Imperial College London

# Faculty of Engineering Five Year Strategic Plan: October 2019

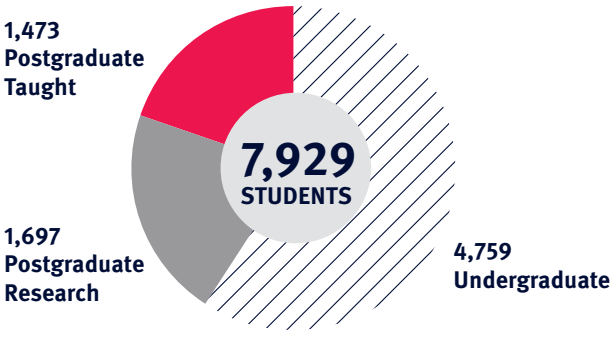
Delivering excellence and impact in research, teaching and translation.

The Faculty of Engineering and its constituent departments are consistently ranked in the top ten engineering and technology schools in the world. Our ambition **over the next decade** is to move to become one of the world's **top five** engineering and technology schools, measured through the quality and impact of:

1. The education we provide
2. Our research
3. Our translation

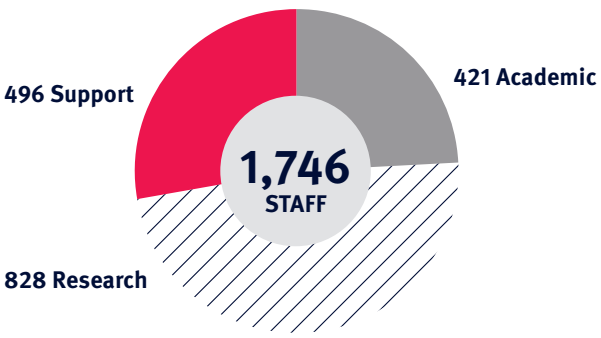
This strategic plan summarises how the Faculty will approach the challenges and enhance the opportunities across these areas.

**IMPERIAL COLLEGE LONDON FACULTY OF ENGINEERING BY NUMBERS (2018/19):**




**10,130** Undergraduate Applications ▶ **5,014** Home/EU ▶ **5,117** Overseas

UG applications: Admissions ratio **7.7 : 1**




**13,547** Postgraduate Applications ▶ **10,658** Taught ▶ **2,889** Research

PG Applications: Admissions ratio **7.5 : 1**

# 1. EDUCATION AND THE STUDENT EXPERIENCE

Our graduates will be equipped with the skills, knowledge, and attributes they need to make an outstanding contribution to address society's global challenges. We will be proactive in developing the highest quality engineering education that is accessible to the widest range of potential students. Over the next five years we will refine our curricula to enhance our students' core Engineering attributes and skills, which are valued by employers and academia. Our approach is outlined below:

## EDUCATIONAL EXPERIENCE

- Review and implement new curricula with a clear focus on ensuring the excellence of our teaching
- Develop further support to enable students to gain experience in industry, entrepreneurship, and research
- Enhance support in digital learning and teaching
- Recognise and reward excellent teaching and student research supervision
- Identify common skills and knowledge that every engineering graduate from Imperial should know, and seek to develop these across the Faculty
- Work at the interface between education and research to provide unique research training opportunities for our students
- Evaluate the longitudinal outcomes of our education developments

## RECRUITMENT AND ACCESS

- Improve access and support for talented UK applicants from disadvantaged and underrepresented groups
- Increase proportions of female and BAME students
- Review our international recruitment strategy to ensure applicants come from a wider range of countries than at present

## SUPPORT AND WELLBEING

- Build an inclusive and respectful community
- Ensure student-facing staff are equipped with the tools and skills to support students effectively with personal challenges
- Ensure all new students transition successfully to the College

## EDUCATIONAL INFRASTRUCTURE

- Identify and work towards the optimal cohort size for each programme
- Enhance our physical infrastructure
- Develop core underlying digital infrastructure services for students and learning analytics

## EMPLOYER AND ALUMNI ENGAGAMENT

- Engage actively with employers to inform development of future curricula
- Strengthen alumni relations to enhance curricula, reputation, and reach
- Work with accrediting bodies to enhance professional skills development for students

# 2. RESEARCH

Our research strategy focuses on maintaining world-class excellence in our core engineering disciplines, maintaining or establishing world-class facilities, hiring and developing outstanding academic staff, and attracting the best research staff and students.

We will build on our track record of multi- and trans-disciplinary research, focussing on global challenges where we are advantaged through our expertise, facilities and/or partnerships. We are actively developing new research opportunities in the following areas:

## TRANSITION TO A SUSTAINABLE ZERO-POLLUTION ECONOMY

| DRIVERS | ACADEMIC STRENGTHS | POSITIONING AND PARTNERS | NEW OPPORTUNITIES |
|---|---|---|---|
| • Need to transition to net-zero $CO_2$ emissions<br>• World-wide plastic pollution, microplastics in the environment<br>• Poor air quality in urban and rural societies | • Fossil-fuel-free transport: Electric vehicles, batteries, fuel cells<br>• Bio-economy: Engineering Biology, biomass for fuel and chemical feedstocks<br>• Circular Economy: systems approaches to whole life-cycle manufacture<br>• Light weighting vehicle structures: both aluminium forming and composites<br>• Engine downsizing: important for hybrid technologies<br>• Decarbonisation technologies: CCS, heat and transport decarbonisation<br>• Global optimization of industrial processes<br>• New business models: Blockchain, fintech | • Energy Futures Lab, Faraday Institution, Imperial-Tsinghua Research Centre on Intelligent Power and Energy Systems, Institute for Molecular Science and Engineering, plus a range of industrial and end user partners | • Machine learning for bioprocess modelling and intensification<br>• Integrated approaches to water-food-energy nexus<br>• Robust, high-performance biosystems employing Engineering Biology<br>• New technologies and business models for a zero-pollution economy |

## ENGINEERING RESILIENT AND SECURE INFRASTRUCTURE

| DRIVERS | ACADEMIC STRENGTHS | POSITIONING AND PARTNERS | NEW OPPORTUNITIES |
|---|---|---|---|
| • Today 55% world's population lives in urban areas; by 2050 it will be 68%<br>• Cities with 1- 5 million inhabitants projected to grow to 559 by 2030<br>• To limit global warming to 1.5°C $CO_2$ emissions must reach net zero by 2050 (IPCC)<br>• The OECD estimates that globally US$53 trillion of infrastructure investment will be needed by 2030 | • The low carbon energy transition: Whole-system analysis, System integration, Regulation and policy<br>• Sustainable Power: Energy storage, fuel cells, solar, wind<br>• Transport technology and intelligent transport systems<br>• Energy efficiency and decarbonisation: Low carbon heat, poly-generation, new conversions/reactions, smart grid<br>• Future Cities: Smart, resilient urban infrastructure, digital energy systems<br>• Water and Air quality: Sustainable water management systems, air quality measurement, sensor networks and modelling<br>• Security/verification: Cyber-physical systems, IoT, data science, privacy and trust | • Centre for Process Systems Engineering, Data Science Institute, Energy Futures Lab, Faraday Institution, Institute for Security Science and Technology, UKCRIC, plus an extensive range of industrial partners | • Re-imagining transport for sustainable decarbonisation<br>• Decarbonising heating/cooling<br>• Infrastructure resilience: digital and human characteristics of systems, IoT environments, ability to continue operating when partially compromised. |

## AI AND MACHINE LEARNING FOR ENGINEERING APPLICATIONS

| DRIVERS | ACADEMIC STRENGTHS | POSITIONING AND PARTNERS | NEW OPPORTUNITIES |
|---|---|---|---|
| • Exponential growth in availability of data and hardware infrastructure<br>• Developments in ML, AI, data science and systems offer potential for transformative leaps forward ('digital disruptors')<br>• Commercial applications through disruptive impact on technology companies and vigorous start-up ecosystem<br>• Ethical implications including dual-use technologies, trust and privacy in AI systems, legislative implications | • Machine Learning: Explainable ML, geometric ML, foundations of ML, statistics<br>• Automated Reasoning: Argumentation, negotiation, coordination, multi-agent systems<br>• Trustworthy AI/ML: Verification, testing, model checking, program analysis<br>• Secure AI/ML: Privacy, cybersecurity, threat detection and mitigation<br>• Systems for AI/ML: Distributed systems, data centres, scalability, data management<br>• Hardware for AI/ML: Hardware/software codesign, FPGAs/GPUs, compilers<br>• AI/ML for robotics and vision<br>• Cyber-physical AI/ML: Sensing, control, self-organisation, Internet-of-Things<br>• Data science and data-centric engineering | • AI for Health CDT, AI@Imperial Network, Alan Turing Institute, Data Science Institute, plus an extensive range of international and academic business partners | • AI for Future Healthcare: Clinical support, medical image computing<br>• AI for Scientific Discovery: AI-enhanced creativity and discovery in chemistry, drug discovery, new materials<br>• Digitization of Manufacturing Life-cycles from discovery, product design, development and testing<br>• Sustainable Smart Mobility: AI for managing urban infrastructure and transport systems, infrastructure for autonomous transport<br>• Safe and Predictable Future AI Systems: AI for critical infrastructure, safety-critical applications, autonomous control |

## AFFORDABLE TECHNOLOGIES FOR AN AGEING SOCIETY

| DRIVERS | ACADEMIC STRENGTHS | POSITIONING AND PARTNERS | NEW OPPORTUNITIES |
|---|---|---|---|
| • Ageing population – need to reduce societal burden of chronic disease<br>• Spiralling cost of healthcare: 9.7% of GDP in UK and 17.2% of GDP in US<br>• Age-related diseases, such as dementia, musculoskeletal conditions and hearing and vision loss, represent a huge burden to the NHS. For example, Arthritis is biggest cause of pain and disability in the UK; each year 1 in 5 people consults a GP about a musculoskeletal condition (8.75 million people) | • Biomedical Engineering/Biomechanics: Arthritis, cardiovascular disease<br>• Medical devices: Sensing and imaging technologies, Nanotechnology, Novel Biomaterials<br>• Medicines manufacturing/vaccines: Bio-process systems engineering, Synthetic Biology, Molecular engineering<br>• Neurotech: Dementia, mental health, hearing loss | • BME Research Hub, Dementia Research Institute, Hamlyn Medical Robotics Centre, RBL Centre for Blast Injury Studies, World-leading Engineering and Medical Faculties, plus an extensive range of healthcare and industry partners | • Creating generalisable AI to deliver personalised and more affordable healthcare: Smart combinations of personalized big data and clinical technology AI to improve health outcomes and patient quality of life<br>• Engineering novel medicines: Reducing time to market and cost of manufacture<br>• Customized replacement tissues and organs by Engineering Biology with additive manufacture<br>• Global Health: Engineering health solutions for the developing world |

# 3. TRANSLATION AND AN ENTREPRENEURIAL CULTURE

We will continue to increase all forms of impact from our research and to deliver an Enterprise culture. We have done this by bringing together staff responsible for handling invention disclosures, patenting and licensing with the industry partnerships and commercialisation staff responsible for securing research income from industry, promoting our research capabilities and available technologies to existing and prospective partners, and supporting the Faculty's interactions with industry. Translation from research to practice can be achieved through:

(i) Publication in open literature and findings made available for free use

(ii) Direct take-up via corporate partners

(iii) Proof of concept studies via translational funds or industry funding, patenting and subsequent licensing

(iv) Licence to spinout

We will work to evaluate **the most appropriate route for each technology** and then seek to actively manage the process of translation to increase the probability of success. Different industry sectors have very different cultures and promoting technology take-up requires experience in that particular sector. We will therefore **engage experts from among our alumni and research contacts base** to be involved with each technology and assist the Imperial team in taking it to market.

There is also a strategic need to develop flexible space which can house multi-disciplinary research teams in response to specific challenges and funding opportunities. Such a space would have maximum value if it expanded our abilities to support research translation and entrepreneurship, for both students and staff.

**IMPERIAL COLLEGE LONDON FACULTY OF ENGINEERING RESEARCH OUTPUTS**

| YEAR | NEW PATENTS ARISING FROM THE FACULTY OF ENGINEERING: |
|---|---|
| 2018-19 | 49 |
| 2017-18 | 45 |
| 2016-17 | 40 |
| 2015-16 | 38 |
| 2014-15 | 37 |

**NUMBER OF PRIORITY FILINGS (2018-19) – BREAKDOWN BY DEPARTMENT**

**2** Aeronautics

**8** Bioengineering

**5** Chemical Engineering

**2** Civil and Environmental Engineering

**16** Computing

**1** Dyson School of Design Engineering

**6** Electrical and Electronic Engineering

**5** Materials

**4** Mechanical Engineering

**58%**

**In 2018, 58.4% of new patents from across College arose from the Faculty of Engineering.**

**OVER THE NEXT 5 YEARS, WE AIM TO:**

**Double the number of licences and spinouts**

**Increase the volume of direct industrial research funding by 50% (to around £45M per annum)**

**See at least 75% of the current industrial research centres renewed**

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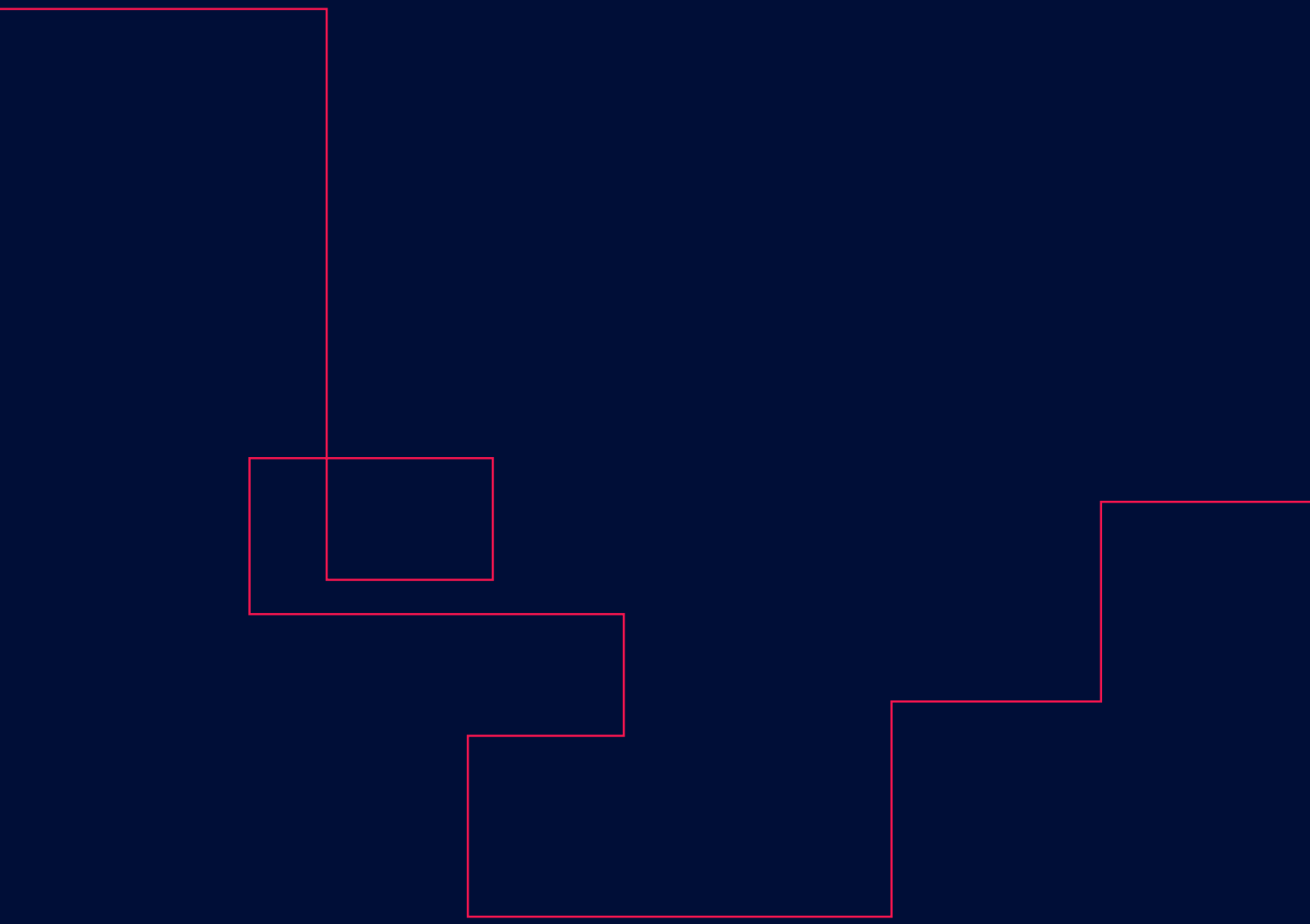

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