Research Assessment Exercise 2020

Impact Overview Statement

University: The Hong Kong University of Science and Technology

Unit of Assessment (UoA): 14 - Mechanical Eng., Production Eng., Textile Tech. & Aerospace Eng.

Total number of eligible staff of the university in the UoA: 37

(1) Context

Unit members are involved in research ranging from seeking solutions for urgent needs for renewable energy and healthcare, to demands for greater efficiencies and competitiveness in manufacturing and service industries. The Department of Industrial Engineering and Decision Analytics (IEDA) and Department of Mechanical and Aerospace Engineering (MAE) share common research interests in broadly-based 'design and manufacturing' areas. IEDA faculty also have strengths in engineering management, logistics, supply chain management, and emerging topics in decision analytics while MAE faculty have a strong presence in thermo-fluid and energy, advanced materials and mechanics, advanced manufacturing, autonomous systems, and aerospace engineering.

Together, this research is achieving i.) ***economic impact*** through increasing efficiency and competitiveness, and new product development (CYH Chao, HH Qiu, RSW Lee, TS Zhao, JK Kim), in industry; ii) ***impact on public safety*** and iii) ***impact on health*** through microsystem and precision engineering technologies applied, for example, in landslide detection (YK Lee) and biomedical devices to detect cancers (SH Yao, YK Lee, DDC Lam); and iv) ***environmental impact*** through engineering solutions that reduce CO2 emissions and pollution, and create cleaner air, e.g. (CYH Chao, TS Zhao, BL Huang) research on new generation energy-conversion technologies and sustainable energy production, and from its aerodynamics and propulsion engineering research for energy-efficient aircraft (X. Zhang, R. Liem, LKB Li). Meanwhile, research in design, manufacturing automation, and robotics has ***economic impact*** through strong industry links in areas ranging from jewelry to microelectronics packaging, as well as computer-aided design, computer-aided manufacturing, control, and precision manufacturing and measurement.

Major beneficiaries are wide-ranging, including individual industries, spin-off companies, employees, urban planners, medical professionals, patients, consumers and the public. It also supports the development of Hong Kong and the Greater Bay Area as a hi-tech hub for innovation and industry.

(2) Approach to impact

Societal impact and technology transfer are important for HKUST and the UoA, as reflected in their inclusion as key performance indicators (KPIs) for faculty. They are promoted through ensuring the relevance of our research; inclusion of public and private sector collaborations in budget allocation to departments; and support for patent applications, licensing technology, and spin-off companies.

Collaborative research and development (R&D): This has been facilitated through institutional links with other leading universities, such as the HKUST-MIT Alliance Consortium, and the use of large-scale Theme-Based Research (TBR), Innovation and Technology Fund (ITF) and Collaborative Research Fund (CRF) grants (e.g. Chao's research on smart control and monitoring systems for energy efficient buildings involving the ITF and CRF funding platforms).

Consultancies: Unit members have been encouraged to take on consulting contracts to help companies at all levels, from setting strategies to solving technical or system design problems. Examples of local and international collaborating partners include the Mass Transit Railway Corporation (MTR), CLP, TownGas, Cathay Pacific, Rolls Royce, HACTL, SF.com, Huawei, EEBus.

Commercialization of research breakthroughs: During the review period, Unit members developed many technologies mature enough for commercialization through startup companies that they and alumni have founded. Examples include Sane Form Ltd. (an architectural geometry optimization service company) and Incus Company Ltd. (developing hearing-aid technologies).

Dissemination of research: The Unit facilitates impact by providing platforms for members to relay their research findings to audiences outside academia. For example, knowledge from the TBR projects "Transforming Hong Kong's Ocean Container Transport Logistics" and "Creation of Rechargeable Electron-Fuels for Stationary Power Supplies and Electric Vehicles" was shared

through international conferences attended by industry participants; seminars for local industrial professional organizations; and promoting relevant Hong Kong industries internationally through researchers' international engagement.

Institutional support: Impact is also facilitated by University resources and services. These include, within IEDA, the Advanced Manufacturing Institute (an international R&D center for manufacturing technology); the Knowledge Transfer Office, Entrepreneurship Center, and Facilities Management Office – the latter working with the HKUST Sustainability Unit through the Sustainable Smart Campus as a Living Lab Initiative to facilitate prototype testing and demonstrations on campus to students, visiting academics, delegations, and the public (e.g. Zhao's e-fuel project).

(3) Strategy and plans

In the next review period, we will continue to emphasize the importance of achieving societal impact, particularly among mid-career and senior faculty, while supporting junior faculty in establishing the strong research foundation necessary for future impact.

We will build on the approach outlined above while encouraging Unit members to engage more directly with industry for collaboration in applied R&D projects. One example of a new high-impact project is the March 2019 launch of the first customer relationship index consortium involving IEDA, the Computer Science and Engineering Department, and industry-based Asia Pacific Customer Service Consortium. The goal is to develop Hong Kong's first Customer Relationship Excellence (CRE) Index and big data intelligence platform for customer satisfaction and sentiment analysis. The project, led by Tsung, has ITF funding.

We will also extend relationships with industrial partners in the wider Greater Bay Area. In particular, we will make greater use of our mainland platforms: the Guangzhou HKUST Fok Ying Tung Research Institute in Nansha, HKUST Shenzhen Research Institute in Shenzhen and the HKUST LED-FPD Technology R&D Center in Foshan, as well as the new HKUST Guangzhou campus, to access funding and talent for collaborative research and knowledge transfer.

The overall aim will be to extend the local and global impact achieved in RAE2020 while fostering Hong Kong and the Greater Bay Area as a leading knowledge-based economy.

(4) Relationship to case studies

The three cases fall into the broadly-based "design and manufacturing" area. All were underpinned by well-funded, cutting-edge research and involved collaboration with industry partners.

Joneja's case, involving research on design for manufacture and assembly in complex architectural projects, was supported by an RGC GRF grant and subsequently a government ITF grant (HK$3.8m, co-sponsored by construction industry partners, including Hacely Engineering and Gammon). It led to Joneja and research students founding spin-off consulting company Sane Form Ltd, which has worked with leading architects such as Norman Foster, Bing Thom, and the late Zaha Hadid on landmark developments in Hong Kong, Macau and Sydney Australia. The project achieved *economic impact* through efficiencies in fabrication costs and time in completing the interior and exterior facades for the developments, and through job creation.

Lee's case, developing improved LED lighting for Hong Kong's MTR, involved close collaboration with the MTR Corporation Ltd, and a systematic process of research, prototyping and trial, before being manufactured by industrial partner Jiuzhou-Mingwell Solid-State Lighting Co Ltd. The significant energy savings achieved have generated *economic impact* for the MTR, and *environmental impact* through reduced energy requirements.

Chao and Qiu's case, on smart green buildings, involved technology development sponsored by mainland China government funding of over RMB15 million. The Building Energy Research Center, at HKUST Fok Ying Tung Research Institute in Nansha was the platform for the research. A total of 17 Chinese patents have been granted, while production is proceeding through industry collaboration with Guangzhou Wanbao Group Co, Ltd, one of the largest manufacturers of household appliances and refrigeration equipment in China.