

Research Assessment Exercise 2020 Impact Overview Statement

University: The University of Hong Kong (HKU)

Unit of Assessment (UoA): 15 chemical engineering, biomedical engineering, other technologies (incl. environmental engineering & nautical studies) and marine engineering

Total number of eligible staff of the university in the UoA: 9

(1) Context

Hong Kong University's UoA15 submission involves staff from the Departments of Electrical and Electronic Engineering (EEE), Mechanical Engineering (ME), Orthopedics and Traumatology (OT), and Industrial and Manufacturing Systems Engineering (IMSE). The nine UoA members form the core of the university's biomedical engineering (BME) research consortium and the BME BEng undergraduate teaching program.

The UoA's mission is to advance knowledge at the intersections of engineering, biology and medicine, and to use this knowledge to innovate technologies that improve human health. HKU BME research is focused in three areas: (i) biomedical imaging; (ii) biomaterials and tissue engineering; and (iii) medical devices and biosignal processing.

These thematic research areas have been designated for long-term development in alignment with (i) the strategic development plans of HKU Faculties of Engineering and Medicine; (ii) the booming medical devices industry and entrepreneurship culture in the Greater Bay Area (e.g., Shenzhen and Hong Kong); and (iii) the regional and global demand for healthcare technologies in these areas.

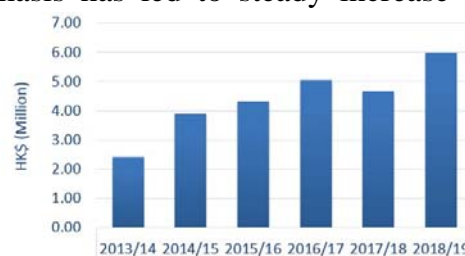
The UoA pursues impact through the public dissemination/utilization and commercial translation of the scientific knowledge it acquires and creates. Over the assessment period, the UoA's impact-driven activities in the three thematic areas have produced a number of innovative technologies that are presently undergoing commercialization.

(2) Approach to Impact

UoA members fully recognize and promote the mutual benefits of engagement with the end-users of their research in the healthcare and medical devices industry (e.g., clinicians in HKU/QMH). Such engagement involves (i) transferring skills/expertise; (ii) identifying research directions for impact; (iii) commercialization; and (iv) improving commercial competitiveness. The UoA has particularly valued and promoted the following approaches.

Applied Research: All UoA members have been strongly encouraged to pursue highly applied research with sponsorship from the HK government and industry since 2013. By closely interacting with clinicians (at HKU Faculty of Medicine and QMH - the largest public hospital in HK) and the medical devices industry, the UoA identifies both healthcare needs and technological challenges. Over the assessment period, this strategic emphasis has led to steady increase of applied research income in the form of HK ITC grants and industrial research contracts (Figure 1), many of which involves human studies and clinical trials.

Figure 1 Annual income from external applied research grants (including HK ITC grants and industry research contracts etc.) received by UoA over the assessment period.



More recently, three large applied research grants were awarded to UoA members: (i) one HKD\$30.3M China MoST National Key R&D Program grant (formerly known as "863 Project"); (ii) one HKD\$3.3M US NIH Brain Initiative Sub-award; and (iii) HKD\$4.3M Guangdong Initiatives contracts. These new awards are all focused on applied research in orthopedic implants and brain imaging devices.

Research Commercialization: In the past five years, all UoA members have been strongly encouraged to pursue commercial translation by actively promoting their research findings and

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establishing start-up companies in the Greater Bay Area. This emphasis has led to a dramatic cultural shift towards entrepreneurship via advanced technology development with specific clinical applications in mind. UoA members and their students have founded four technology start-ups in recent years:

- Conzeb Limited: Co-founded by UoA member Dr. K Tsia; ultra-high-throughput cancer diagnostic tools based on ultra-high-speed optical imaging and artificial intelligence.
- Novel Sonics Limited: Co-founded by UoA member Dr. W Lee; human myocardial functional assessment tools based on quantitative ultra-fast ultrasound elasticity imaging.
- Living Tissue Company Limited: Co-founded by UoA member Prof. B Chan; cartilage regeneration therapy based on mesenchymal stem cell-based tissue engineering.
- Lifespans Limited: Co-founded by UoA member Prof. W Lu; more effective and safer bone implants for elderly osteoporotic patients that are based on anti-migration designs and quantitative mechanical engineering simulations.

These companies have raised private cash investment of ~HK\$33M with a total estimated valuation of ~HK\$290M so far, winning a number of regional entrepreneurship competition prizes. Led by UoA member Prof. Wu, another start-up is being spun off to develop MRI for accessible healthcare.

Engagement beyond Academia: All UoA members have proactively maintained close relationships with industry, healthcare sectors and non-academic organizations relevant to their research, and with the general public. The forms of engagement include: (i) regular visits to medical devices companies in the region; (ii) technical consultancies to leading medical devices companies (e.g., Mindray Medical Shenzhen, the largest medical devices companies in Mainland China); and (iii) active panel and advisory memberships in HK ITC, HK Science and Technology Park (HKSTP), HK Applied Science and Technology Institute (ASTRI), HK Department of Health, HK Institute of Engineers (HKIE), and private entities such as PricewaterhouseCoopers (PwC). For example, UoA member Prof. W J Kao is presently on sabbatical from HKU and serves as the Director of Biomedical Technology Cluster at HKSTP. These activities have also led to a cultural change in which UoA members are now more vocal in disseminating and promoting their research findings to the general public. Examples include the recent South China Morning Post coverage of research work by UoA members Dr. K Tsia and Prof. E Wu, and the selection of Prof. Wu's brain imaging research work as one of Top 10 Neuroscience News Stories of 2017 by TechnologyNetworks.com.

(3) Strategy and Plans

Over the assessment period, all members have been strongly encouraged to translate their research findings and knowledge for direct socioeconomic and healthcare impact. This priority is supported through the UoA's staff recruitment priorities, the mentoring and performance assessment of existing staff, and BME research facility planning. These strategies have led to significantly increased research translation and impact, particularly through applied research projects and technology entrepreneurship in the areas of biomaterials, tissue engineering, and biomedical imaging. The UoA shall continue to augment research impact with more supportive teaching load flexibility, resources allocation, new staff recruitment, and continued engagement

(4) Relationship to Case Study

The impact described in the submitted case study has directly resulted from the key facets of the UoA's current strategy and approaches outlined above. The submitted impact case study is concerned with biomaterials. It describes the impact of research work led by UoA member Prof W Lu. This is currently being pursued by a spin-off company (presently with USD\$1.75M initial fund and ~USD\$13.0M valuation, and clinical trials underway) headed by Prof Lu's former PhD student, Dr. Sloan Kulper, to develop next-generation bone implants for elderly osteoporotic patients.

Note that this research also led to a recently awarded 2019/2020 China MoST National Key R&D Program grant (as the first and only such award directly to HK so far) with Prof Lu as PC, focusing on industry-university-research collaboration to advance medical implant technologies.