

Research Assessment Exercise 2020 Impact Overview Statement

University: The Hong Kong Polytechnic University |

Unit of Assessment (UoA): 14 - mechanical engineering, production engineering (incl. manufacturing & industrial engineering), textile technology and aerospace engineering |

Total number of eligible staff of the university in the UoA: 69 |

(1) Context

UoA14 of PolyU comprises Departments of Industrial & Systems Engineering, Mechanical Engineering and the technology section of Textiles and Clothing. The UoA has a broad portfolio of applied research that appeals to a wide range of users and beneficiaries. The main types of impact relevant to research and the associated beneficiaries are:

Impacts on government & the public We continued our active involvement in space tool design for China's Chang'e Missions. The wide media coverage illustrated that HK was in the arena of space instrumentation research and the work was invited to showcase in various STEM public lectures and exhibitions. Our knowledge management (KM) team offered knowledge transfer services to various government sectors including Police Force and Social Welfare Department on a regular basis; the team leader is also an Honorary Advisor to the Hospital Authority, Correctional Services Department, and the Australian Government Consultative Committee.

Impacts on health and environment Our thermofluids & combustion group has served the society in combustion and pollution control through developing technologies such as pollutant emission controlling devices for motor vehicles, and nanofiber-particle filtration and gas purification that received numerous international awards, and were licensed to industry. We also helped the recycling industry in compliance of "Promotion of Recycling and Proper Disposal (Electrical Equipment and Electronic Equipment) (Amendment) Ordinance 2016".

Impacts on practitioners and professional service Research for Commercial Aircraft Corporation of China, Ltd. led to airworthiness certification standard for aircraft composites. We also developed a number of innovative instruments for evaluating textiles and clothing and formed the basis for international standards, e.g. Moisture Management Tester became the tool for four standards in the US and China that have already been extensively adopted by industries worldwide.

Economic impacts Our new market-leading technologies (such as Nu-Torque, see case study) have produced higher quality products at lower cost and environmental impact, and with significantly increased productivity and profits for companies worldwide. Our space tools design was converted into commercial success of invention of the world's first internally minimally invasive surgical robotic system. The State Key Laboratory of Ultraprecision Machining Technology (SKL) served more than 100 fibre-optic communication enterprises in HK and China via consultancy, manufacturing cycle was shortened and efficiency improved. We have delivered technologies in sound and vibration control to China Academy of Space Technology (CAST); the technologies were also adopted by China Light & Power and China High-speed Railway.

(2) Approach to impact

2.1 Fostering links with industry and develop sustainable partnership through a number of mechanisms: a) We invite senior representatives from industrial and government sectors to sit our Departmental Advisory Committees (e.g. CEO of MTR, Director Public Affairs of Swire Pacific Ltd, Chairman of the HK Research Institute of Textiles and Apparel Ltd (HKRITA)). They offer insight on global trend and line up potential industrial collaborators; b) Our academic staff hold 120 advisory roles in industrial, government, and professional bodies for serving community and networking; c) We invite industrialists and government officers for laboratory visits almost every week and often lead to Innovation and Technology Fund (ITF—one of the major industry-support funds in HK), collaborative research projects and consultancies; d) We actively showcase our research achievements to industry in exhibitions (we participated in 62 exhibitions in the RAE period) such as the International Exhibition of Inventions of Geneva. We have received a total of 157 awards,

and some resulted in commercialization. With our concerted effort and through the various means above, 163 ITF projects totaling \$448M were secured in the RAE period. We were awarded the highest amount of ITF to a department of industrial/manufacturing/mechanical engineering in HK. Our industrial network also gave rise to 21 collaborative and 4 contract research projects. Our deliverables were often commercialized.

2.2 Impact industry through commercializing our research We provide seed funding and central support and training for early-stage commercialization. Our staff and students are greatly benefitted from the PolyU Lean LaunchPad, a 10-week, evidence-based entrepreneurship development programme. Also, the Innovation and Technology Development Office (ITDO) supports patents and IP applications. As a result, 19 licenses were issued to companies worldwide. Success stories included the compound eye system developed by SKL which was later licensed to Marvel Digital Ltd that aims to be the largest naked eye 3D display provider in the global market. 3 spin-off and 2 start-up companies were set up, including one with 50 staff, AdvanPro, which has obtained investments of over \$30M from angel fund and venture capital funds for mass production of fabric sensors. The minimally surgical robotic system technology initiated by some medical professors of The University of Hong Kong and developed by an engineering team of the UoA funded with ITF was transferred to a startup venture named Bio-Medical Engineering (HK) Ltd.

2.3 Consultancy and advice to external bodies to achieve technology transfer. 608 projects were conducted with companies in HK and overseas totalling \$72.8M. They not only led to industrial benefits, but also shaped policymaking. Examples included our expert advisory services which cumulated in the formulation of HK Police Force's 5 years Strategic Plan as well as a governance framework for KM.

2.4 Seminars and Continued Professional Development (CPD) training programmes for industry We organize seminars and conferences to introduce our research to specific user groups and find new partners for collaboration. These fora also help us understand the latest industry concerns. Recent examples include: a series of seminars on electrical waste disposal to assist the e-waste recycling industry innovate and improve compliance, with a total attendance of 350; an international conference series in intimate apparel with 800 industrial attendees, including Wacoal (Japan) and Triumph (Germany). Also, 65 industrial workshops, public lectures and exhibitions about textile technology were held. In mechanical engineering discipline, events on pollution/noise control, green energy materials and structure health monitoring have attracted more than 1,500 non-academic attendees. CPD is another route to transfer our knowledge to industry and we ran 6 intakes of Certified Knowledge Professionals with a total of 140 attendees.

2.5 Public engagement We strive to raise interests in STEM education via wide exposure in media, such as the space projects, expert advice for car accidents, and textile advancements. Public lectures examples included "Chang'e lunar projects" (300 attendees), "From Chang'e to non-invasive micro surgeries" at HK Science Museum, and space project exhibit at 2017 Innotech Expo (110K attendees). We also have staff liaising with secondary schools to disseminate our applied research achievements by offering lab tours, school talks and STEM workshops around the year.

(3) Strategy and plans

Leadership, Support and Recognition of Impact Activities We foster a culture of translating research into impact. Every staff member can engage in consultancy or outside activities for up to 1 day per week as per University's guidelines. Performance in impact activities is recognized in appraisal. In the RAE period the UoA successfully persuaded the senior management to increase the recognition of impact activities in the promotion exercise. PolyU Technology and Consultancy Company Limited gives various KT awards annually as encouragement. We provide financial support (such as return of overhead, provision of seed money) and reduction in teaching load to nurture KT collaborations. Our theme group leaders mentor junior colleagues to engage in them. We continue to utilize institution's infrastructure such as the Innovation and Technology Development Office which provides IP management. We will continue to make good use of Central Research Facilities such as 3D printing, Chemical and environmental analysis, Materials

characterization and device fabrication, and Big data analytics for technology advancement. PolyU also hosts the HK Research Institute of Textiles and Apparel Ltd. which acts as a broker between HK academia and the textile and clothing industry.

Networks with industry, Mainland China and the world

- To expand strategic research activities and develop partnership to address societal challenges
 - A very successful case was the development of instruments for space missions through long-term collaborations with European Space Agency, CAST and Swedish Institute of Space Physics. Building on the successes of the previous two lunar missions, we are committed to develop critical instruments for China's first Mars exploration mission (2020), and the Jupiter Mission (2022).
 - Locally the technology attracted collaboration with Water Supplies Department on robots for underground waterpipe maintenance. Two projects with \$7.5M were successfully completed and a \$10.8M one on-going. Further large-scale projects are being negotiated and forthcoming.
 - The SKL will participate in "Reference algorithms and metrology on aspherical and freeform lenses" funded by European Commission's Horizon 2020 to tackle the lack of international governing standards on measurement of ultra-precision freeform surfaces for optics industry.
 - To leverage on our advanced Smart Wearable Technology to build ties with world-leading companies, such as Luthai, Texhong, P&G, Philips and Alibaba, to meet the great demands for smart wearable technology and bio-textiles in the ageing society and IoT trend.
 - To actively participate in the nation's Greater Bay Area (GBA) initiative to build new industry links. (a) to leverage on the facilities and infrastructure of our Mechanical Engineering Research centre in PolyU Shenzhen Research Institute for the Great Bay Area initiative; (b) to offer a Master program in textile and clothing technology in Shenzhen with the aim of attracting more mature students from industry and to explore new collaborations in China; (c) to explore to branch out our SKL in GBA to contribute to the precision and optics industries.

Public engagement in science The UoA will continue to expand its outreach programme, including public lectures, exhibitions, invited talks, lab visits and STEM workshops, co-ordinated by full-time supporting staff, to raise students, teachers, parents' as well as public interests.

(4) Relationship to case studies

The case studies exemplify the success of our approach as outlined above. In particular, our textile related **case studies (1&2)** illustrate our commitment to fundamental research aimed at solving problems for industry, and both demonstrate the success of the approaches and strategy outlined above. Specifically, the unit worked closely with HKRITA, a funder of translational research, to secure funding for the development of the moisture management tester and Nu-Torque (**2.1**). Close partnerships were developed with companies, such as Luthai, through collaborative research (**2.1**) who then licensed the technologies through ITDO (**2.2**).

Case study 3 arose from a high-level space research programme supported by CAST in the nation's lunar exploration missions, and the conversion of the technology to develop a surgery robotic system for minimally invasive surgery through ITF projects. The success of this case just could not be realised without the supports of the university through allocation of extra space for the setting up the Micro-Nano Fabrication, Precision Robotics and the Extreme Environment laboratories, and large funding (\$13M) via the University's project of strategic importance scheme and matching fund and return of overheads by Department as seed money to establish long-term collaboration with international space research organizations and reach out to public via exhibitions and public lectures. This impact case thus indicates clearly our successful approaches of **2.1, 2.2, 2.3 and 2.5**.

Case study 4 started when the PI was recruited strategically as a Chair Professor in the area of product innovation & green technologies in 2005. In addition to providing significant amount of equipment/space/grants/PhD scholarships to the PI for his research on nanofiber technology, PolyU and the department provided assistance for the PI to establish close connections with relevant government departments and industrial partners by organizing news conferences, technical seminars and demonstrations and teaching release. This case impact once again indicates our successful approaches of **2.1, 2.2 and 2.4**.