviser, Justin Leung (ESD), Wu Shangjing (ESD) Chen Xiaoming (ISTD) Du Shengye (ESD) and Sun Zihan (ESD)



(L-R) Cheow Yi Jian, Jeremia Juanputra, Yuan Yongxi, and ISEEC organiser

## Exciting Undergraduate Research Opportunities Programme (UROP) Projects in ESD

In ESD, you will have the opportunity to participate in exciting UROP projects that will give you a real-life research experience. Working together with ESD faculty, you will rigorously explore, investigate and validate hypothesis and glean useful insights. Through UROP, you will also get the chance to work on cutting edge research projects and participate in the different phases of standard research activity (i.e. developing research plans, writing proposals, conducting research, analysing data and presenting research results in oral and written form). Here are some of the on-going UROP projects that students are undertaking in ESD.

**Aviation Data Viewer (Peter Jackson)** - In preparation for the formation of the Aviation Studies Institute and the launch of SUTD's thrust in Aviation, Peter Jackson led a UROP team project to develop a database of aviation data together with a prototypical user interface. The purpose of the database is to use publicly available data to support student projects in aviation, particularly in air traffic flow management. The purpose of the user interface is to permit manipulation and visualization of the data. The functional structure of the project is illustrated in Figure 1.

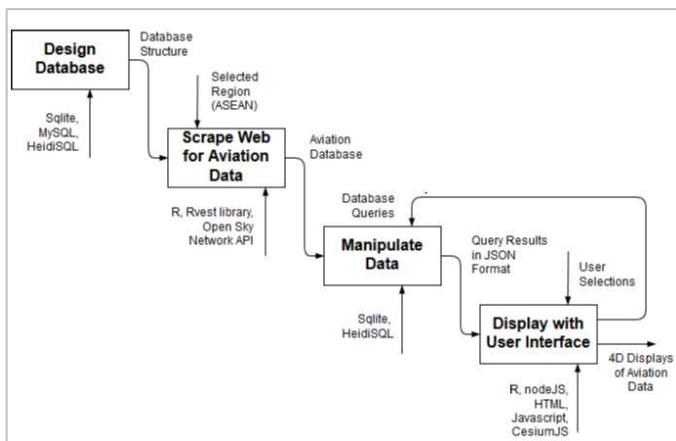


Figure 1. Functional structure of the project

As can be seen, the UROP students had to gear up and master a variety of technologies: database managers, structured query language (SQL), web-scraping libraries, online database APIs, R scripting, Javascript, HTML coding, and visualization libraries (CesiumJS). There were numerous obstacles to overcome such as queries that ran for days without returning any results but we are all more expert as a result. Different student groups took on different challenges but, in the end, we had an eye-popping display that made good use of one of ESD's Interactive WhiteBoards.

The students were able to demo the result at the 2019 SUTD Open House (Figure 2). Kudos to the students who made this happen: Jordan Tay Jin Jie, Kang Min Zhe, Zhang Siyao, Li Yingjie, Zhou Zhi, Giannie Lim Jia Yu, and Lee Rui Lin Eunice.

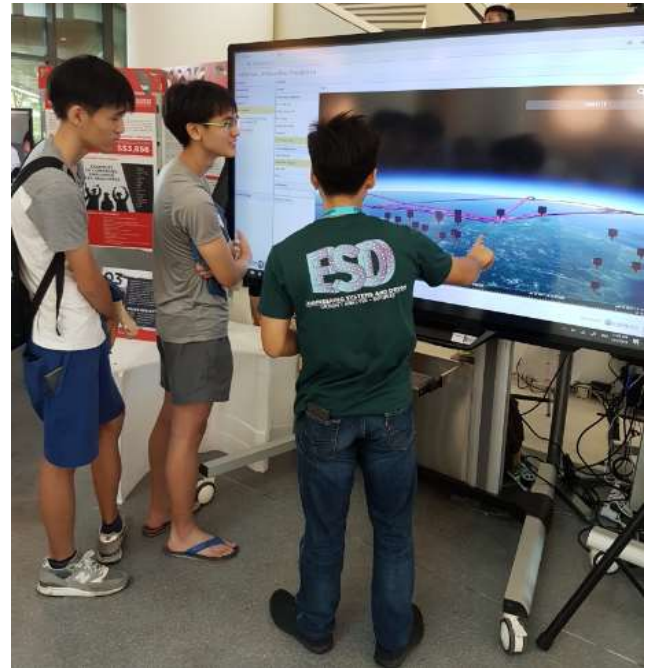


Figure 2. Demo at the 2019 SUTD Open House

**Urban Freight Transport Data Analytics and Visualisation (Lynette Cheah)** - With increasing urban population and built density, as well as rising consumer demand, it is increasingly more challenging to transport goods in an efficient and sustainable manner within compact cities. Optimizing urban freight transport is a complex socio-technical problem, with implications for urban planning, transportation system planning, and infrastructure planning. Towards this end, our research team has collected a number of meaningful datasets that are useful for the planning of urban freight system in Singapore. In this UROP project, we aim to analyze truck parking supply characteristics to better understand their implications on truck movements within the city. The goal of the project is to map and visualize multiple truck parking-related data to facilitate parking infrastructure planning. For example, one of the maps constructed using GIS (see Figure 3) reflects accessibility to industrial areas for different zones (TAZ) in Singapore. This score is important because truck drivers are more likely to choose parking lots that are closer to their workplaces, which are likely to be industrial areas.

### Industrial Accessibility Index – TAZ Level

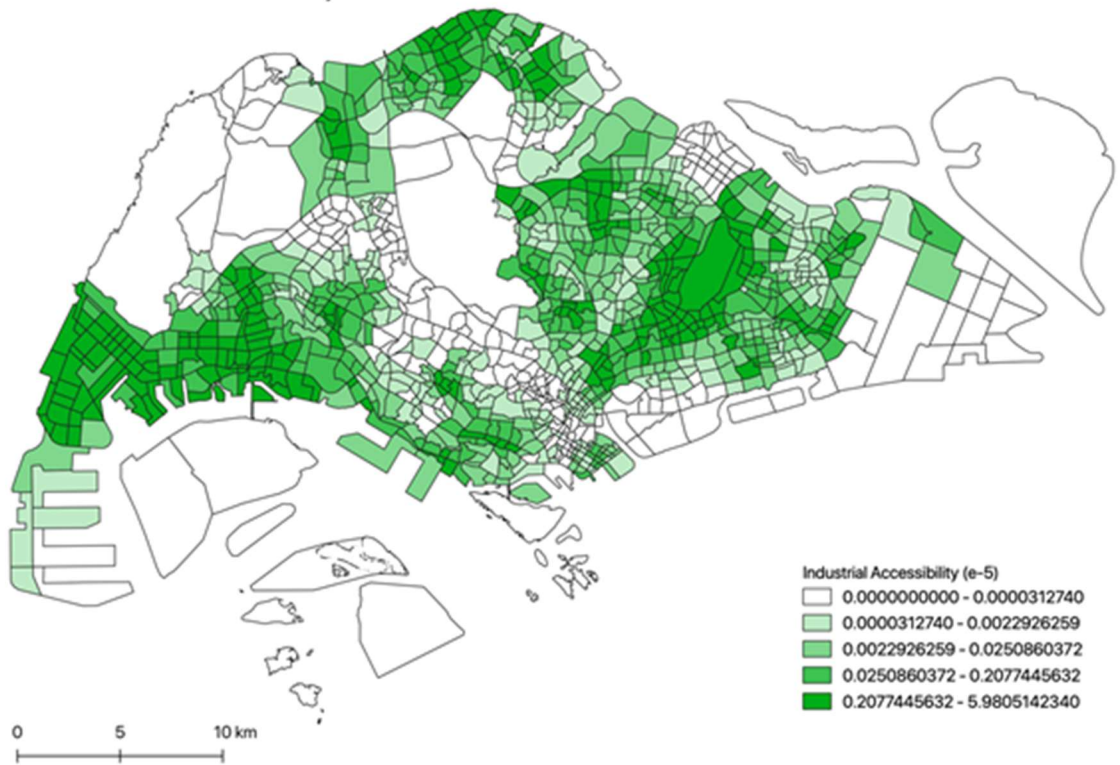


Figure 3. TAZ level for different zones in Singapore



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