Engineer Progress: Unlocking Innovation

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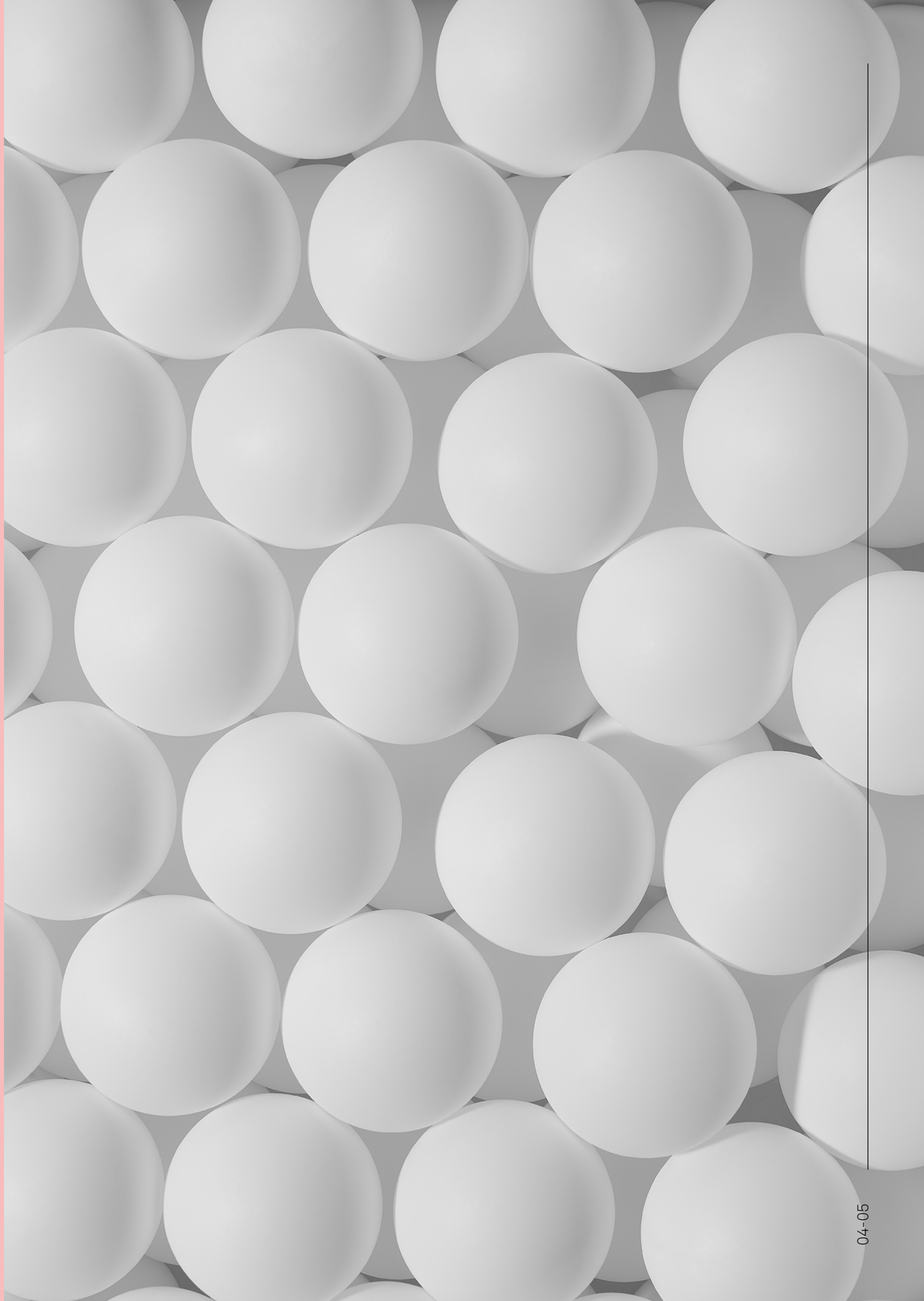
Chapter 01: Introduction



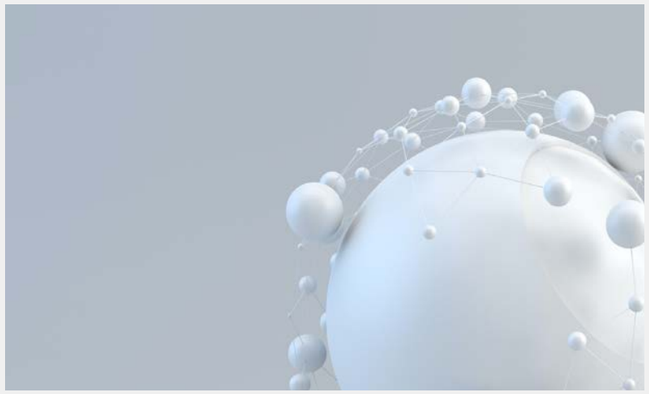
How do we unlock innovation?

Designing the key

To unlock any door, you need the perfect key. Every inch must be perfectly carved to the unique proportions of the lock it will open – a process requiring care, thought and design.

When we talk about unlocking innovation for the UK, each of these factors must similarly be considered. There is an opportunity to open a door to greater disruption, growth and digital transformation across UK manufacturing, science and technology. But to do so successfully – to engineer progress – will require us to design the key.

The pandemic was a window that showed us what lies behind the door. It revealed our capacity to come together and solve problems under a unifying purpose and, in the midst of its challenges, any number of opportunities for future innovation were revealed.



But if we are not careful, our window of opportunity for great change will slam shut. If we fail to re-think and re-shape our approach to innovation, harnessing what works and understanding what doesn't, then our moment of reset will remain just that – a moment.

Designing the key to unlock innovation was the challenge posed to a group of senior manufacturing and technology leaders at the first in a series of Tharsus Engineer Progress roundtable discussions. A summary of which is shared here and has inspired the themes and contributions presented in this report.

Exploring the challenges

It is important to recognise that digital transformation is not purely reliant on new and emerging technologies, but leverages existing technologies; re-purposing them and accelerating their use. This was particularly pertinent in the pandemic, when video conferencing tools, for example, moved from the margins to the mainstream.

The challenge to address is how we enable this overnight innovation to become embedded for the long-term.

The challenge saw the organisations accelerate the manufacture of two agreed designs, based on existing materials – demonstrating the art of the possible, and the power of sharing expertise and socialising IP.

By working to a common purpose, the guard rails came down, allowing industry to be more progressive. The Government's decision to underwrite these risks meanwhile, demonstrated the role the public sector has to play in our innovation story.

Having a clear problem statement has often been helpful for driving innovation. COVID-19 no doubt was this and many existing technologies plugged the gap. But as we emerge into a 'new normal', we have to be pro-active rather than reactive.

One initiative particularly stands out from the pandemic, where a clear problem accelerated innovation and indeed, collaboration. The VentilatorChallengeUK, a consortium of cross-sector UK industrial, technology and engineering businesses, produced more than 14,000 ventilators in 12 weeks to boost NHS capacity.

The UK has historically struggled to turn its start-up firepower into scale-up success. This has not been the case in the pandemic. And so, how do we drive similar levels of adoption in so-called 'normal circumstances'?

What we learned through this experience and the pandemic as a whole, is that innovation is a team sport and you learn from your last match. And to succeed requires making the most of opportunities and taking control, not letting the disruption happen to you.

Embedding innovation

Innovation does not happen by mistake. You need innovators, who can act as a catalyst and offer strategic direction, to turn ideas to reality. We need to leverage the power of the entrepreneurial spirit; those with ambition, drive and the willingness to take risks and collaborate. With this mindset, we can align incentives and create a governance structure where everybody wins.

A challenge for younger companies in particular is balancing their innovative ideas with the amount of funding available. How do you know how to choose the right ones?

The answer lies with their two most important stakeholders: colleagues and customers.

It is crucial for organisations to leverage the ideas of their employees – who are ready and willing to try new things and to innovate, so long as they are allowed to do so.

Digital skills are an essential part of the formula for innovation, and the next generation of the workforce has these skills in spades.

At the same time, ask your customers what they want to see you create? What solutions can you offer that will make a positive impact on their lives? Utilise their ideas and feedback, make them a part of your innovation story.

Where innovation often falls down is around user value. Investors need clarity on the commercial opportunity. If an organisation can show the benefit of their solutions to a wider customer base, then this will in turn attract more investment. Funders will invest in companies with a clarity of purpose and direction, which demonstrate a potential and capacity to scale. Similarly, aligning with Government targets – such as its 10 Tech Priorities – can lead to greater public-private collaboration. Find what you do best, where you can make the largest impact and look to scale that.

The path to progress

Historically, there has been a challenge to translate the UK's world-leading research and development onto the production shop floor. The power of partnerships can help to do this – again, as shown by collaborative efforts like VentilatorChallengeUK.

We need to foster an ecosystem of 'co-opetition', where it is aligned values, ideas and shared best practice that drives businesses to innovate. Share what we do well, as well as where we are failing, so that others can learn from mistakes.

This in itself will require a mindset shift that encourages data sharing. Worries about confidentiality – while important from a data protection perspective – are a barrier to innovation and collaboration. We have to build the governance and legislation that allows for responsible data sharing and use this to power a structural shift in culture and trust.

Levelling up will also be crucial. To innovate anywhere, we have to capitalise on ideas everywhere. We need everyone to play their part and cannot afford to miss out on a large proportion of the country's knowledge and skills, simply because they do not have the funding or the resources to maximise their impact.

COVID-19 showed that we can work together in the face of a shared problem, but there is an even greater challenge that will need the same urgency to collaborate: climate change.

The need to become more sustainable is not just an environmental challenge, but a business one. The younger generation of consumers and workers are increasingly choosing to work for organisations with a strong social conscience. As we have already explored, leveraging both of these stakeholder groups will be crucial for embedding innovation and attracting the funding for game-changing ideas. In turn, these game-changing ideas are necessary in order to find the solutions to the environmental challenge.

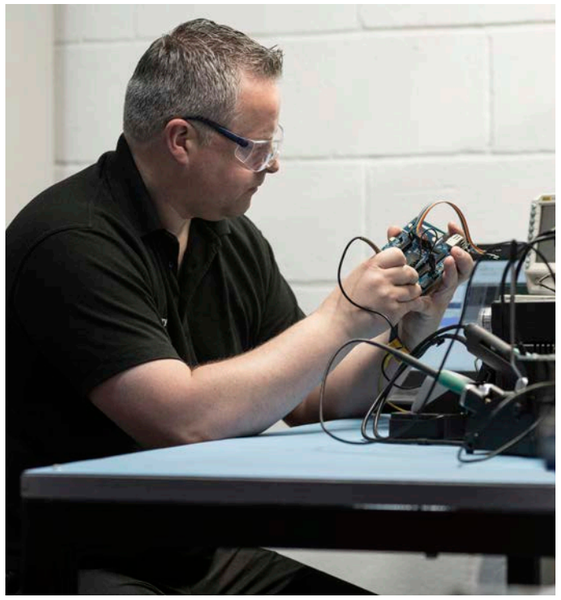
What comes next?

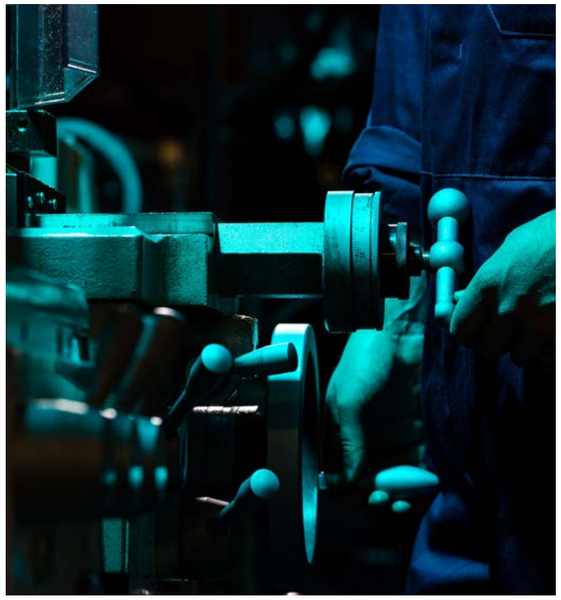
The overarching theme that came from this discussion was that of collaboration. Without it, the innovation door that we want to unlock will remain closed.

And so, we have identified three central themes to explore throughout this report, each of which will demonstrate the power of collaboration in building up the UK's innovation ecosystem:

- **Spinning out innovation:** How can we work together to leverage the UK's world leading research and development capabilities, to spin out more successes and fund ideas – taking them from concept to the production floor?
- **The power of IP:** What we learned in the pandemic is that Intellectual Property, when shared, can drive faster progress. How do we continue to build a thriving innovation ecosystem, particularly as the growth of data allows for larger scale collaboration?
- **Scaling up to success:** The UK's start-up ecosystem has long been one of Europe and the world's most exciting, but its scale-up success has not matched this. How do we leverage the potential of our start-up landscape and overcome the barriers to scaling up?

In the following pages, you will read key insights from experts on each of these themes. Utilising their insights and experience, alongside what we have learned throughout the pandemic, we can create that key to engineer progress and unlock innovation.





Foreword:

Delivering innovation-led growth

Pippa Sharma
Deputy Director, Technology Strategy and Security, Business Growth Directorate, Department for Business, Energy and Industrial Strategy

Innovation is central to tackling some of the biggest challenges the world is facing today, whether that is helping to mitigate climate change or supporting an ageing population. The development of a vaccine here in the UK during the pandemic provides an excellent example of government leadership in marshalling innovators within industry and academia behind a clear and urgent mission, resulting in significant real-world impact.

The UK is renowned for its science and innovation strengths, ranking fourth in the Global Innovation Index. But there is always more to do. As the Chancellor outlined in 'Building Back Better: Our Plan for Growth', infrastructure, skills and innovation are identified as the three pillars upon which we will rebuild our economy post-Covid.

To this end, the Government released its Innovation Strategy in July 2021, setting out the long-term plan for delivering innovation-led growth. Its primary objective is to boost private sector investment across the whole of the UK, creating the right conditions for all businesses to innovate and giving them the confidence to do so.

The strategy sets out our vision for the UK to be a global hub for innovation and prioritises seven 'Technology Families' based on the UK's R&D and industrial strengths, their transformative potential, and security and societal need. These families are:

- Advanced Materials and Manufacturing
- AI, Digital and Advanced Computing
- Bioinformatics and Genomics
- Engineering Biology
- Electronics, Photonics and Quantum
- Energy and Environment Technologies
- Robotics and Smart Machines

Whilst we recognise that the technologies highlighted within these seven families are at different stages of their maturity, many are growing rapidly and all have the potential to be transformative, both in terms of disrupting global supply chains but also changing the way in which our societies operate.

A good example of this is Robotics and Autonomous Systems, the total UK market for which is forecast to grow significantly by 2030. Smart machines with the capabilities to sense, think and act are enabling new solutions beyond traditional manufacturing sector uses. We know the potential of autonomous cars and drones, and the importance of a strong ecosystem that encourages growth, addresses barriers to innovation and helps empower industry to overcome them. This may be in the form of sharing the burden of risk in the early stages of development or providing accessible funding options to support businesses in the process of scaling up.

The Innovation Strategy commits us to increasing annual public investment in R&D to a record £22 billion and to launching new Prosperity Partnerships to establish business-led research projects for new technologies.

To harness the global talent into our innovative sectors, the Government plans to introduce new High Potential Individual and Scale-up visa routes, revitalising the 'Innovator' route to attract and retain high-skilled, globally mobile talent. It also commits to supporting, through Help to Grow: Management, 30,000 senior managers of small and medium-sized businesses to boost their performance, resilience and long-term growth.

But the publication of the Innovation Strategy is just a starting point. It was developed in consultation with a wide range of stakeholders from industry, academia and thought leaders. Engagement with each of these cohorts will continue, to ensure that we stimulate the economy through innovation and allow our thriving technology community to reach its potential and to lead the world in developing solutions to the most pressing problems.

This report series from Tharsus is a valuable contribution to the ongoing efforts to foster innovation, particularly in the technology sector. It was a privilege to be able to take part in a fascinating and engaging roundtable discussion and to hear the views of some of the most exciting innovators in the country.

Chapter 02: Insights from the Innovators

From research to development:

Spinning out innovation

Steve Foxley
CEO, AMRC

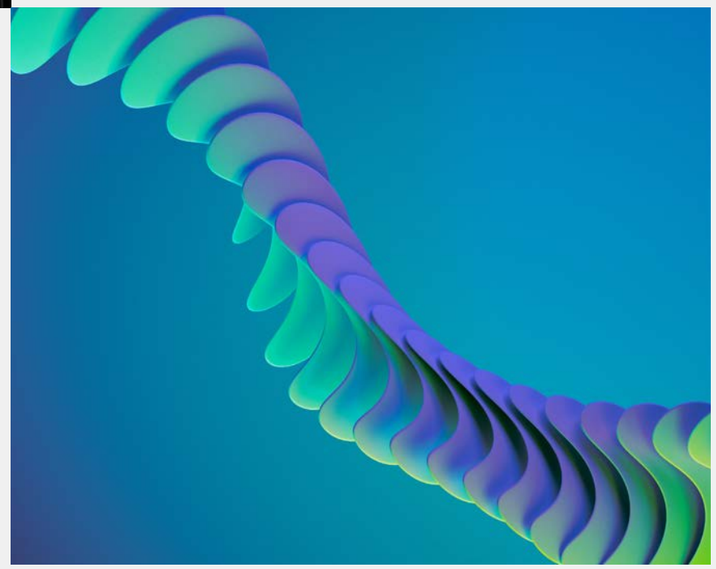
The University of Sheffield Advanced Manufacturing Research Centre (AMRC) is a network of world-leading research and innovation centres working with advanced manufacturing companies around the globe. It is part of the High Value Manufacturing Catapult (HVMC), an alliance of seven technology and innovation centres working with companies of all sizes to bridge the gap in – and accelerate the activity between – technology concept and commercialisation.

Here, AMRC CEO Steve Foxley explains why we should be optimistic about the UK's R&D capabilities, lessons from across the pond, and how this country can be a leader in the green transition.

There is a tendency in this country to criticise our academia for failing to translate much of our world-leading fundamental research into commercial innovations. To some extent, this is true. According to the QS world university rankings 2022, 18 of the top 100 universities globally are based in the UK. In contrast, just four of the 116 capital-backed European unicorns are UK university spin-outs.

But we should put these figures into context. It has only been in the past decade or so that the Catapults have been launched. Compare this to Germany, which has had an equivalent for nearly 70 years, we are at the very beginning of our journey.

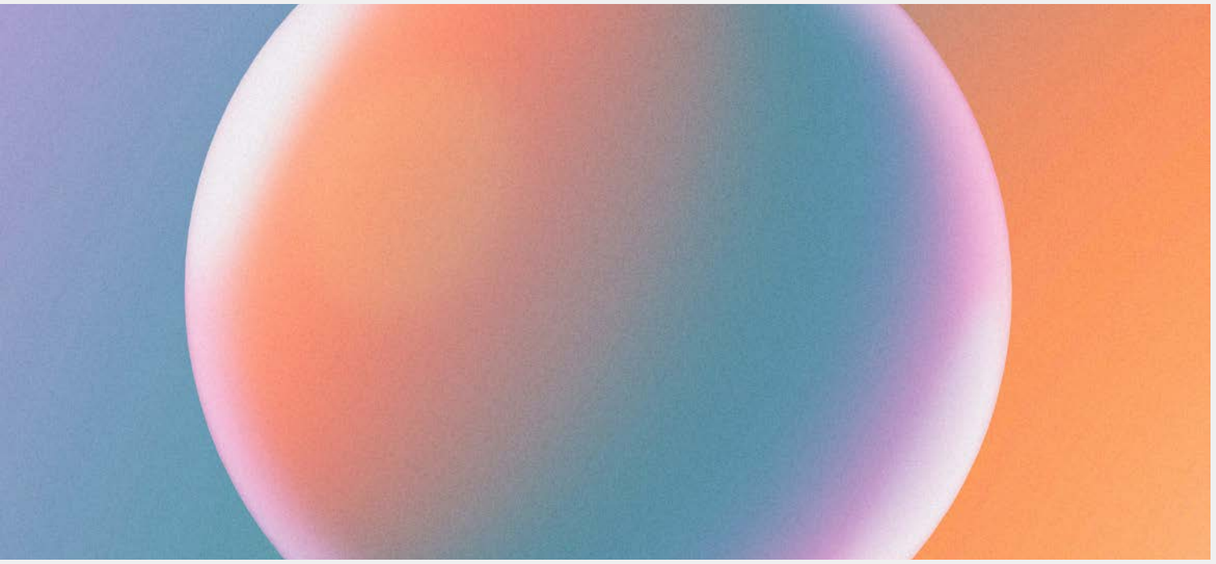
And there have already been some incredible success stories. The top 20 inventions to come out of the HVMC have been valued at more than £16 billion, so this is not a case of throwing the baby out with the bath water. We have a framework for innovation. What we are lacking is the ability to scale that on a consistent basis.



One of our hurdles – and this is something we have learnt from our peers at MIT – is around our categorisation of businesses, which are too broad. In the UK, we talk about small and medium enterprises (SMEs) as a general term. In the US, they have another category: Innovation Driven Enterprises (IDEs), organisations that have created a specific innovation, which they have an ambition to commercialise – whether that is in terms of a new technology, disruptive business model or new market approach. The strategy of academic researchers at the likes of MIT therefore, is to look at how they develop and scale these IDEs, while in the UK we are not distinguishing them from the rest of the SME ecosystem.

Many of the businesses at the AMRC already fit perfectly into that IDE definition. We have to continue identifying where these businesses are, nurturing them and encouraging them to spin out.

Another lesson we took from MIT was about the importance of engaging an entire ecosystem to drive growth. You have to bring entrepreneurs, industry, academia, business support groups and local government all around the same table, identify everyone's role and spot where there are gaps.



Most notably, we find there to be a scarcity of venture capitalists in most regional ecosystems. In the Golden Triangle of London, Oxford and Cambridge, we see the highest potential for spin out success, but it is not these areas that many manufacturers in particular are based. More often than not, they are in the North, denying them easy access to many of the country's VCs.

There are a number of possible routes to addressing this. Firstly, ensuring our IDEs across the country have the capabilities to access and engage with VCs in the Golden Triangle, particularly around the language they use, so that they can make a pitch that connects.

On the flip side, we must ensure our VCs have the maturity to understand our most innovative technology businesses and the role they can play in society. The US and other European ecosystems are more successful at scaling partly because their investors know the right questions to ask.

We should also work harder to align the ambitions of the public and private sector. Now it has been made clear that the Government are committed to investing in northern communities and businesses through the levelling up agenda, R&D spending should be a part of this. This can be leveraged to foster a more equal and prosperous innovation ecosystem.

We would ask the Government to increase its R&D spending from 1.7% of GDP to 2.4%, with a disproportionate focus on the development side and an assurance that this funding is spread out to the right places. The Catapults therefore have a responsibility to work with public sector leaders and advise them where the industrial demand is, while also aligning with government priorities themselves to understand the type of innovations they want to invest in.

In the context of our two most urgent challenges as a society: the pandemic and climate change, there is incredible opportunity to collaborate. While the pandemic impacted many businesses, we saw their incredible resilience, particularly in manufacturers who pivoted to develop urgent materials such as PPE, ventilators and treatments.

This became an alignment with government priorities out of necessity, and we should be viewing climate change similarly. The drive to net zero is only going to increase, and we are already seeing many researchers double down on their R&D in the green space, so that they can be at the forefront of these technologies. With this, we are seeing the rise of new green innovation sectors, such as the hydrogen and zero carbon economies, and disruption to construction, transport and defence.

I am massively optimistic for the future of innovation in the UK. We have some of the world's best fundamental research and alongside it, a blueprint to translate that into real world, commercial impact. We have not prolifically scaled these innovations yet, but with increased focus on the levelling up agenda, the growing maturity of the Catapults and the green innovation we are seeing, there is an opportunity for the UK to be in the top five globally for manufacturing by the end of this decade.

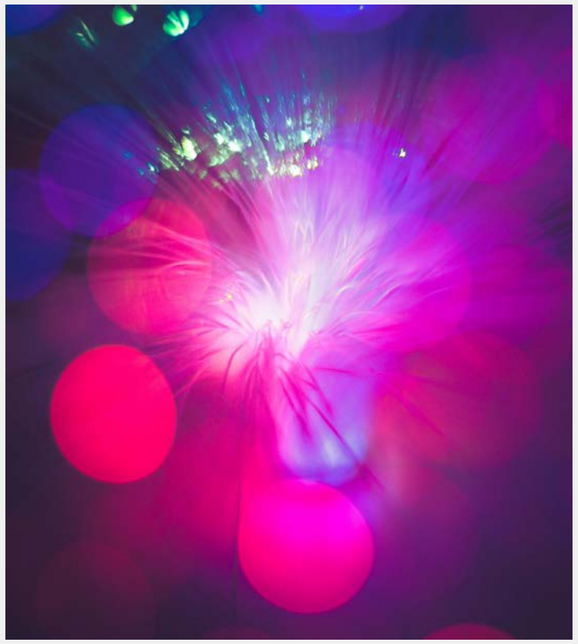
IP: the fuel tank of innovation

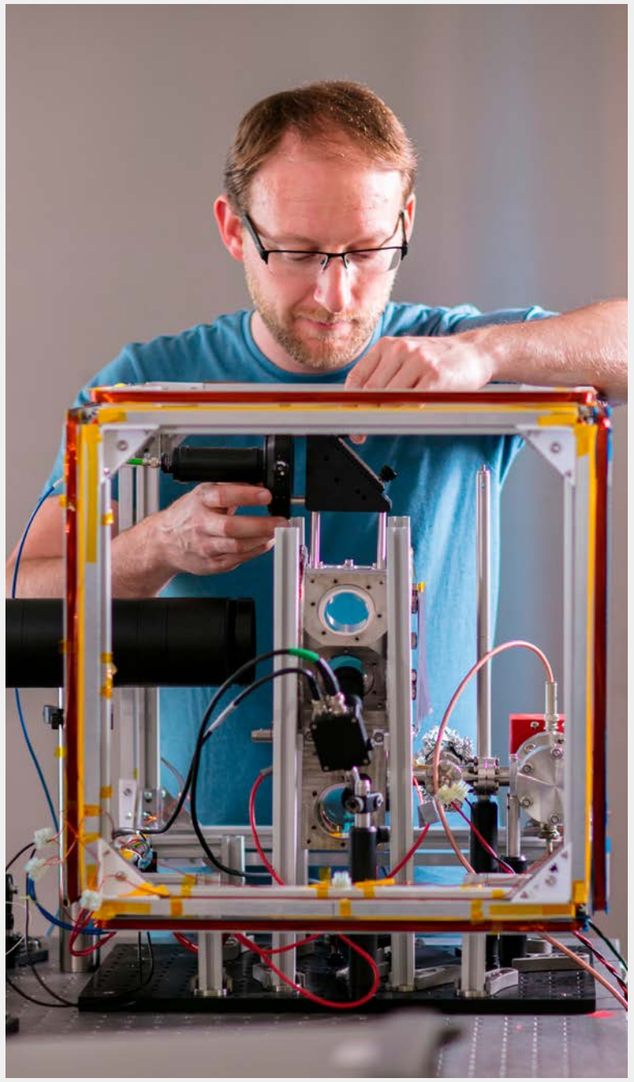
Dr Graeme Malcolm OBE
CEO and co-founder,
M Squared

With more than 450 different patents, photonics and quantum technology company M Squared has been regularly recognised as a front-runner in Metis Partners' annual IP100 league table, ranking the companies with the best Intellectual Property asset strength and track record in exploiting IP.

Here, M Squared's CEO and co-founder Dr Graeme Malcolm OBE shares his insights into growing an IP-rich company, why start-ups should embrace the challenge of developing their own IP, and the power of IP in unlocking innovation and growth.

We have had the analogue era and are currently living in the era of digital. What comes next is quantum. M Squared is leading this next generation technology, which will have profound implications on some of the world's greatest challenges.





In response to climate change, we have developed cameras that can measure the Earth's levels of pollution and climate emergency gases, which can only be seen from space. Meanwhile, quantum computers will allow us to compute the ever-increasing amount of data stored on our planet (set to reach more than 200 zettabytes, or 200 trillion gigabytes, by 2025). A digital computer would take millions of years to process this.

As a trailblazer of quantum, we are driving the front end of hardware-based technologies. Central to that innovation is our record in IP. This gives us an intangible fuel store that can be used to develop both important technologies and ways to apply them in the real world.

What I see, however, across the UK's innovation landscape in many early-stage start-ups particularly, is a fear of developing their own IP. Why? Because it can take time for these intangible assets to become profitable.

A failure for companies to develop their own IP assets, is one of several barriers to growth that mean this country's scale-up ecosystem does not match its start-ups. You cannot successfully raise investment unless you have freedom to operate or commercial security with potentially valuable, scalable IP.

This reticence to develop unique IP is something that start-ups must overcome in order to drive growth. There is a power in building a new company on a clean sheet of paper: it gives you unlimited potential to create something. And not just something, but something important. Something relevant that address a problem. That is what drives commercialisation, investment and the patience of consumers to wait for your technologies to come to market.

As a start-up, if you are looking for investment, think of your IP assets as an extra fuel tank. They may not be needed at the start of your journey, but they will carry you forward. Intangibles make up 84% of all enterprise value on the S&P 500 and the best way for them to be recognised is to protect them.

At M Squared, we had a clear idea of the technologies we wanted to develop that were beyond the state of the art. At each stage of trials, we demonstrated and proved a technology, and then moved onto the next stage and did it again.

Those step-by-step journeys are how you build up a portfolio of IP assets that you can bank as you go. They may not become valuable for five to 10 years, but they are the pinch points that give you a commercial monopoly on your technology.

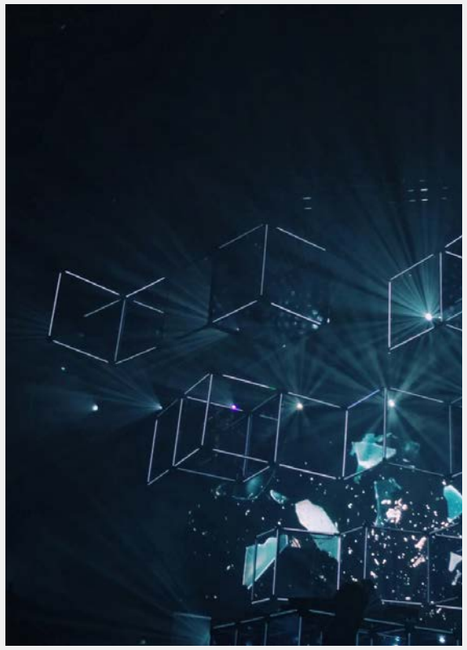
But not only do our start-ups have to get comfortable with developing their own IP, our businesses across the board have to become comfortable with sharing it. This is something that newcomers to consortia initially find difficult, fearing that their IP will be diluted. But we have seen the value of collaboration during the pandemic particularly; from the development of the vaccines or the VentilatorChallengeUK consortium.

Necessity is the mother of invention. And the urgency to innovate is why there has been such enthusiasm to collaborate during the pandemic. Now, we need to take those lessons forward to define the next chapter of innovation for the UK.

If we look to our friends across the pond, the big IT players are often collaborators as much as they are competitors. That duality is something we need to get comfortable with. Yes, you have to protect your IP, but this process will not always have the biggest impact. Sometimes it is more important to co-operate and licence it – to look for those win-win scenarios.

Silicon Valley took its time to get used to this, but now collaboration is built into its innovation DNA. The UK has a geographical advantage as a relatively small country, which makes it easy to foster collaboration throughout it. With some of the best research and development capabilities in the world at our universities – with talent hubs in the Golden Triangle of London, Oxford and Cambridge, as well as Glasgow, Manchester, Bristol and more – there is no reason we cannot commercialise our success on a similar level to MIT or Stanford in the US.

We have the talent, we have the capabilities and we have the funding. This is half the battle. The next step is fostering a belief in these hubs and within our start-up ecosystem that they can turn their ideas into IP and power a new era of innovation.



How the UK can scale up success

Priya Guha MBE
Venture Partner,
Merian Ventures

Priya Guha MBE is a venture partner with Merian Ventures, a performance and data-driven firm that focuses on companies founded, co-founded or majority owned by women innovators. Priya is an experienced advisor to US and UK technology start-ups, a council member for InnovateUK, a non-executive director at Digital Catapult and former UK Consul General to San Francisco.

Here, Priya takes a look at the traditional challenges UK firms have faced in turning early-stage potential into scale-up success and the cultural changes that can power growth.

Historically there have been a number of well-known challenges for UK start-ups looking to scale. Market access and talent are two large barriers to overcome, which can be in part addressed by regulatory changes – trade agreements that provide access to global markets, and an open policy and positive culture towards immigration that makes it easier for the best talent to come to the UK.

The third barrier we have faced is access to capital. This is one area that has been addressed over the past few years, with more funding becoming available from UK-based VCs, when traditionally the greatest sums have been found outside our own ecosystem. But there is still more work to be done, particularly if we are to successfully scale our world-leading academic research and development.

Commercialising our R&D is an ongoing challenge. We are rightly renowned in the UK for our higher education institutions, which have been at the forefront of innovations from quantum, to AI, to vaccine development. But in spite of this, our system tends to predominantly recognise this innovation through an academic lens. It means we are not seeing a volume of start-ups come through, who can take ground-breaking ideas to scale.

To attract more funding into this ecosystem, we have to foster a culture that allows researchers to grow businesses, and businesspeople to gain experience of academia. This will enable a more seamless transition between the two.

This cultural shift has already happened in the US, where it is seen as both normal and encouraged for academics to commercialise their research and take on other business interests. This is the case throughout entire senior faculties, who may also be angel investors themselves and will hold advisory and board positions on their students' spin-outs.

To address this, we need to shift the rewards structure for academics, so that they are encouraged to commercialise their research, while also recognising that universities are not separate from business and society. There are potentially significant advantages to the two being linked for the UK economy.

When you have a successful scale-up landscape, this has benefits far beyond those individual organisations. On an economic level, scaling allows entrepreneurs to exit, which in turns leads them to do two things: start another company – which can have its own positive impact and be scaled itself, leveraging the experience of the founder – and re-invest their funds into a wider portfolio of companies. It is a virtuous cycle of talent and investment.

Beyond an economic impact, the most successful business also have a societal impact. There is no market to scale if your product/ solution has no user value. And when we talk about user value, there is no greater value than an innovation that can help to tackle a major societal issue. As a result, one of the key criterion most investors will look at, is the potential positive impact of any business. Gone are the days when a single, financial bottom line was all that mattered. Today, profit and purpose are inextricably linked.

We have seen this clearly throughout the pandemic, where there has been an unprecedented acceptance of technology in our daily lives. It has accelerated an already existing trend of tech for good, which has allowed investors to identify new sectors for growth – most notably in healthcare.

But our Achilles heel when it comes to impact innovation remains a disengagement between what many entrepreneurs believe will make a difference and what actually will. This comes down to the age-old challenge of diversity. A lack of representation means that innovations are often no developed with the broadest customer base in mind.

Women's health is a prime example that has been historically underserved by research and commercialisation. It is only in the past few years that it has been realised that addressing 51% of the global population makes eminent economic sense. Ethnic minority communities, as well as under-represented regions of the country, have too often been similarly disconnected from the entrepreneurial ecosystem.

In the context of scaling, businesses are missing out on opportunities, as they are not developing the ideas with the greatest potential or considering every perspective. Investors will not just fund an idea. They have to have a sense about how that will translate into practice. Many brilliant ideas have come to nothing, because they did not have a commercialisation strategy that considered the benefits their innovation should have for the whole of society.

While there has been progress, we have to work considerably harder to open up this ecosystem to everybody. Only then will early-stage innovation turn into scaling potential.

Chapter 03: Conclusion

Conclusion:

Innovation will be driven by collaboration and purpose

Brian Palmer
CEO, Tharsus

Innovation, to me, is not just having ideas, but following through on them. The most successful entrepreneurial businesses are those who see an opportunity and then really go and deliver on that opportunity. The UK is world class at coming up with early-stage ideas – as we have looked at in this report – but now the challenge how we commercialise our world-leading IP, spin out innovation and building the strategies we need to scale effectively.

Finding solutions to problems through technology is what gets us out of bed. It is not about trying to make things a few percentage points more efficient. It is not about costs. It about innovation.

And this is a great time to be an innovator. I think there is a real need for businesses to respond to the disruption that we are seeing in the world and make progress. A lot of companies have woken up to the fact that the world is changing at the fastest pace it ever has in history, and at the slowest pace it ever will again – to paraphrase Michael Dell – and I agree.

We have really seen an acceleration of progress over the last two years, and that is good for innovators. Many industries have seen five years of digital transformation happen in five months, and companies have evolved rapidly and adapted to the new conditions to not only cope, but in many cases to absolutely thrive even in the most challenging sectors. And the success of these business transformations has been achieved through unprecedented levels of focus and collaboration. This is something we have seen in the private sector, as well as in public-private initiatives.

The pandemic has shone a light on the UK's ability to be world leading in delivering solutions to market. The VentilatorChallengeUK and the vaccine rollout have shown the impact of breaking down corporate silos, the capability of the UK as a nation, and how critical engineering is to the world's ability to respond to change.

Where we are seeing innovation really come together is through big data. That enables so many exciting technologies, such as AI, to be brought together, to create new ways of doing things, as well as far greater collaboration and optimisation of networks.

Now, we must harness these solutions – the type that can overcome big, multifaceted, complex challenges – and ensure that the momentum and excitement that has been created around these can be nurtured, developed, and used as a stepping-stone to a more collaborative future.

And it has shown, from my perspective, the power of having a clear purpose. Not just at an organisational level, but also at a project level. What is the purpose of each project you undertake? Of each technology you develop? Of each product you sell? Without knowing the answers to these questions, any opportunities to scale, commercialise and make an impact will be lost.

It is this need to prove a purpose that has enabled effective collaboration, both within and also across organisations, many of whom would never have considered working together previously.

Looking forward, I think you can view this as a time of uncertainty or a time of opportunity. Personally, I see it as a time of huge opportunity. And that is not just from a business perspective. There is an opportunity as leaders to have a significant and positive impact on the world.

There are fundamental challenges that we need to face. And to do this requires collaboration beyond businesses in the UK. The world needs to come together to solve these. Most notably, climate change.

Achieving Net Zero will require inspirational solutions that can only really be achieved if we have a clarity of purpose across industries and borders. Even if the goals are long-term, you have to have a North Star to work towards. With that purpose, as well as the innovation and collaboration mindset we have seen during the pandemic, I am confident companies can come together to co-create solutions to climate change that make both business and environmental sense.

Having looked more broadly at how we unlock innovation in this report, I am excited that we will be taking a deeper dive into the key challenge of Net Zero in the second report of this series. Once again, we brought together some of the UK's most innovative sustainable leaders to focus on how we unlock innovation and move towards a greener future. These are insights that we look forward to sharing, as we continue our journey to engineer progress for the UK.