Written evidence from Royal Academy of Engineering (ENB0047)

Introduction

The Royal Academy of Engineering ('the Academy') is the UK's National Academy for engineering and technology. We are grateful for the opportunity to submit a response to this important inquiry. It has been informed by the expertise of our Fellowship, which represents some of the nation's best practicing engineers, including leading researchers, industrialists, innovators, and entrepreneurs.

Engineering biology is the application of rigorous engineering principles to the design of biological systems, with the objective of contributing to economic activity and sustainable and resource-efficient solutions to the societal challenges faced in food, chemicals, materials, water, energy, health and environmental protection[1].

Engineering biology has potential the solve long-standing problems and make possible new approaches in fields as disparate as medicine, sustainability, and transport. It is an area where the UK has already built considerable technical capacity, with funders and companies ready to capitalise on the potential for rapid growth and commercial development. However, momentum is easily lost, and there is much the government and engineering community must do to ensure that progress continues to be made.

The content of this response builds on the Academy's 2019 report, *Engineering Biology a Priority for Growth*[2], and from our submission[3] to the Department for Science, Innovation, and Technology's consultation on the topic in 2023. Both pieces of work were guided by the expertise of engineers across this sector, including academics at the forefront of the discipline and entrepreneurs working to transform these new insights into innovative new products and services.

Having established these solid foundations of engineering biology in the UK, now is the time to ensure their longevity, and build on their success to accelerate translation, demonstrate commercial scale, and secure the value from such activities in the UK.

[1] *Engineering Biology: A Priority for Growth*, Royal Academy of Engineering, 2019
[2] *Engineering Biology: A Priority for Growth*, Royal Academy of Engineering, 2019
[3] *Submission to Engineering biology: call for evidence*, Royal Academy of Engineering, 2023

The Academy would be delighted to provide further information on the content of this submission, or to assist the Science and Technology Committee in any way as it continues to consider these important issues. If you have any questions about this submission, please do not hesitate to contact the Academy via publicaffairs@raeng.org.uk.

What are the UK's key strengths in the area of engineering biology?

The UK's research strengths in engineering biology are predominantly located in universities and are spread across a wide range of disciplines including data science, molecular biology, biomathematics, and control and systems engineering, reflecting that engineering biology is inherently multidisciplinary. The UK is already a world-leader in data science research, and this position is integral to progress advances in engineering biology in the UK. The Synthetic Biology for Growth programme was critical to establishing the UK's research strengths in engineering biology.

However, while UK the momentum that the UK has built around engineering biology and its connected disciplines is not self-sustaining. Without deliberate policymaking and sufficient funding sources, this growth will taper off and the UK academic and industrial advantage in this area may wane.

What should the role of UKRI be in supporting engineering biology? Which research councils are most involved in funding it? Are there areas where more could be done to support interdisciplinary research? What would the best mechanisms be for achieving this?

Engineering underpins synthetic biology. It is the engineering driven approach that will deliver methods, tools, standardisation, design, analysis and ultimately optimisation of biological systems that sets it apart from 'classical' biology. Engineering research skills, such as systems and control engineering are essential for continuing to develop the foundational capabilities of engineering biology. These skills are required to advance the engineering driven approach that will deliver methods, tools, standardisation, design, analysis and ultimately optimisation of biological systems.

We have heard concerns that engineering biology in the UK is becoming increasingly biosciences focused, to the potential determinant of the current and ongoing success of engineering biology in the UK. While it is

crucial that EPSRC and BBSRC work together on engineering biology, we encourage even greater engagement from EPSRC to maintain and grow the UK's strengths in engineering biology research.

The foundational capabilities underpinning engineering biology are still being developed and engineering is primarily responsible for these. It is crucial that the UK retains strengths in the key underpinning engineering research areas, such as systems and control engineering.

Does the Government's "National Vision for Engineering Biology" set out the right priorities for government to develop the engineering biology field in the UK?

The Academy submitted evidence to the consultation[4] which resulted in the National Vision for Engineering Biology. The vision outlined by DSIT is one we would certain align with, but there remain some areas where it could strengthened or that we feel could be set out in greater detail by the government.

In the Academy's view the Vision's objective most in need of development 'adoption of in the wider economy', where more ambition and detailed actions would be transformative. In particular, we would have liked to see greater attention paid to the role of government procurement. Public procurement accounts for around a third of all public expenditure with £292 billion spent a year[5], hence it has the potential to be a powerful lever to stimulate innovation, especially in sectors such as engineering biology, where SMEs play a major role. However, current public procurement processes too often stifle R&D and innovation at numerous stages. The Academy has explored the role that government procurement can play in driving innovation as part of our wider series on strategic advantage through science and technology[6].

For the UK to most benefit from the economic opportunities afforded by engineering biology, taking calculated and measured risks is essential. Engineering biology has the potential to completely reimagine the products and processes involved in many existing industries, making it a highly disruptive technology. Companies can sometimes perceive such risk as a radical departure from business as usual. The culture change, the interdisciplinary skillsets and the facilities required, are often

[4] *Submission to Engineering biology: call for evidence*, Royal Academy of Engineering, 2023
[5] *Strategic advantage through science and technology: how can public procurement drive innovation in pursuit of national goals?,* Royal Academy of Engineering, 2022
[6] *Strategic advantage through science and technology: how can public procurement drive innovation in pursuit of national goals?*, Royal Academy of Engineering, 2022

unfamiliar to them. It is vital that companies take a mature approach to risk, balancing the attraction of hanging back until the technology has been demonstrated at scale, with the rewards of being successful early adopters and the risk of being left behind. Government has a pivotal role in supporting balanced risk-taking by directly reducing the risks involved, mitigating the risk for others including by sharing analysis on future demand for engineering biology, public procurement, being prepared to shape markets and accepting occasional failures as inevitable.

There is a compelling case[7] for the public sector to support businesses to manage the risks associated with late-stage R&D and incentivise business investment – the socio-economic benefits from the new products, processes, services and technologies are shared, so the risk must be too. Procurement is an avenue by which government, through acting as a reliable customer of risky but potentially transformative technologies, can provide an effective stimulus for innovation and business growth[8].

We were happy also to see the government place importance on the role played by skills in the engineering biology sector. However, the section discussing talent and skills highlighted a common issue in how engineering is conceptualised in engineering biology. As part of Figure 8[9], which shows the frequency of skills mentioned by respondents to the call for evidence, we would suggest that engineering it unrepresented at only 11% among the other 'Scientific' skills, especially compared to the 41% of respondents lists skills in the biosciences. While biological skills are vital for engineering biology, we have concerns that the low frequency with engineering is mentioned could be evidence of a lesser attention being paid to engineering research skills, such as systems and control engineering, which are essential for continuing to develop the foundational capabilities of engineering biology. These skills are required for the engineering driven approach that will deliver methods, tools, standardisation, design, analysis and ultimately optimisation of biological systems.

We were pleased to see the creation of the Engineering Biology Steering Group announced with the strategy. In our 2019 report, we recommended increase joint working between Synthetic Biology Leadership Council (now Engineering Biology Leadership Council) and the Industrial Biotechnology

[7] *Late-stage R&D: business perspectives*, Royal Academy of Engineering, 2019
[8] Consultation response to Green Paper: Transforming public procurement, Royal Academy of Engineering, 2021
[9] *National vision for engineering biology*, Department for Science, Innovation, and Technology, 2023

Leadership Forum and are pleased that an expert group has been convened to advise the government on the direction for this sector. For this group to be as successful as possible, it must work to break down the silos that exist not only between academic disciplines but between those working in academia and industry.

Trusted and capable leadership within government and the civil service is needed to deliver the broad and complex strategic advantage through the science and technology agenda in a 'sector' as complex as engineering biology. Government must own this agenda, ideally with cross-party engagement. Leaders will need to be empowered to make decisions at pace, deploy resources, and accept and learn from failure. These leaders must also have a good understanding of their science and technology domain and excellent access to expertise.

How can the UK maximise the economic potential of developments in engineering biology?

Government should take action to increase the availability of risk funding for development, commercialisation and scaling of engineering biology companies. Government support for innovation and development is critical for reducing the risk to investors and for bridging a funding gap when private investors are not ready to invest especially in the case of disruptive and deep tech technologies. This should be done on a sustained basis; funding mechanisms such as the Industrial Biotechnology Catalyst which are targeted at supporting the engineering biology through the translation stage, have often been intermittent, creating uncertainty and impacting the confidence of businesses to participate and invest. This is also an area where government procurement mechanisms can act to reduce risk and provide a source of investment for engineering biology businesses.

The government should also support the establishment of facilities to support the translation and the testing of technical scaling activities. Access to technical expertise and guidance as well as access to equipment are essential for companies to demonstrate and prove the concept of their technology in a risk-reduced way and there is a gap in the UK of such support. Significant investment has been made in the UK to establish facilities such as the CPI (The Centre for Process Innovation). However, accessing these facilities can be challenging for time- and money- poor companies, especially small and micro-SMEs. Companies need to consider

technical scaling early on during technology development and company growth in order for it to be effective. Companies often underestimate the time, cost and changes that their technology might need for commercial success.

The value proposition of engaging early with translation infrastructures should be communicated clearly by EPSRC, BBSRC, Innovate UK, the leadership councils, and with the KTN playing a clear role and mobilising other parties. An incentive scheme, such as innovation vouchers, could be used to encourage and facilitate SMEs to access translational infrastructures. Such facilities should be designed with industry input and be separate though well-linked to universities.

What more can the Government do to foster public understanding of engineering biology? Is public acceptability of these technologies a barrier to deployment in the UK?

Public acceptance of engineering biology and its associated technologies is a prerequisite for deploying these in the UK. To support wider understanding of the technology, we recommend that efforts are made to ensure businesses, policymakers and the public understand the opportunities it provides. This can be done by communicating and promoting the applications of engineering biology and the solutions it offers, and by increasing joint working between the Synthetic Biology Leadership Council and Industrial Biotechnology Leadership Forum.

As well as encouraging understanding by the public, activities must take place to ensure the public can R&D in this area. We have highlighted Responsible Research and Innovation (RRI) as a potential approach to this problem. Using RRI, government and research institutes can assess sectors such as engineering biology for the impacts they might have on society, how the public could potentially react to them, and how institutions might go about fostering the design of inclusive and sustainable research and innovation and facilitating societal approval.

RRI is pivotal in the growth and commercialisation of engineering biology. Although the wording and descriptors vary between sectors and organisations, with RRI a well-recognised label in academia, with the fundamental components and values observed to be embedded in engineering biology across both academia and industry.

Trust is also built by listening to the concerns and aspirations of the public. Building on good quality public dialogue such as the Royal

Society's on Genetic Technologies is essential, and this dialogue itself recommends "Encouraging those campaigning in the field of genetic technologies to work with the Royal Society to engage the public in a balanced discussion of the issues involved."[10]

Finally, there is generally a very high level of trust among the public in engineers. The engineering profession should continue to build on this in the area of engineering biology, by following ethical principles described by the Royal Academy of Engineering and the Engineering Council which include being "aware of the issues that engineering, and technology raise for society, and listen to the aspirations and concerns of others."[11]

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[10] *Genetic technologies public dialogue*, Royal Society, 2018
[11] *Statement of Ethical Principles*, Engineering Council and Royal Academy of Engineering, 2017