

IfM | REVIEW



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INSTITUTE FOR MANUFACTURING (IfM)

The IfM is part of the University of Cambridge's Department of Engineering. We are a dynamic body of researchers, educators, practitioners, professionals and technical experts contributing to world-leading research and education. With a focus on manufacturing industries, the IfM creates, develops and deploys new insights into technology, management and policy.

IfM ENGAGE

IfM Engage is an embedded knowledge transfer company within the Institute for Manufacturing (IfM). We combine research excellence and industry expertise to conduct bespoke strategic consultancy, talent and leadership development and company membership programmes. Our profits are gifted to the University of Cambridge to fund future research.

COVER IMAGE

Credit: Amy Reinecke / Institute for Manufacturing

SUSTAINABILITY

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WELCOME TO ISSUE 16

Welcome to the latest issue of the *IfM Review*. It is always a pleasure to showcase the breadth of work taking place across the Institute for Manufacturing, and this issue is no exception.

From sustainability challenges to cutting-edge manufacturing technologies, we explore how research, innovation and industry collaboration are shaping a better future.

One focus in this issue is the journey towards **net zero in manufacturing supply chains**. With growing pressure on industries to reduce emissions beyond their direct operations, our Centre for International Manufacturing is leading the way in addressing Scope 3 emissions – one of the toughest hurdles in achieving sustainability goals.

Sustainability is also at the heart of our feature on **Plastic to Ghar (P2G)**, an inspiring initiative led by Dr Curie Park that is transforming plastic waste in Nepal into much-needed housing materials. We also explore how **Raynor Foods** is gamifying sustainability efforts, using digital tools to engage employees and drive environmental impact.

Technology and innovation remain central to our work. The Centre for Industrial Photonics has developed a

laser-assisted cold spray technique, a breakthrough in additive manufacturing with significant potential for aerospace applications. Meanwhile, **semiconductor manufacturing** is under increasing global scrutiny, and we take a closer look at how the decision to create a new independent UK Semiconductor Institute follows a key recommendation from an IfM Engage study.

This issue also celebrates individual achievements. **Jonathan Fisher**, an ISMM alumnus, has been shortlisted for the **James Dyson Award** for his innovative wearable device designed to help Parkinson's patients regain mobility – an excellent example of engineering making a tangible difference in people's lives.

Whether we are addressing sustainability, advancing industrial technologies or supporting the next generation of manufacturing leaders, the IfM community continues to push the boundaries of what is possible.

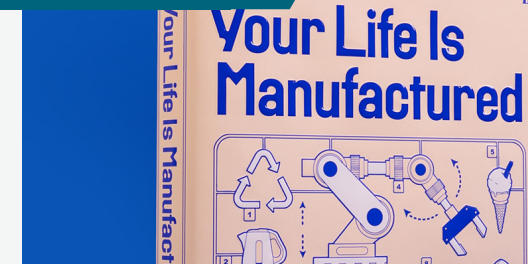
We hope you find this issue insightful and inspiring.

T. Minshall

Tim Minshall
Dr John C Taylor
Professor of innovation
and Head of the Institute
for Manufacturing



NEWS



YOUR LIFE IS MANUFACTURED

Your Life Is Manufactured, a new book by Tim Minshall, Head of the IfM, has been published. In a fascinating exploration of the manufacturing world, Tim highlights the complex and often unseen journeys of the products that shape our daily lives.

In an era where manufactured goods are everywhere, few stop to consider the intricate processes that bring these items into existence. As Head of the IfM, Tim offers a unique perspective, guiding readers through the vast global network of manufacturing – from mega-factories and engineering laboratories to seaports, distribution hubs, supermarkets and homes – shedding light on the hidden systems that shape the modern world.

In *Your Life is Manufactured: How We Make Things, Why It Matters and How We Can Do It Better*, Tim reveals the astonishing pathways taken by everyday objects – whether it's the thousands of litres of water required to produce a single pair of jeans or the smartphone components that travel across the world multiple times before reaching our hands.

Through in-depth research and engaging storytelling, the book explores how manufacturing has shaped the modern world and how it can pave the way for a more sustainable and equitable future. This sentiment is echoed in Tim's working life, where he leads the IfM on its mission to manufacture a better world.

The book, published by Faber and Faber, offers valuable insights into the profound impact of manufacturing on society and the environment, empowering readers to make informed choices about the products they use and the world they wish to create.

Featured in the Financial Times "What to Read in 2025", the book is now available for purchase in hardback, ebook and audio online and at major retailers.



UK-INDIA CRITICAL MINERALS PARTNERSHIP GAINS MOMENTUM WITH GROUNDBREAKING COLLABORATION

The IfM and CPI, an independent technology innovation centre, are collaborating with partners in a unique UK-India initiative to enhance innovation and investment across the entire life cycle of critical minerals. This includes establishing an observatory to monitor supply chains and material flows of critical minerals from mines to electric vehicles.

Together with the Indian Institute of Technology (IIT), Bombay, the IfM will establish an observatory to facilitate collaboration among leading academics, innovators and industry by sharing supply chain data. The aim of the observatory will be to create an industrial data infrastructure for the UK and India. This will enable the identification of risks, opportunities for recycling and areas with shortages. It will offer recommendations to strengthen global supply chains and minimise disruptions in both the UK and India. The goal will also be to test new technologies, like personalised AI, to ensure stable supply chains and promote trade between the two countries. Lastly, it will improve critical minerals capabilities through increasing knowledge sharing around extraction and refining.

Professor Tim Minshall, Head of the IfM, says "Given the global challenges related to critical minerals affecting all nations, this programme is extremely important and timely. This observatory will play a key role in ensuring that technological innovation can be achieved in a way that is resilient, secure and sustainable. We are delighted that this programme is being taken forward as an international partnership, reflecting the fact that addressing critical mineral challenges requires an international approach."

Dr Mukesh Kumar, Head of the IfM's Industrial Resilience Group, says "The University of Cambridge's IfM Industrial Resilience Group is leading part of this project, establishing one of the world's first critical mineral supply chain observatory labs. By building the largest data infrastructure for critical minerals, we aim to identify supply chain vulnerabilities, enhance capabilities and promote ESG and sustainability."

Watch this short video for introduction to the Global Supply Chain Observatory:





ISMM STUDENT AWARDED MASTER'S IN MOTORSPORT SCHOLARSHIP

Chris Tagnon is the first Cambridge University student to be awarded a Master's in Motorsport Scholarship from The Royal Academy of Engineering and seven-time Formula 1 world champion Sir Lewis Hamilton's charitable foundation, Mission 44.

Chris – currently studying an MPhil in ISMM at the IfM – will receive financial and careers support as part of the scholarship programme. The aim of the programme is to encourage more students from Black or mixed Black backgrounds to study for a Master's in motorsport engineering or associated discipline, and to address the under-representation of Black people in UK motorsport. Chris is one of eight UK graduates to be awarded the scholarship this year.

“Being awarded the scholarship is such a great feeling,” says Chris, “especially with the link to Lewis Hamilton. I've been passionate about motorsports since I was a kid, and he has been an idol of mine throughout my journey to this point. I'm so excited to be a part of this initiative and the doors it will open.”

Mission 44 was founded to build a fairer, more inclusive future for young people in underserved communities through grant-making, research and advocacy. The aim of the Master's in Motorsport Scholarship is to address the under-representation of Black and mixed Black ethnic engineers and accelerate the rate of progress of change.

The new awardees were welcomed to the programme at a special event on 11 November at the Formula 1® Exhibition at Excel London, where the scholars were able to have a Q&A session with engineers from Formula 1® and the Mercedes-AMG PETRONAS F1 team.

“Motorsports has some of the most innovative and cutting-edge manufacturing facilities, with the ability to produce custom, ultra-specialised and precision parts for some of the most well-engineered cars in the world. After ISMM, I would like to work at the intersection of motorsports and wider industry, bridging the gap and applying the specialised engineering know-how to impactful applications, like venture development in aerospace, energy or clean mobility,” says Chris. “But the ultimate dream is to be a team principal in Formula 1®. There are only 10 in the world!”



IFM SECURES GRANT FOR MAJOR PROJECT IN SAFEGUARDING FOOD SUPPLY CHAINS

The IfM's Centre for International Manufacturing has been awarded a major grant from UK Research and Innovation (UKRI) to build resilience in the UK's food system.

Led by Principal Investigator Jagjit Singh Srail, Director of Research in the Department of Engineering at the University of Cambridge, the “Resilience in Agrifood Systems: Supply Chain Configuration Analytics Lab” (RASCAL) project will study the balance between UK food production and imports, especially in light of disruptions caused by economic, political or climate factors. It will also form part of the University's Interdisciplinary Research Centre on Food System Resilience.

The project comes at a time when risks to the UK's food system, such as geopolitical instability and climate change, are rising and innovative ways to ensure the resilience of food supply chains are essential.

“The focus is on the balance between home (UK) production and imports, and how this may change based on cascading risks resulting from disruptions associated with economic, socio-political or climatic issues. We will create an interactive digital lab that enables exploration of multiple scenarios involving cascade risks, and potential mitigation interventions,” says Jag.

“The RASCAL project will bring together a highly collaborative, interdisciplinary team from biological sciences, engineering and management to co-develop intervention strategies. Our UK stakeholder partners from across the food supply chain will share data, enabling us to integrate previously disconnected information.”

Under the overall goal of ensuring the UK is better prepared for unexpected challenges, this project is part of a wider set of funding from UKRI to ensure the robustness of UK supply chains and secure essential resources and food supplies for the future.

Find out more about the project:



MBE FOR IFM GRADUATE AND BBC ROBOT WARS JUDGE

Does responsible and professional science and engineering communication need to be dull? Not at all, according to IfM alumna Dr Lucy Rogers, who was recently awarded an MBE in recognition of her services to engineering.

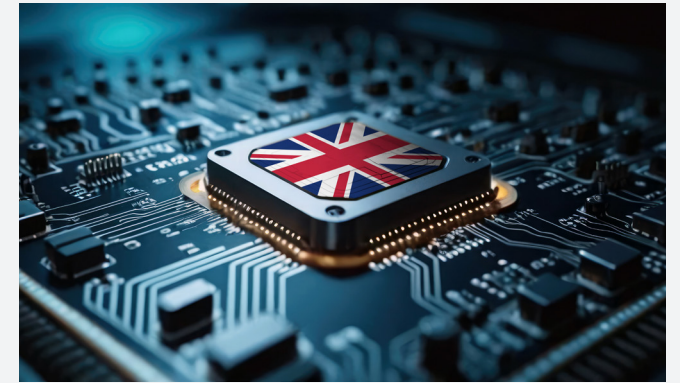
Throughout her career, Lucy has established herself as a respected inventor with a playful touch. Her inquisitive mind has led to numerous inventions, and she is also highly regarded as a science writer. Many people may recognise her as one of the judges on the BBC's Robot Wars from 2016 to 2017.

Lucy was a Master's student at the IfM on the Advanced Course in Design, Manufacture, and Management (now the MPhil in Industrial Systems, Manufacture, and Management) from 1995 to 1996. She remembers her Cambridge days with fondness.

“The variety of experiences, including in-company projects, coupled with the informative lectures from people within industry I had on the course, were a wonderful grounding in different aspects of manufacture. The presentations at the end of each mini-project also gave me invaluable experience, and the European tour opened my eyes to opportunities beyond the UK.”

Asked what it means to her to receive the honour of an MBE, Lucy says: “A recognition of the value of the breadth of my experiences is fantastic, as I believe we need not just people who have specialist knowledge but also people who can join the dots between specialities and see problems and solutions from a wider point of view.”

Lucy is a Fellow of the Royal Academy of Engineering and the Institution of Mechanical Engineers, and an Honorary Fellow of the Institution of Engineering Designers.



UK TO ESTABLISH INDEPENDENT SEMICONDUCTOR INSTITUTE FOLLOWING IFM ENGAGE STUDY

The decision to create a new independent UK Semiconductor Institute follows a key recommendation from an IfM Engage study. The institute will be vital to supporting the government's £1 billion Semiconductor Strategy, which aims to unite and advance the UK's semiconductor sector.

The rationale behind the UK Semiconductor Institute, recommended by IfM Engage in a Department for Science, Innovation and Technology-commissioned report and supported by the Semiconductor Advisory Panel, is to create long-term momentum for the industry.

The report was the result of a 10-month study, during which data and information was collected from over 185 organisations and 400 individuals from across the UK. Delivered by a consortium led by IfM Engage, the study identified key initiatives that could help develop a strong semiconductor industry in the UK, including establishing a UK National Semiconductor Institute to oversee strategic activities and coordinate relevant infrastructural investments.

Study lead Nicky Athanassopoulou, Head of Solution Development at IfM Engage, stated: “This is an extremely important and timely announcement with the potential to deliver far-reaching economic and societal impact.

“IfM Engage was uniquely positioned to bring together industry and academia to deliver this study, and we are delighted that our efforts will help contribute to the growth of the UK's domestic semiconductor industry, boosting and commercialising leading-edge UK innovation, and providing security of supply for critical national infrastructure.”

The new institute will spearhead efforts to grow the semiconductor sector as part of the government's £1 billion strategy. Operating independently from the government, it will serve as a central hub to attract investors and boost foreign investment in British semiconductor companies.

Read the full story on page 38.



FIRST MANIFESTO FOR GLOBAL INDUSTRIAL SAFETY LAUNCHED

The Global Initiative for Industrial Safety (GIFIS) has launched the world's first Manifesto for Global Industrial Safety, pioneering a safer world through technology adoption. Authored by members of the IfM, the manifesto marks a significant step towards addressing both emerging and long-standing safety risks affecting workers worldwide.

Every year, around 3 million deaths are linked to poor safety measures and hazardous work environments, resulting in a 3.9% loss of global GDP, according to the United Nations Industrial Development Organization (UNIDO). New technologies like IoT, AI and robotics can improve innovation and supply chain flexibility, presenting both risks and opportunities for workplace safety.

The manifesto outlines five guiding principles and vital contributions required from industry, government, academia, regulators and international organisations to promote the safe adoption of technology in new industrial processes. The manifesto champions the use of technology to tackle safety risks for workers worldwide, marking a significant development in global industrial safety.

Authored by members of the IfM, including those from Cambridge Industrial Innovation Policy, and developed in collaboration with GIFIS, a partnership with UNIDO, Lloyd's Register Foundation and the Global Manufacturing and Industrialisation Summit (GMIS), the manifesto is the first of its kind.

"Cutting-edge technologies are driving the creation of more innovative products, intelligent factories, and adaptable supply chains. These technologies offer fresh opportunities to confront global industrial safety challenges. Therefore, it is a perfect time for the manifesto to concentrate on global endeavours to tackle emerging safety issues and harness the power of technology to provide solutions," said Dr Carlos López-Gómez, Cambridge Industrial Innovation Policy, and manifesto co-author.

Download the manifesto:



WOMEN IN MANUFACTURING CONFERENCE 2024

The IfM hosted the second Women in Manufacturing: Changing Perceptions conference at the Manufacturing Technology Centre in Coventry last October. Co-organised with Innovate UK Business Connect and High-Value Manufacturing Catapult, the event brought together over 160 delegates to discuss gender diversity and inclusion in the manufacturing sector.

The Changing Perceptions conference is the flagship event for the Women in Manufacturing UK (WiM UK) initiative, established in 2022. Led by a dedicated network of academics, practitioners and industry professionals, WiM UK's mission is to offer networking opportunities, peer support, thought leadership, industry expertise and policy advocacy to create a more inclusive manufacturing landscape.

As a founding partner of WiM UK, the IfM brought together industry leaders, innovators and policymakers for the conference to explore the vital role of women in driving innovation within the manufacturing sector. Through dynamic discussions, interactive workshops and inspiring keynote sessions, the event focused on breaking down barriers, fostering diversity and highlighting the transformative potential of women in manufacturing.

The conference started with a keynote session from the IfM's Jennifer Castañeda Navarrete and Zoi Roupakia. They presented key messages from their new report, *The Women in UK Manufacturing 2024: Addressing Labour Shortages and Bridging the Gender Gap*, co-authored with Dr Viktória Döme and Guendalina Anzolin.

The report outlines the progress and challenges faced by women participating in UK manufacturing over the past year, and it addresses two of the most pressing challenges faced by the industry: labour shortages and the gender gap.

Download the report:



NEW EU HORIZON-FUNDED PROJECT: THE IMPACT LICENSING INITIATIVE

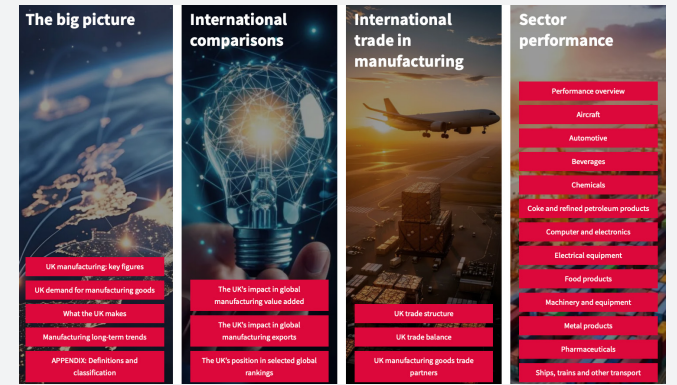
The Innovation and Intellectual Property Management (IIPM) Laboratory at the IfM is part of a consortium of five international partners taking part in a new EU Horizon-funded research project, the Impact Licensing Initiative.

The aim of the Impact Licensing Initiative is to optimise the use of technologies and data to address societal challenges in Europe and beyond. The project will run until July 2027, with a total EU contribution of €1,778,125 under the Digital, Industry, and Space funding programme.

Professor Frank Tietze, Head of the IIPM at the IfM says, "We are very excited kicking off this new EU Horizon-funded project, which sets out to research and promote a more societally compatible licensing framework for technologies. The Impact Licensing Initiative project is at least partly a continuation of our work from the IPACST project, our POINT study for the European Commission and what we did during the pandemic, such as on open patent pledges."

Coordinated by the Impact Licensing Initiative in Belgium, the project aim is to develop an integrated toolkit, including six instruments and two training modules, along with a network of intermediaries across the EU to scale-up impact licensing.

This strategic approach will help to optimise the use of intellectual property and data for societal benefit while also boosting innovation and research.



CAMBRIDGE INDUSTRIAL INNOVATION POLICY LAUNCHES UK MANUFACTURING DASHBOARD

Cambridge Industrial Innovation Policy has launched the UK Manufacturing Dashboard to help policymakers and industry leaders understand the state of UK manufacturing.

The tool provides a comprehensive overview of the sector, emphasising its role in the national economy and its performance on the global stage.

The dashboard is built around a range of carefully selected indicators, offering a holistic view of manufacturing. It tracks trends in areas such as productivity, employment, trade balance and sector-specific performance across industries, including automotive, pharmaceuticals, machinery and transport.

Updated annually, the dashboard benchmarks the UK's manufacturing performance on an international scale, offering stakeholders valuable insights into how the sector stacks up against global competitors. By leveraging the latest data, it provides a comprehensive view of the sector's performance.

"The dashboard is designed to give users a clear understanding of the UK manufacturing sector and its broader impact," said Dr Carlos López-Gómez, Cambridge Industrial Innovation Policy. "By providing accessible and actionable data, the dashboard can support decisions that drive innovation, resilience and competitiveness in manufacturing."

Explore the dashboard:





STRENGTHENING UK-JAPAN TIES THROUGH INDUSTRIAL INNOVATION POLICY

A significant step towards bolstering industrial innovation policy cooperation between the UK and Japan took place on 9 October 2024 at the British Embassy in Tokyo. The workshop, organised in collaboration with the British Embassy in Tokyo, Japan's Ministry of Economy, Trade and Industry (METI), the IfM, and the Babbage Policy Forum, brought together policymakers, industry leaders and innovators from both nations.

Dave Smith, the UK's National Technology Adviser, and Takahiro Ueyama, Executive Member of the Council for Science, Technology and Innovation, and adviser to the prime minister, led discussions between UK and Japanese delegations. The aim of the discussions was to foster dialogue on international policy approaches to industrial innovation, focusing on shared challenges and opportunities.

Attendees explored solutions to create impactful strategies, ensuring both countries remain competitive in today's rapidly evolving global landscape while rebuilding industrial capabilities.

"This gathering showcased an inspiring exchange of ideas on how science, technology, and industrial policy can come together to shape the future of global innovation. From exploring sectoral strategies and bridging the gaps between research and application, to leveraging alternative data for policy development, the discussions highlighted the valuable insights we can gain by learning from each other's experiences and approaches," said Professor Sir Mike Gregory, Chair of the Babbage Policy Forum, University of Cambridge.



INAUGURAL MENTAL HEALTH INNOVATION EVENT AT THE IFM

IfM Engage co-hosted its inaugural event for mental health innovation with The Foundation for Young People's Mental Health (YPMH), titled "Collaborate to innovate: Working together to improve mental health outcomes". Delegates from various sectors, including healthcare, education, the justice system and local authorities, gathered to explore how business management tools developed at the IfM can be used to prevent and treat mental illness.

The IfM's Peter Templeton, Dr Nicky Athanassopoulou, Dr Florian Urmetzer, Professor Tim Minshall and Professor Peter Jones from the Department for Psychiatry led and delivered the day's sessions, which covered the case for action to improve mental health outcomes, the multidisciplinary and interconnected nature of mental health "cause and effect", innovation management strategies and the IfM's Ecosystem Mapping and Roadmapping tools.

"Feedback from delegates regarding the approaches for improving mental health co-developed between the IfM, IfM Engage and YPMH was very positive," said Peter Templeton, Founder of YPMH. "The responses showed that the structured methods were perceived as being 'very to extremely useful', both within participants' organisations and across their ecosystems."

Find out more about the YPMH approach in this new booklet about depression:



CAMBRIDGE FESTIVAL AT THE INSTITUTE FOR MANUFACTURING 2025

On Saturday, 22 March, IfM opened its doors as part of the Cambridge Festival. Staff and students were thrilled to welcome members of the public, providing a glimpse into the manufacturing world through an engaging array of talks, activities, and demonstrations.

Among the varied learning experiences, guests were fascinated to discover how to create a battery from lemons, learn techniques for building a better paper airplane, understand our perception of sound, have a go with Versius®, the next-generation surgical robot by CMR Surgical, and immerse themselves in the Cambridge Space Programme through VR goggles.

"It was such a wonderful day. The paper airplane my son made has been a hit and is still bringing him joy. He's so excited to take it to his school's show-and-tell this week to share the secret of how to make it fly the best!" says Carly Meaden, who brought her family to the IfM for the event.

Professor Tim Minshall, Head of the IfM, shared insights through his talk "Your Life is Manufactured". Using the journey of toilet roll from tree to supermarket and production lines illustrated through cake, he showcased research from the IfM to unveil the complexities of making and moving products. Illuminating this hidden world, he left attendees pondering: Why do we make it that way, and can we do it better?

"Tim's talk was exceptional - he engaged a packed room of attendees ranging from primary school students to people in their 70s," says Kasy Chong, who attended with her 6 year-old aspiring engineer. "He took us on a fun journey of understanding how our everyday lives are manufactured. When Tim asked the audience about the "R" words, my son whispered to me, "Rethink" - What a powerful reminder that we should always rethink how we can make the world a better place."

A huge thank you to the more than 40 volunteers who dedicated their time and energy to run activities, greet our guests, and ensure that everyone left feeling inspired. Your dedication and enthusiasm ensured the day was a complete success!



UK INNOVATION REPORT 2025 LAUNCHED AT THE INSTITUTE FOR GOVERNMENT

On Thursday, 20 March, policymakers, industry leaders, and experts gathered at the Institute for Government for the official launch of the UK Innovation Report 2025. The event, held both in person and online, provided a platform for discussing the report's key findings and their alignment with the UK's evolving industrial strategy.

Published by Cambridge Industrial Innovation Policy, the report presents crucial evidence regarding the country's industrial strengths, challenges, and opportunities within a changing economic landscape. It offers an overview of the competitive position of major UK manufacturing sectors over the past decade, comparing their economic and innovation performance against those of other leading economies.

This year's report arrives at a particularly significant moment, as the UK government has placed industrial strategy at the core of its growth agenda, emphasising investment, technology adoption, and high-growth sectors. The past year has also underscored the growing need for evidence-based industrial and innovation policymaking. Recent public consultations on industrial strategy, scale-up financing, and technology adoption highlighted the renewed need to enhance the evidence base available to policymakers.

Attendees had the opportunity to hear from Lord David Sainsbury, Chancellor of the University of Cambridge and former Minister of Science and Innovation, as well as Dr Carlos López-Gómez, co-author of the report, who outlined its key findings and strategic implications.

A panel of leading industry and policy figures, including Oliver St John (Department for Science, Innovation and Technology), Grace Atkinson (ATLAS Composite Technologies), Kate Fairhurst (Make UK), and Andrew Parry (Department for Business and Trade), engaged in an insightful conversation on how this year's findings can help shape future innovation policies.

Download the report here:





E-WAVE: POWERING THE FUTURE OF ELECTRIC SHIPPING

IfM Engage, the knowledge transfer arm of IfM, is part of a consortium of 18 interdisciplinary partners from across Europe involved in the e-Wave project. The project aims to advance the boundaries of high-voltage technology for electric vessels, powering the future of electric shipping. Funded by the European Union's Horizon Europe Framework Programme for Research and Innovation, it will receive EUR 7.5 million over the next four years.

The maritime sector faces challenges in its transition to sustainable, all-electric vessels. Primary obstacles include the low energy density of current battery systems, safety concerns, and the need for durable, sustainable materials. Additionally, economic viability remains a significant barrier to widespread adoption.

To address these issues, the EU has funded a new research project: e-Wave. The project brings together 18 expert organisations from solution development, research, technology, and shipbuilding to advance high-voltage technology for electric vessels.

By developing high-energy-density batteries, scalable modular systems, and an integrated safety concept, e-WAVE aims to enhance sustainability, safety, and efficiency in maritime transport. The project will also explore circularity through bio-based materials and recycling, supporting the EU's goal of reducing the environmental footprint shipping.

Led by Nicky Athanassopoulou, Head of Solution Development, IfM Engage will enhance the project by creating a strategic technology roadmap to ensure EV maritime powertrain technologies align with market demands. They will conduct horizon scanning to identify emerging trends and potential disruptions, thereby developing a comprehensive view of the sector. The new technology developed will be evaluated regarding the overall system performance and ecological impact. With their extensive experience in innovation management, Nicky and her team aim to position e-Wave as a leader in sustainable maritime transport solutions, ensuring long-term relevance and impact.

Find out more about the project: <https://ewave-project.eu/>



BRINGING SPACE TO LIFE: IFM HOSTS LARGEST STEM OUTREACH FOR CHINESE STUDENTS

From August 5 to 9, 2024, Dr. Bang Ming Yong (Bang) organised the Cambridge Space Programme (CSP), an outreach STEM initiative for 70 students aged 12 to 15 from China at the IfM.

CSP is the largest outreach programme hosted at the IfM, combining STEM skills like 3D printing, electronic prototyping, web development, generative AI, and virtual reality (VR) with management principles. Students, divided into 13 groups, operate “start-up companies” to create products for alien customers on Planet AE7.

Bang, a member of the IfM's Centre for Technology Management (CTM) and Deputy Director of the i-Teams Programme, designed the programme to blend STEM learning with practical application for greater engagement. The initiative received support from IfM members, Bang Technologies, and Cambridge Dream.

The students were guided by the Space Director, portrayed by Emeritus Professor Malcolm Bolton, and encountered challenges aimed at enhancing critical thinking. They received incomplete or misleading information about the alien planet, which they could clarify by exploring the planet through VR or “interviewing” alien customers. Students also had opportunities to design and 3D print keys to unlock treasures chests.

On the final day, each group presented their product, a one-minute video, and a product website. The presentations showcased creative ideas, such as a luxury toilet for aliens and an alien hospital.

Overall, the CSP was a success, blending education and innovation in a true IfM fashion, allowing students to experience manufacturing's impact on improving worlds—both human and alien!

("OXBRIDGE{AI}") CHALLENGE

where innovation meets excellence

SUCCESS FOR IFM START-UPS AT OXBRIDGE AI CHALLENGE

Teams from IfM celebrated huge success at the 2024 Oxbridge AI Challenge, with 3 out of the top 10 teams coming from our institute.

innex.AI, led by Dr Carl-Magnus v. Behr and Dr Jan H. Blümel, were awarded Oxbridge AI Challenge Trailblazers & Winners of the Rutland Foundation Prize, while OmnAI, led by Tim Schoonbeek and Michael Vogeser, and Omnisent, led by Robin Daiber, were recognised as Game Changing finalists.

The Oxbridge AI Challenge is an annual early-stage pitch competition and incubator for AI start-ups from the Cambridge and Oxford ecosystems. Challengers vie for a share of a £60,000 prize across three rounds by pitching their start-ups to panels of expert judges.

In the first round, the 200+ competing start-ups were given 5 minutes to present their vision to a panel of 15 judges, either online or in-person at regional events. From there, 32 teams were selected to advance to the semi-finals, where they pitched once more to another panel of judges. Ultimately, 10 start-ups were chosen to move on to the final, held at the Shoreditch Exchange in London, where they delivered their final pitch to a panel of industry experts and an audience of over 100 people, from which the winning teams were selected.

Applying to the challenge not only enters you into the competition but also connects start-ups with the Oxbridge AIx community - a supportive network focused on addressing pressing global issues. Additionally, participants can engage in matchmaking sessions to find potential co-founders, receive one-on-one mentorship, and gain credits for Azure, OpenAI, and other resources from Microsoft for Start-ups and other partners.

Carl and Jan reflect on the impact the competition has had on their start-up, “Participating in the Oxbridge AI Challenge was incredibly enriching, thanks to the fantastic support from the team. They helped us refine our strategy and pitch, enhancing our presentation skills and clarity of vision. We are deeply grateful for the support and the impact it has had on our journey.”

SHOESTRING DIGITAL

SHOESTRING PARTNERS WITH UNSW CANBERRA

UNSW Canberra has recently become the latest academic collaborator in the Digital Shoestring programme, expanding its international reach and making its low-cost, accessible digital technologies available to more small businesses.

Associate Professor Matthew Doolan from UNSW Canberra will lead the coordination of the Shoestring programme in the Australian Capital Territory and surrounding regions.

The partnership builds on a successful regional programme with the government in Western Australia, extending the Shoestring offering to a broader area of the country.

Duncan McFarlane, founder of Shoestring and Professor of Industrial Information Engineering, says: “We are excited to be collaborating with UNSW Canberra and expand our International Shoestring programme. We know how impactful Shoestring can be on small companies – this collaboration will allow us to grow Shoestring's reach in a new region and help many more SME's in the months and years to come.”

The programme is expected to progress in three phases: scoping, demonstration & pilot, and roll-out, to ensure the right support is in place in the region. During the collaboration, Digital Shoestring will help shape the programme, offer support in training and continue developing a catalogue of “shoestring-ready” hardware and software technologies, while UNSW Canberra will be the academic lead responsible for establishing an ecosystem of SME end users, industry associations and education/training organisations within the region, to help guide activities.

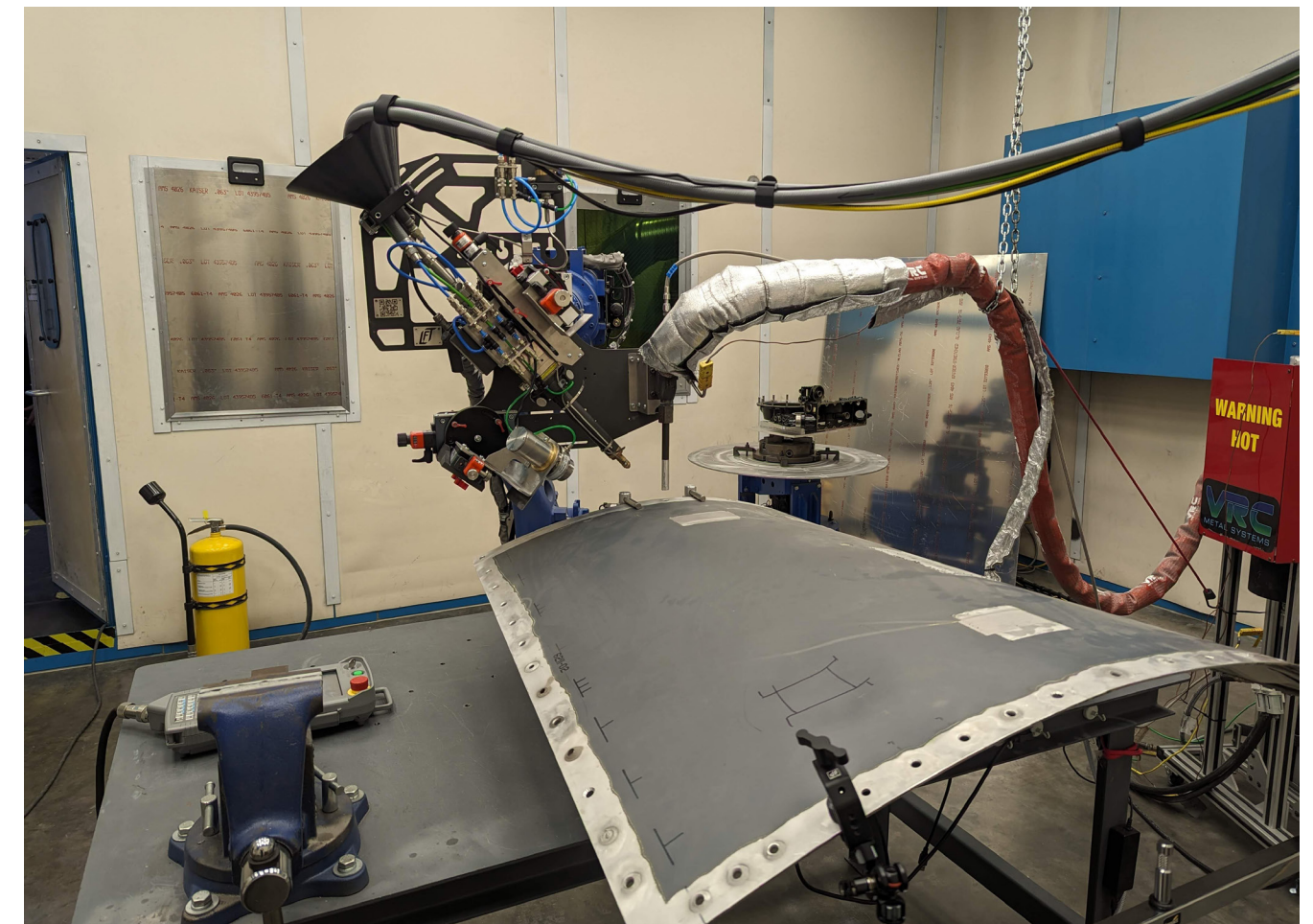
“We are excited to collaborate with Shoestring and look forward to bringing the program to Australia to help businesses implement simple, cost-effective digital solutions,” said Associate Professor Matthew Doolan, UNSW Canberra.

Find out more: <https://digitalshoestring.net>



LASER-ASSISTED COLD SPRAY: A NEW GENERATION OF INNOVATIVE MANUFACTURING TECHNOLOGY

The Centre for Industrial Photonics (CIP) at the IfM has developed a groundbreaking additive manufacturing technique: laser-assisted cold spray (LACS). The process uses localised heating of a supersonic powder stream with a laser to deposit metals and cermets to build, coat or repair parts, overcoming the high-temperature and material limitations of comparable techniques such as thermal spraying.



LACS equipment set up to add a coating to repair a panel aircraft wing

The Centre for Industrial Photonics (CIP) at the IfM has developed a groundbreaking additive manufacturing technique: laser-assisted cold spray (LACS). The process uses localised heating of a supersonic powder stream with a laser to deposit metals and cermets to build, coat or repair parts, overcoming the high-temperature and material limitations of comparable techniques such as thermal spraying.

The CIP team has demonstrated the effectiveness of LACS in aerospace applications, where high-precision and localised material deposition are critical. This technique enables on-demand fabrication of high-quality coatings and component repairs, extending aircraft lifespan. Additionally, LACS reduces the material waste and energy consumption of traditional methods, supporting the industry's transition towards net-zero emissions.

Additive manufacturing

Traditional manufacturing techniques typically involve removing excess material from a solid block to achieve

the desired shape using subtractive methods. In contrast, additive manufacturing builds structures layer by layer, commonly termed 3D printing. The LACS process can create parts from scratch or add coatings and features to existing components, proving particularly useful for high-performance coatings, critical component repairs and additive manufacturing in the aerospace, process, energy and biomedical industries.

This innovative manufacturing method offers several advantages over traditional techniques, including the rapid production of custom complex parts with minimal material waste. It enables the integration of multiple materials to achieve enhanced properties, allowing components to be tailored to specific applications. Additionally, it eliminates the need for costly moulds or extensive machining, making it particularly valuable for industries requiring low-volume, high-precision parts. By adopting this approach, manufacturers can achieve greater design flexibility, efficiency and precision in production.

As of 2023, the United Kingdom holds approximately 7.6 % of the global additive manufacturing market, with an even smaller share in additive-based coating systems. The global additive manufacturing market is projected to grow significantly, reaching between \$70 billion and \$88 billion by 2030, depending on various market analyses. This anticipated growth underscores substantial opportunities for innovation and development within this rapidly expanding industry.

Laser-assisted cold spray

The CIP at the IfM, under the leadership of Professor Bill O'Neill and his team of laser engineers and manufacturing experts, is pioneering advanced additive manufacturing methods using both cold spray and powder bed fusion.

"Cold spray is a technique for rapidly fusing powdered metals, cermets (composites of ceramic and metal) or polymers without melting them, which can then be used for building, coating or repairing parts. I first encountered cold spray while working at the University

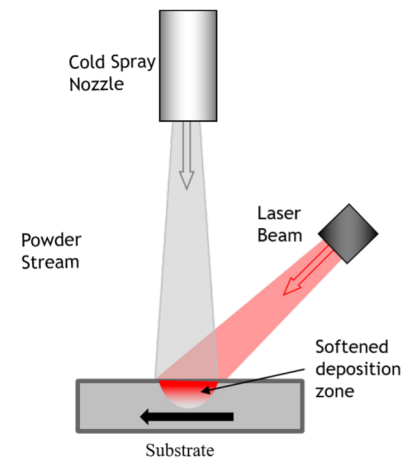


Illustration of the LACS process, showing the laser beam heating the powder deposition zone.

of Liverpool and set up my first facility dedicated to it there,” says Bill.

“At first, we concentrated on using nitrogen as a carrier gas for the powder. When working with high-strength materials such as titanium and aluminium alloys – commonly used in aerospace – we found that helium was essential for achieving optimal deposition. This is because helium, because of its lower molecular weight, enables higher particle velocities in cold spray, enhancing impact energy and improving adhesion to the substrate.”

The requirement for helium posed a significant challenge because of its cost, which is around £80 per minute of operation. Even state-of-the-art recycling efforts recovered only around 85% of the helium. Additionally, the equipment necessary for recycling greatly restricted the size of the parts that could be manufactured, as they had to fit within a size-limited chamber designed to capture the excess helium.

“Imagine trying to apply a coating to a section of aeroplane cladding,” says Dr Andrew Cockburn, Senior Research Associate in the CIP lab. “Being able to do that within the constraints of a helium-recycling system is just unrealistic. We needed to find a more practical solution for these high-strength materials, and that’s when we started investigating using lasers.”

To remove the barriers caused by helium, the team invented a process now known as “laser-assisted cold spray (LACS)”. LACS facilitates more efficient deposition of solid-state material powders by adding a laser to heat the deposition site locally (reducing the

substrate yield stress), resulting in a stronger bond between the materials without the need for melting.

Beyond the reduction in cost from removing helium, LACS has some significant advantages over other cold spray methods:

- **Enhanced adhesion and deposition efficiency.** The localised laser preheating **softens the substrate**, improving particle bonding and deposition efficiency. This results in stronger coatings than conventional cold spray, and other thermal spray processes, especially for high-strength materials like titanium and refractory metals.
- **Deposition occurs at a lower particle velocity**, meaning the powder’s structure is retained in the coating/part. This is a significant advantage for materials with specialised properties that are easily damaged, such as nano-structured coatings and rare earth magnets.
- **Improved material compatibility.** LACS enables the deposition of **harder and more challenging materials** that typically have poor adhesion in standard cold spray. This includes **cermets, refractory metals and oxidation-resistant alloys**.
- **Reduced residual stresses and porosity.** The laser’s thermal input reduces residual stresses within the coating, leading to improved mechanical properties. It also minimises porosity, enhancing the structural integrity and durability of the deposited layer.
- **Minimal thermal impact on substrate.** Unlike traditional thermal spray methods, LACS keeps the substrate below melting temperature, avoiding phase transformations or distortion. This makes it ideal for heat-sensitive materials and applications where preserving base material properties is critical.
- **It’s fast** – coatings can be added at up to 10 kg per hour.
- **Lower temperatures of the overall process.** Laser assistance allows the process to operate at lower gas temperatures, for example 400–700 °C, compared to up to 1200 °C for cold spray, reducing power consumption and simplifying system design.

- **Fine-tuning of coating properties by creating customised powders** enables specialised characteristics such as magnetism, solid-state lubrication and enhanced wear resistance to be introduced into deposits. Grading composition provides local control of properties and allows the stresses at interfaces between dissimilar materials to be reduced.

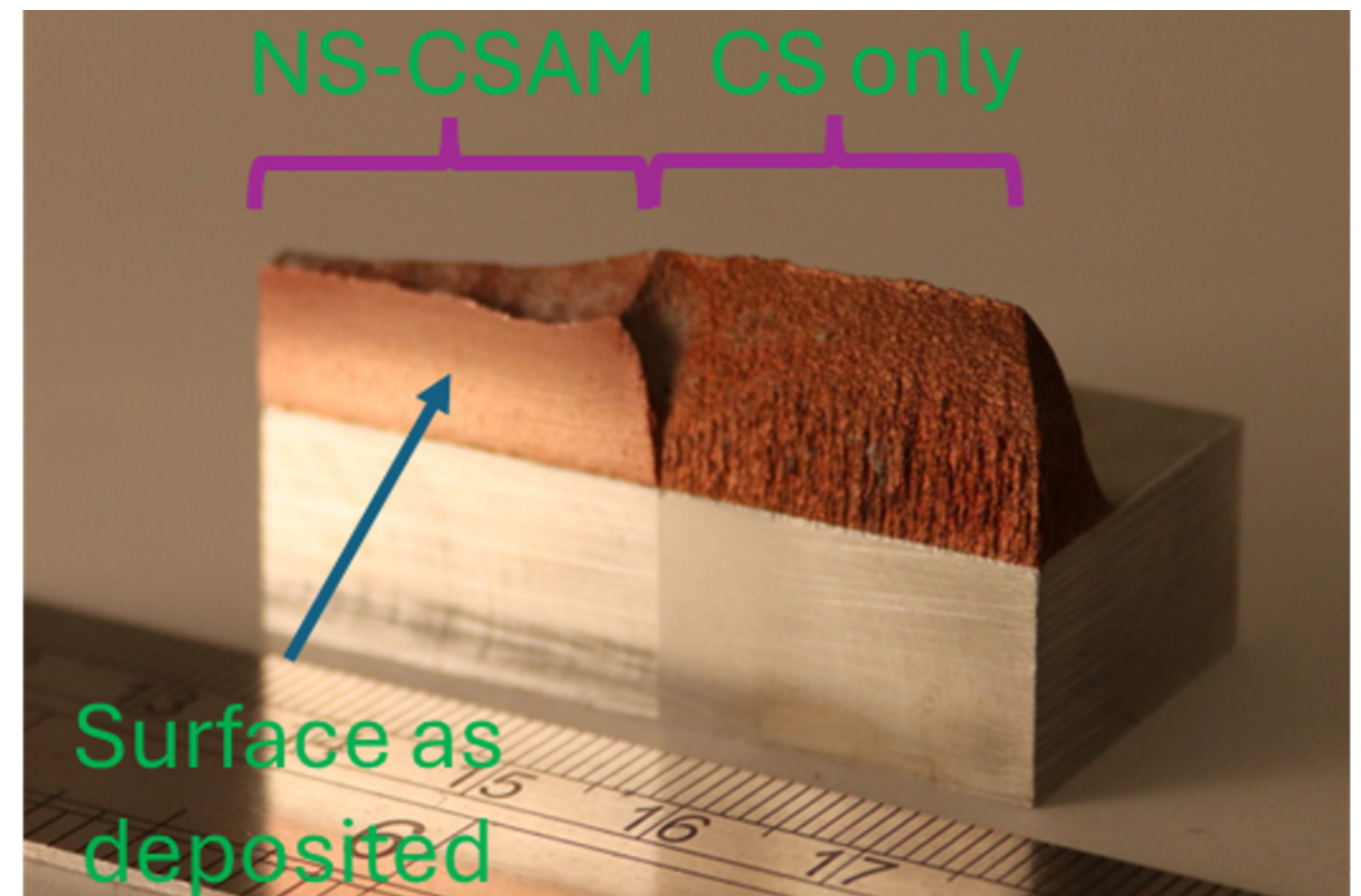
“Developing a new generation of innovative manufacturing technology with advanced processing capabilities could significantly aid the transition to net zero,” explains Bill.

“The ability to customise the properties of the materials is a real game-changer and has a huge range of potential applications; examples are producing lightweight components for electric vehicles and aerospace, creating hydrogen storage systems, enhancing wind turbine maintenance, manufacturing energy-efficient batteries and fuel cell components, and developing advanced heat exchangers for industrial energy savings and catalyst coatings for carbon capture.”

LACS in practice – aerospace

A particular advantage of LACS is its ability to both build and repair custom parts, a capability that is acutely useful for aerospace. They require high-precision, high-strength and relatively low-volume manufacturing of typically complex parts. Using traditional manufacturing techniques, the most cost-effective solution is to manufacture all the parts necessary for a particular model at one time and store them in a warehouse until they are needed. This creates two main issues: storage is space-intensive and costly; and, once the parts are used, there simply are no more for repair. As a result, aircraft can become unusable, as there are no replacement parts to fix them – Concorde G-BBDG is a high-profile example before the model was ultimately retired in 2003.

LACS offers a sustainable, cost-effective and efficient option for repair, and, in more extreme cases, remanufacture from a base part. Traditional repair techniques, such as welding, are unsuitable for high-performance applications, for example 6000 series aluminium. The heating needed to adhere the new and old material together impacts the strength and reliability of the repaired part.



Comparison of deposited surface for net shape cold spray additive manufacturing (NS-CSAM) and cold spray (CS), clearly showing the controlled deposition given by NS-CSAM.

WE ARE EXCITED TO WORK TOGETHER WITH INDUSTRY PARTNERS TO REALISE THE POTENTIAL OF THIS UNIQUE AND IMPACTFUL TECHNOLOGY

Bill and his team have shown that the relatively low-temperature, localised laser heating used in LACS allows new material to be added without negative side effects. Furthermore, as with 3D printing, the LACS equipment has the potential to be programmed to build to a specified design from a computer model, allowing complex, digital designs to be quickly turned into tangible products.

“This is transformative for many industries, allowing custom parts to be created and repaired on demand in a short time frame, having low-cost, low-energy budget and efficient use of materials,” says Dr Martin Sparkes, Principal Research Associate in the CIP lab. “We are excited to work together with industry partners to realise the potential of this unique and impactful technology.”

Limitless potential

The next step for the CIP lab is to enhance the capability of LACS to “3D print” a shape. The team are exploring several avenues to achieve this goal, including mounting the part on a moving arm to allow it to be moved in 3D space and increasing the control

over the direction of the powder stream to produce crisp, smooth edges.

“Currently, we have little control over the shape of deposition of the powder. This is not an issue for coatings but presents a significant restraint for part-building applications. Our next goal is to find a solution to this limitation, and we already have some very promising results,” says Bill.

“The potential applications for LACS are limitless, and we are motivated to deliver a technology that can significantly aid in the transition to net zero, through both a more efficient, low-waste manufacturing technology and the doors it opens for sustainable product development.”

To find out more about LACS and the broader work of CIP, and to contact the team, visit: <https://www.ifm.eng.cam.ac.uk/research/cip/>



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ISMM STUDENT SHORTLISTED FOR THE 2024 JAMES DYSON AWARD FOR PARKINSON'S DEVICE

Jonathan Fisher took part in the 2023/24 cohort for the MPhil in Industrial Systems, Manufacture and Management at the IfM. He was shortlisted for the 2024 James Dyson Award for his wearable biomedical device, Peter. The device helps people suffering from Parkinson's disease to regain their ability to walk by alleviating the symptoms of freezing of gait.



Introducing Peter

Parkinson's disease is a neurodegenerative disorder that affects over 10 million people worldwide, with 1 in 37 people expected to be diagnosed in their lifetime. The condition can cause more than 40 debilitating symptoms, which robs sufferers of their independence and quality of life over time. Inspired by watching the impact of the disease on his father's life, Jonathan made it his mission to alleviate one of the most debilitating symptoms, freezing of gait. This unpredictable symptom causes sufferers to suddenly lose the ability to walk, their legs "freezing" as if glued to the floor for several minutes. This severely impacts independence and quality of life and often leads to falls and accidents.

His solution is Peter. Named after his father, Peter is a wearable biomedical device that helps to alleviate freezing of gait and was shortlisted in the global top 20 for the 2024 James Dyson Award. The award recognises outstanding inventions by young engineers and designers globally, giving the winner a cash prize to advance their invention.

"Sir James Dyson is one of my heroes, so knowing he personally reviewed my design is an incredibly exciting moment," says Jonathan. "The support, exposure and recognition from this award will elevate Peter's development and open doors to connections and opportunities that I wouldn't have had otherwise."

This announcement builds on the device's earlier success. Peter won the 2023 New Designer's "Formula 2GX Passionately Purposeful Creative Innovators Award" and was shortlisted for both the Joseph Joseph and DCA New Designer's Awards.

Award-winning design

The device is simple and discreet in design, comprising a neckband worn touching the collarbones and a sensor attached to the wearer's shoe. The sensor automatically detects when your leg has stopped moving and sends a signal to the neckband, triggering it to play a rhythmic signal. This signal has previously been proven to alleviate the symptoms of freezing of gait without the need for medication.

"While simple, the concept is effective and provides an 'invisible', discreet and user-friendly solution to millions of people around the world suffering from Parkinson's disease," explains Jonathan.

Although it may appear to be a simple solution, its impact on users is significant and far-reaching. Parkinson's medication becomes less effective over time, so delaying its use can lead to a better quality of life for a longer period of time. The use of non-invasive technology, like Peter, helps to manage symptoms and reduces the need for medication.

Professor Roger Barker, a Parkinson's expert at the University of Cambridge and Addenbrooke's Hospital, says, "Walking problems are a major issue for many patients with Parkinson's disease. Better ways of treating it are urgently needed and this promises to be an exciting new approach."

The device can also significantly increase quality of life, fostering confidence, independence and freedom.

"Walking is such a big thing," says Jonathan. "It allows you to integrate into society and gives you so many more options for what you can do. The ability to be active, be involved in communities and maintain independence for as long as possible is such a positive for Parkinson's sufferers, both physically and mentally."

The design process started during his undergraduate studies in Product Design at Brunel University, where he saw a gap in the market for a low-cost, discreet and accessible solution to freezing of gait. While solutions exist, they are bulky, expensive and play a constant signal, which is less effective and annoying for users. Peter went through many iterations before the design was finalised, using dismantled





headphones, Velcro and foam models and 3D-printing to test and refine all aspects of the device.

Jonathan involved users and experts at every stage of the design process, getting feedback from patients, caregivers and medical professionals to inform the user-friendliness and comfort of the design. Final forms of the device were tested with empathy tools to simulate Parkinson's symptoms and ensure its suitability.

Impactful learning leads to impactful people

While the initial design was completed as part of his undergraduate studies, Jonathan attributes much of his onward journey with Peter to the ISMM Programme at the IfM, particularly the broad content of the curriculum and consideration of all the factors needed to bring a product to market. The programme was recommended to him by a former manager and ISMM alum, who acknowledges its impact on the success of their own career and who knew Jonathan would benefit from the broader education in manufacturing and management it offers.

"The course has given me the confidence to take the venture forward. The exposure to different topics, meeting an amazing network of people and the skills I have gained have been invaluable in my ability to take this

product further," he says. "There are so many talented and amazing people at the IfM and, studying on the ISMM programme, they are all available and enthusiastic to talk to you about their work."

In particular, he credits Course Director Florian Urmetzer for encouraging him to apply for the James Dyson Award. It was under his recommendation and support that Jonathan submitted the application and had the skills and confidence to pitch Peter to the awards judging panel.

"Before taking part in the ISMM programme, I would have been daunted by pitching the device to the judging panel. However, as part of the course we were presenting to academics and industrial professionals almost weekly. Pitching to the judging panel almost felt like an everyday occurrence and enabled me to present the device at its best."

Accelerating innovation

Spurred on by Peter's early success and the confidence and skills built during the ISMM programme, Jonathan is determined to see his product through to market.

"User testing will be assisted by Parkinson's disease experts at Addenbrooke's Hospital, including the head of a Parkinson's disease research

group and a consultant neurologist. Both have verified this concept would work. Successful trials would lead to further funding rounds for mass clinical trials, certification and production," explains Jonathan.

Jonathan has been accepted to the Accelerate Cambridge programme at the Judge Business School, which was introduced to him through ISMM. He has since spent six months on the programme, which offers a structured approach of 3-month blocks combining entrepreneurship training, regular coaching, and mentoring, as well as access to shared workspace.

Currently, he has secured early-stage funding through the Cambridge NeuroWorks Fellowship which will allow him to continue developing the device, building on earlier financial support from Wolfson College, Cambridge and Brunel University London. "I'm excited to see what the future holds!" he concludes.

If you are interested in learning more about Peter or discussing potential collaborations, you can connect with Jonathan on LinkedIn: <https://www.linkedin.com/in/jonathanlukefisher/>

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ACHIEVING NET ZERO IN MANUFACTURING SUPPLY CHAINS

In today's rapidly evolving industrial landscape, achieving net-zero targets has become a critical objective for many manufacturing firms committed to sustainability. However, reaching beyond these goals to encompass broader Scope 3 emissions – those linked to the entire life cycle of products and their supply chains – presents a formidable challenge.

The IfM's **Centre for International Manufacturing** has been leading efforts to address these complexities. Here, **Jagjit Singh Srai**, Head of the Centre, and Director of Research in the Department of Engineering, shares innovative strategies and examples of interventions that are transforming the manufacturing value chain for a more sustainable future.

Can we redesign products, production and supply chains for sustainability?

Manufacturing companies are increasingly setting ambitious goals to achieve net-zero targets, marking significant advances in their sustainability initiatives. This enthusiasm for sustainability is buoyed by a surge in consumer demand for products produced using sustainable and ethical practices. Furthermore, regulatory bodies are enacting stricter guidelines, compelling companies to embrace sustainable solutions. This change may also be fuelled (but not always!) by the advocacy of shareholders, leadership teams and employees to produce more sustainable goods and prioritise sustainability.

However, it can be challenging for companies to include broader Scope 3 goals and consider the impact of their products' usage in their supply chain operations. Achieving this requires a thorough assessment of various product designs, production methods and supply chain set-ups. Key areas to focus on include alternative materials and energy sources, production processes, delivery methods and the product's sustainability during its use. The effort is even greater for companies transitioning to new operating and business models adopting circular economy principles.

At the Centre for International Manufacturing, we work closely with industrial and institutional partners to address these challenges by considering alternative (renewable) materials, exploring smaller-scale manufacturing operations closer to the market, and evaluating the opportunities these interventions provide for redesigning supply chains. Our expertise in the analysis, design and operation of manufacturing supply chains is applied across sectors from food and healthcare to automotive and aerospace.

Exploring the different options throughout the manufacturing value chain is important when it comes to creating more sustainable operations. Figure 1 (below) provides examples of interventions that can shape future supply chain configurations, such as exploring alternative renewable feedstocks, evaluating new production processes or developing supply chain scenarios that promote circular business models.

Below we explore four areas of our work in this space.

1. Using renewable resources for sustainable production

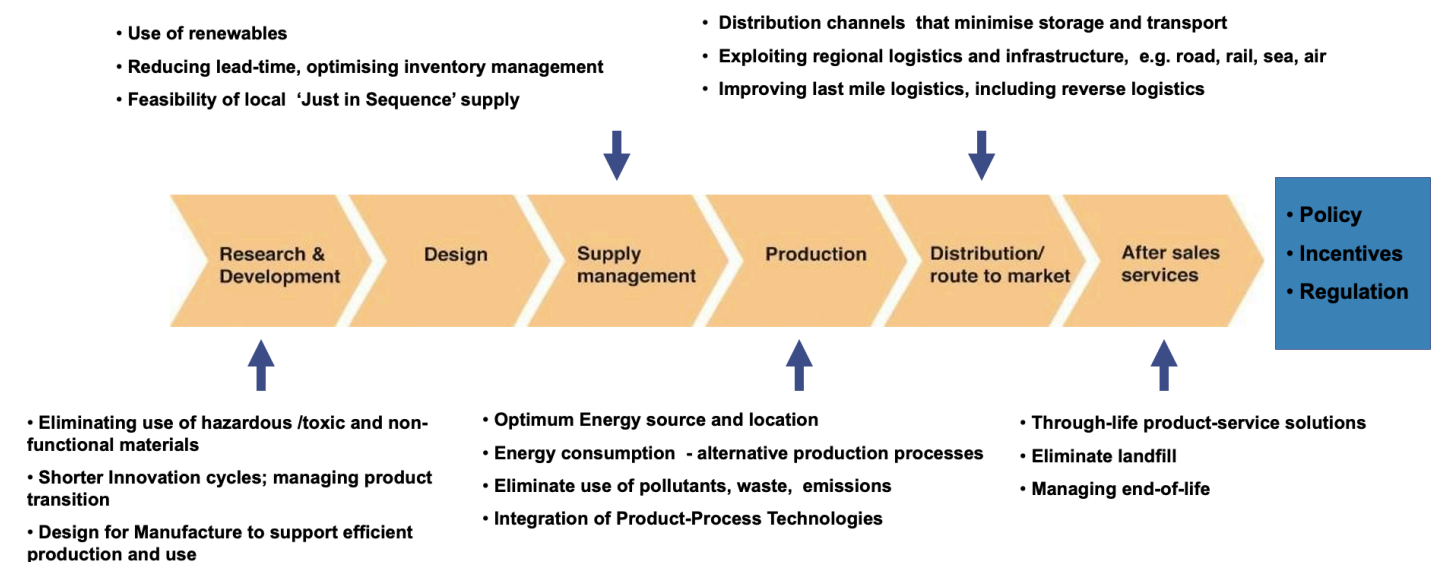
By leveraging expertise in supply chain design, our team has looked at how renewable feedstocks can be more extensively used in manufacturing supply chains. While using resources efficiently, we aim to minimise waste

and reduce environmental impact. For example, we have created new methods to consider alternative feedstocks as a supply-driven matter rather than determined by customer demand. In the context of renewable feedstock, our process involves evaluating the feedstock's characteristics and technology options for converting it into primary and secondary raw materials for specific markets.

An example of this concept is the use of terpenes as sustainable chemical feedstocks currently sourced from the petrochemical industry. Terpenes are natural compounds found in citrus, turpentine and pine oils, but they are also available as by-products of industrial production. They can be converted into chemical feedstocks and offer an alternative to current fossil fuel sources, transitioning to renewable resources. This transition potentially offers several benefits, including new sustainable manufacturing processes, reduced feedstock costs, increased supply security and minimised environmental impact.

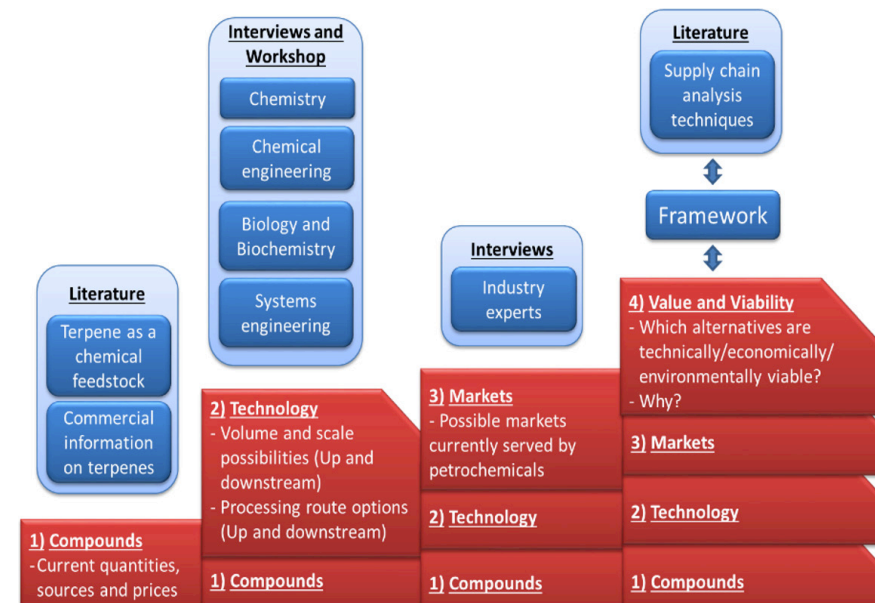
Another example of using by-products of industrial processes has been our work conducted in a major research project, project TIGR2ESS, a collaboration between Cambridge and India, and more recently Pakistan. The project, funded by the Global Research Challenges and Cambridge Newton Funds, involved exploring the feasibility of alternative supply networks and

Figure 1. Example intervention strategies in delivering sustainable supply networks



Source: courtesy of Srai, J.S.

Figure 2: Supply Chain Evaluation Framework for Renewable Feedstocks



Source: Srar, J.S. et al 2018, "Circular supply chains and renewable chemical feedstocks: a network configuration analysis framework", *Production Planning & Control*, 29(6): 464-482. DOI: 10.1080/09537287.2018.1449263.

public-private partnerships to produce, at scale, primary agri-production, but also the reprocessing of by-products into value-added products.

For instance, we have worked on transforming localised circular supply networks that use post-harvest rice straw stubble – currently burned on-site to clear the fields, leading to significant air pollution in the region – into revenue-generating industrial products from what was previously considered waste. Discovering alternative uses for such waste not only solves the waste-management challenge burdening farmers and the local community but can also assist in reducing emissions, lowering air pollution and improving livelihoods. Exploring possible production pathways and creating markets for processing agricultural waste straw helps to tackle sustainability challenges in agriculture. The initiative has also led to a policy intervention that promotes involving intermediaries, bridging public and private interests such as social ventures or the farmer-producer organisation model. This work has been captured in the academic literature, articulating the opportunities of involving social ventures or FPOs to design by-product supply networks drawing on the case of rice straw.

2. Organisational capabilities for delivering sustainable supply chains

To assess management capabilities in advancing sustainable supply chain practices, we have developed an evaluation framework based on several cross-case studies.

The Sustainability Maturity Assessment tool compares sustainable supply chain practices in multinational companies. It offers a comprehensive evaluation of the maturity of sustainable supply chain practices, encompassing sustainable supply network design, network integration and connectivity, network efficiency, process development and reporting, and product-service enhancement. These five dimensions are assessed against environmental, social and economic objectives. Additionally, the framework assesses both "existing" and "desired" capabilities, encompassing the company's end-to-end supply system, including inbound supply, internal manufacturing, downstream distribution and alignment with direct/indirect customer needs. The outcomes of the assessment reveal performance gaps and provide actionable steps for the organisation to strengthen its sustainability and digital transformation strategy.

For example, on one particular dimension, a low score indicates minimal attention to waste management, prevention and disposal, with waste being sent to landfill. A medium score suggests the presence of a formalised zero-waste strategy, albeit partially implemented in a limited part of the supply chain. Ambitions may be present, but the formal policy is only partially implemented in a factory setting. A high score indicates a focus beyond the factory – for example adopting circularity principles and considering the entire product life cycle, including using renewable energy in production. On the product side, actively pursuing repair, recycling and refurbishment may also be indicated.

3. Developing circularity approaches through strategic partnerships and innovative metrics

Our research team has been collaborating with the World Economic Forum on the Circular Transformation of Industries (CTI) initiative, which helps industries transition towards a circular economy, focusing on sustainability, economic growth and supply chain resilience.

We have worked on analysing case studies from leading multinational enterprises to understand how to transform operating and business models from linear to circular. As a result, our efforts have led to the creation of White Papers discussing the crucial role of partnerships in enabling a circular economy and identifying six important enablers to drive transformation pathways towards circular supply networks. This work led to the Circular Transformation of Industries: The Role of Partnerships White Paper, which explores the enabling role of partnerships in creating circular solutions.

This work has been presented at recent Davos meetings, leading to new initiatives to promote circularity in selected sectors.

The centre is actively supporting the CTI initiatives, with two additional content pieces in the pipeline that focus on demonstrating the positive impact of circular models and the need for standardised metrics to assess circularity.

4. Leveraging digital technologies in circular supply chain ecosystems – promoting repair, remanufacture and resell

In collaboration with industry partners, we have developed an approach to inform circular supply network transformation strategies to support implementations beyond incremental sustainability improvements. This approach focuses on the entire life cycle of products, emphasising activities such as repair, remanufacturing and reselling to maximise resource use and minimise the generation of waste. The heart of this initiative explores the role that digital technologies can play in circular ecosystems. The approach enables organisations to visualise and manage the intricate web of resource exchanges – material, financial and informational – between supply network and ecosystem actors.

Unlike traditional linear supply chains, circular supply chains are characterised by multiple usage cycles and reverse logistics for reprocessing. Consequently, recovering products at the end of their life cycle is paramount to fostering circular and sustainable business models. This newly developed method identifies key intermediaries that facilitate material exchanges and manage the essential information flows required for circular operations. Crucially, it maps out stock and resource flows, ensuring the efficient operation

of the entire system. By highlighting these interactions, the method uncovers opportunities for implementing digital technologies, advanced production techniques and organisational changes that promote circularity. For instance, the concept of "circularity brokers" emerges – individuals, entities, or digital platforms that connect materials and products after their use cycle with the demand side to maintain the flow of materials within the circular economy.

This approach illustrates how digital technologies can support the design of sustainable supply chain ecosystems, offering practical solutions for businesses committed to reducing their environmental impact and enhancing their operational resilience.

Do the numbers add up? Ensuring robustness in redesign strategies

Our centre bridges the gap between data modelling experts and those focused on strategic, operational and system-level perspectives. To ensure the robustness of our approaches, we have developed a range of tools to quantitatively evaluate various aspects of sustainability interventions. These modelling tools analyse scenarios for raw material sourcing, alternative production processes, location footprint implications and inventory management, complementing our strategy-level frameworks.

Want to know more?

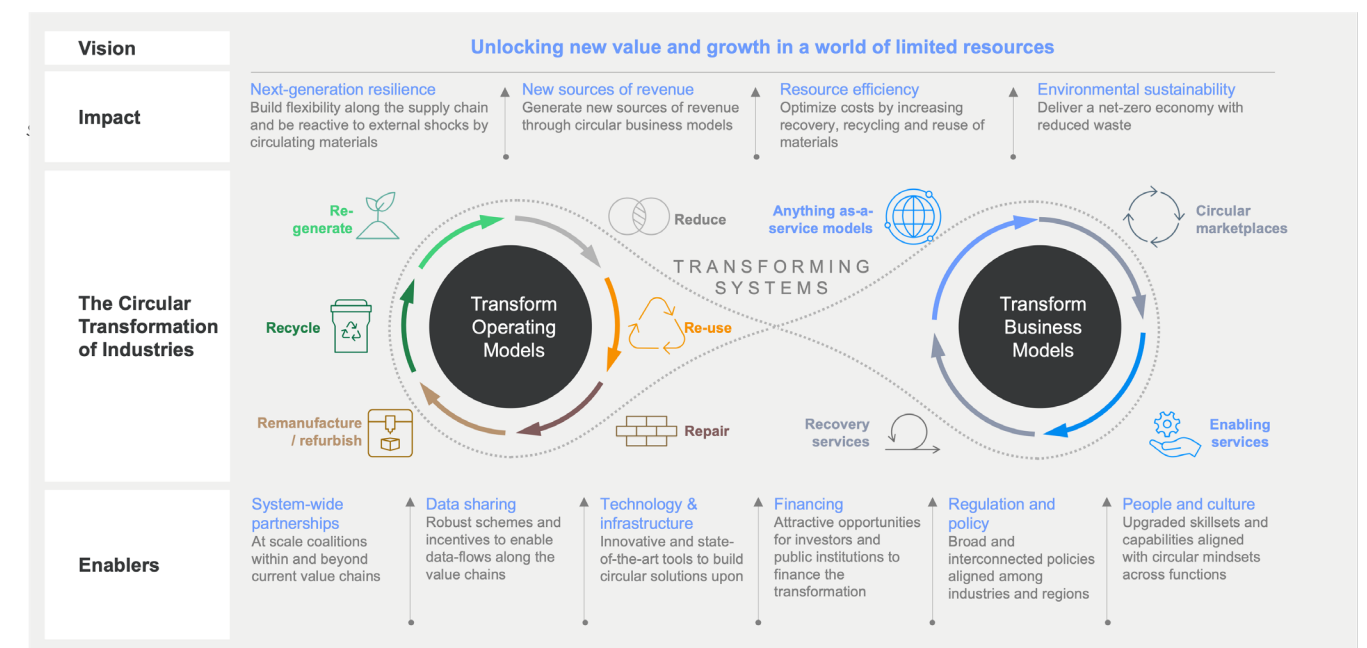
At the Centre for International Manufacturing, we work closely with industry to develop research into practical solutions. We are always looking to expand our network of industrial partners to advance research and develop manufacturing solutions for the future.

For further information about research and collaboration opportunities with the Centre for International Manufacturing, please contact:



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Figure 3: Circular Transformation Operating and Business Models



Source: World Economic Forum 2024, "Circular Transformation of Industries: The role of partnerships". https://www3.weforum.org/docs/WEF_Circular_Transformation_of_Industries_2023.pdf



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FROM PLASTIC WASTE TO BETTER HOMES IN NEPAL

Every day, another 600 tonnes of plastic waste end up littering Nepal's streets and mountains, often with dire consequences. The country has seen a dramatic increase in plastic imports over the last decade, and although they are a resilient, convenient and versatile group of materials, plastics require responsible management to prevent damage to people, animals and the environment.

Dr Curie Park, of the Centre for Industrial Sustainability, set up the Plastic to Ghar (P2G) project in 2022. "Ghar" means "house" in Nepali, and the aim of P2G is to set up local innovation capacity to tackle Nepal's plastic waste problem by turning it into a solution to other pressing problems. With support from the Sustainable Manufacturing and Environmental Pollution Programme (SMEP, funded by UK Aid and UNCTAD), which covers 13 intervention areas in South Asia and Sub-Saharan Africa, Curie and the local teams are about to enter the penultimate phase of their project, which sees plastic waste transformed into useful housing materials, and communities transformed into hubs for innovation.

The plastic pollution problem

Diversity is a defining feature of Nepal, encompassing both cultural and geographical elements. With altitudes ranging from 70 to over 8,848 meters above sea level, many inhabited areas face challenges connecting to robust waste-management systems due to the rugged topography. Trekking is the only way to transport things from A to B, and villagers find it difficult to take the waste back to town. Across the country, it is common to see open fires for plastic burning that produce toxic fumes, especially where households are out of reach of collection systems because of the rugged topography. Where plastic accumulates in large landfills, burning leads to even greater harm, including the deaths of livestock in the area.

The plastic pollution problem co-exists with two other significant challenges: poor housing and deforestation. Generally speaking, there is no concept of thermal and sound insulation in most Nepali homes. As a consequence of the devastating 2015 earthquake, which left nearly 3.5 million people homeless, new homes were built to a very basic standard. As per the authorities' advice, buildings were equipped with corrugated galvanised iron (CGI) sheets for roofing instead of the previously common stone shingles. As a result of

this change in construction methods, many Nepalis are now only shielded from the elements by a thin sheet of metal.

While CGI sheets are lighter and safer than traditional roofs in the event of an earthquake, they have little to offer in the face of summer heat, winter cold and the noise of torrential rain during the monsoon season. The noise is often so severe that it has a detrimental effect on the quality of sleep and education, and the lack of protection against temperature extremes is a risk to health. Furthermore, most Nepali homes rely on firewood for heating and cooking, meaning deforestation has become a significant problem.

Innovation stems from dissatisfaction

From an outsider's perspective, these facts indicate that Nepal is facing numerous significant challenges, all of which could have adverse effects on the populace's standard of living. However, when Curie first visited the country, she observed that the internal perspective differed from the external one.

"Nepalis are the happiest people ever!" she says. "People have a humble and grateful attitude to life, and they don't like being stressed. Coupled with the belief that nothing is impossible in

Nepal, there is a feeling that everything will be OK, but there is no rush to change the things that are not working. If I had just parachuted in with this project money and told people what to do, it would have been an easy way to alienate the locals."

Aligning the two perspectives meant that Curie had to tread carefully and remember that the project should be done by the locals, for the locals, with the local waste. For the duration of the project, her role has been that of facilitator, lowering the threshold for local entrepreneurs to bring their ideas to fruition.

"We don't want to give people fish: we want to learn how to fish together. We are trying to encourage innovative thinking, but innovation tends to come from a place of dissatisfaction. We don't want to make people feel dissatisfied, but rather to see that with simple means, they can help themselves, their communities and the environment," she adds.

From new ideas to local businesses

Each project in the Sustainable Manufacturing and Environmental Pollution Programme (SMEP) seeks to identify profitable, scalable and sustainable uses of environmental pollutants, tailored to the cultural and

economic context. In Nepal, that means using plastic waste to create durable and practical building materials to lift the local standard of living, while limiting the environmental damage of plastic burning and littering.

In the very first stage of the project, Curie focused on building her network of collaborators and was glad to find a lot of interest in participating. Once it was established that the project had potential, the team had plastic-processing machines imported and installed, and they made plans for two competitive MAKEathon to take place at FabLab Nepal. The task for participating entrepreneurs, students and villagers: develop a product using existing technology to transform plastic waste into durable housing products for Nepali homes.

Contestants, a mix of local and international entrepreneurs, were encouraged to assess their ideas against three criteria. First, they had to ensure that the logistics of creating their chosen product would be manageable. That meant thinking about how to source the plastic, to ensure that the

equipment needed for production was available, and that there would be a market for the finished product. Second, they were asked to think about durability to ensure a long-lasting second life for the plastic. And, third, they had to consider the extent to which the product would meet an existing critical need in their local community. A total of 26 local and global participants attended the first MAKEathon, which resulted in seven open-source innovations and three winners, who went on to receive systematic start-up training. In the second MAKEathon, 44 local participants from across Nepal attended, and out of 6 contestants another 3 winners were awarded the opportunity to receive training. Then followed a process of business incubation, including prototyping, masterclasses and coaching, leading to the launch of three businesses, serving their local communities using the local waste. The original six start-up cohorts gradually evolved into three strong ones. Some discontinued, and the members of the discontinued teams join the other teams eventually making them stronger often filling the missing skill gaps.

Paramendo

Different plastics are suited to different purposes, and Paramendo has set its focus on two kinds of polyethylene. They use LDPE (low-density polyethylene) to make thin roofing repair sheets that can be melted onto damaged parts of roofs, and HDPE (high-density polyethylene) to make beautiful marbled tiles for flooring and furniture.

KleanIt Upcyclers

KleanIt Upcyclers (KIU) transforms Multi-Layer Plastic (MLP) into sturdy beams that replace wooden lumber using extrusion. These beams are used to make furniture such as benches, sofas, and tables. MLPs are thin plastic films with aluminium layer sandwiched inside, commonly used to protect crisps and noodles in packets. They are often the most tricky type of plastic waste. Not only beams and furniture, KIU is active in diversifying their portfolio from injection-moulded flowerpots, period bracelets, coaster, photo frames, decking and pavement blocks.

Green Decision Labs

Using discarded polypropylene plastic (PP), Green Decision Labs makes under-roof insulation wool, which improves thermal insulation temperature by up to 5 degrees. First, the raw materials are pelletised and converted into plastic wool using a Polyfloss machine, and then the wool is felted and compressed in a cold press machine. To enhance the fire resistance of the felt, a mud-soaked cotton fabric is added on top, inspired by the traditional wall-finishing method of Nepali homes. Finally, the felt is rolled up for ease of transport and use.

Together, these three businesses provide a set of housing products with the potential to substantially improve living standards in Nepali communities at very low cost. The small-scale remanufacturing units in the villages reduce the transportation cost of housing materials that often increases the total cost threefold. Overall, the P2G project is expected to transform the country's plastic waste into useful products, improve the air quality by ending plastic burning, and reduce reliance on firewood.

Impact Hub Kathmandu is the local management and implementation partner on the P2G project, and Padmakshi Rana, Executive Director and Co-Founder, is very pleased with the project's progress to date.

"It's been an incredible journey of learning, unlearning and relearning with the University of Cambridge team and the P2G entrepreneurs," says Padmakshi. "Plastic waste is an ever-growing concern in Nepal. Through the P2G project, we have been able to provide a platform to the Nepali entrepreneurs for designing and developing community-based innovative solutions out of plastic waste, and resilient business models."

Planting a seed

At the current stage of the project, with the new businesses up and running, Curie wants to spend more time in Nepal. In previous years she has spent less than half of her time there, but things are changing. Many smaller day-to-day decisions need to be made, especially about the challenges around scaling, but there are also bigger strategic questions to address about where the project is going and how it can inspire similar



Ad-hoc maintenance of CGI roofing in local houses in remote villages, photo taken during the P2G team's visit to Ree Village. Copyright 2024 © Curie Park.

projects elsewhere. Each incubee has been awarded £800 for their activities from the SMEP project, which supports activities like travelling, raw material purchase and company registration fees. These investments help businesses to be financially and environmentally sustainable.

"P2G is about education and capacity building, and many of our learnings from Nepal are transferable to other locations with adverse environments. We hope that when this project comes to an end, we will have planted a seed of innovation culture that will flourish into the future," Curie concludes.

Looking ahead, Curie and the teams are working to ensure that market demand will sustain the new businesses. Because the Nepali market is import-heavy and price-sensitive, the P2G businesses have a competitive advantage over many competitors, whose transportation costs sometimes lead to a tripling of the final product price. This advantage, in addition to an innovation-focused mindset, puts the new businesses in a good position to meet current and future community needs in lasting and sustainable ways.



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Innovation tools, expert talks, mentoring and prototyping support were provided to the MAKEathon at FabLab Nepal. Copyright 2024 © Curie Park.





GAMIFYING SUSTAINABILITY: DELIVERING WORKER ENGAGEMENT FOR ENVIRONMENTAL IMPACT

Raynor Foods is renowned for its innovative initiatives and is currently focusing on the challenge of inspiring its entire workforce to enhance sustainability. In pursuit of this goal, they have initiated the S3 Project in partnership with the IfM and other academic and technological collaborators to establish a digital twin factory for real-time monitoring of carbon emissions. They plan to use gamification to involve employees in reducing the company's carbon footprint.

Raynor Foods, the 2023 British Sandwich Association Manufacturer of the Year, and the largest supplier of sandwiches to the NHS, has always been a leader in sustainability. In 2009 they pioneered the carbon footprinting of sandwich products, and they have an extensive track record of sustainable innovation delivering projects, including eliminating non-biodegradable plastics and creating the Intense™ tomato, which cut waste and increased product life. To this end, they approached the IfM, part of the University of Cambridge, who have been leading the development of a gamification programme to make improvements in sustainability.

To maintain this position and push the boundaries of sustainability, Raynor Foods saw an opportunity to tackle arguably their biggest challenge to date – how to motivate everyone in the company, from the shop floor upwards, to work towards improving its sustainability performance. To achieve this, Raynor Foods, in collaboration with a consortium made up of the Institute for Manufacturing (IfM), the University of Lincoln and Software Imaging, came up with a highly innovative high-tech response linking employee recognition and rewards to measurable KPIs in sustainability performance – known as the S3 Project.

The aim of the S3 Project is to create a digital twin factory using state-of-

the-art technology to track carbon emissions in food manufacturing. By incorporating aspects of gamification to motivate the workforce, and real-time carbon monitoring, the aim is to demonstrate carbon reductions. The project has three main elements: smart people, smart processes and smart factory.

Smart factory and smart processes

The foundations of the S3 project have already been established, with the University of Lincoln leading much of the work. They analysed what improvements were needed in terms of CO2 reduction, discovered what digital tools would be needed to accomplish these reductions, and were then involved in developing and deploying these tools. These included a highly sophisticated set of sensors connected to game links attached to pieces of equipment or worn by employees.

One of the most impressive pieces of technology is the Ultra-Wide Band Mesh, developed by Software Imaging. It is effectively an invisible mesh that covers the entire enterprise and can locate a digital link within 5 to 10 cm. "It is effectively the backbone of our whole project," says Tom Hollands, Innovation and Technical Director at Raynor Foods.

"You can associate links with a piece of equipment, or to people, or to processes. And because we flooded

the whole area, and it's got a very granular accuracy, you can do some fantastic things with the technology that we're only starting to discover now. You can add the links to scaled waste bins, which allow you to associate the amount of waste with a process. You could also add links to doors on room-sized fridges and freezers to highlight if they are open," says Tom.

"These links enable you to geolocate people to a process. If you measure the process from a CO2e performance perspective, you can assign performance to individuals and teams who work in that area, even if they only work in the area for 30 minutes."

Because the groundwork was done by the consortium in terms of identifying technology aligned to business and sustainability needs, some impressive results are already becoming visible.

The S3 Consortium have already been able to track a saving of 38 tonnes of carbon emissions through smarter processes. "As a business there are great correlations between wasted effort, wasted time and higher emissions. Tackling overproduction, stock rotation processes and end-of-production waste were all key factors that led to the reduction," says Tom. But Raynor Foods wants to go much further. "This is just a starting point, and we are expecting the savings to grow through gamification. We're aiming

to be net zero by 2030, which is a deliberately ambitious target. But it's got to be, because we're running out of time, and if nobody starts moving the dial quite quickly, we're all going to be in a really unpleasant place," says Tom.

Smart people and gamification

The company knew that the only way to do this was to get the entire workforce on board. "Because it's only through an engaged workforce that we're going to deliver these things. We want to make sustainability more relevant and personal to them. One area we hope to move the needle on is making the invisible – things like CO2 emissions – visible, to motivate staff to find ways to reduce waste they can't necessarily see," says Tom.

With the data in hand and an awareness of the changes that needed to be made, the challenge was to convey this information to the workforce in a way that would engage them on a personal level, and to encourage the behaviours and values that Raynor Foods want to live by as an organisation.

To this end, they approached the IfM, which has been leading the development of a gamification programme to make improvements in sustainability. The system, which allows employees to earn points that transform into a variety of rewards and benefits, is the most advanced and innovative such system in the food industry.

"It's an engagement and education tool that allows us to motivate and achieve behavioural change, while making the work fun and valuable for the employees" explains Ergün Güngör, Research Associate at the IfM's Centre for Industrial Sustainability. .

Discovering motivating factors

For the system to work, Raynor Foods first needed to discover the rewards that would be meaningful to their workforce. This process involved Ergün interviewing 8–10 "Sustainability Ambassadors" appointed by the company. This enabled him to get a good idea of areas that were important to employees and then design a survey that was shared with the entire workforce. This covered a range of questions from what motivated employees to what worried them and how they would like to improve themselves.

"A flexible work-life balance was the top motivating factor, which came as a surprise to management because money had always seemed a prime concern when questions were asked on the shop floor," says Ergün. "Personal development, a supportive working environment, recognition and appreciation, and challenging and meaningful work were other important factors."

"Ergün has been brilliant in sitting down and doing interviews, workshops, walkabouts and gathering data to understand everyone's individual motivations, and how the rewards can then recognise that," says Tom.

"It's not all about money. We've learnt that. It's about achievement, recognition, development, and wanting more quality time with their families, such as having holidays or trips to the zoo paid for," says Tom. Certain desires, such as dinner with the managing director, donations to charities and even English lessons have been particularly surprising.

Armed with this information, the team went into workshops with management to look at ideas for the reward and recognition systems, a process that entailed aligning budgets with the promises that could be made. Ideas that came out of the workshops included a dream prize raffle, which would make somebody's dream come true, a company-wide factory celebration day, paid training and additional holidays.

Creating KPIs that deliver worker engagement and environmental impact

Employees can win the rewards in a variety of ways, including meeting KPIs, with performance monitored by digital game links that they wear around their necks. It was important that the game be fair, inclusive and positive in nature so they can never lose points. And at the most basic level they can gain them for simply coming to work on time.

Managers have emphasised how personal KPIs are linked to business KPIs, for instance energy use. "If we go into the warehouse or goods area, we incentivise people to keep the doors shut as long as possible because 80% of our energy is used in refrigeration and freezer systems," says Tom. As a lot of energy is used in melting cheese for the

company's "croque top" products, KPIs are also linked to that particular team to encourage more efficient working practices.

Linking business and personal KPIs took on added significance during the project when Raynor Foods changed from being a family-owned business to an employee-owned trust. "We're all colleagues now. We have monthly colleague forums, which include representatives from across the business, where we meet up and discuss how we can improve things," explains Tom.

This greater agency within the company has also played into other ways that employees can win points, such as coming up with ideas that can help the organisation's sustainability goals. If an idea is implemented, points are then awarded according to the percentage of CO2 emissions they save. Employees can also win points by investing in themselves by taking courses, including English language classes for non-native speakers to help them better integrate into the company.

Once the gamification aspect is fully operational, there will be a phone app that allows employees to log in and check their progress, CO2 savings and scores.

"My feeling is that once the gamification programme is fully deployed and people start getting recognised and rewarded, it's going to seem like a very attractive thing to the whole workforce," says Ergün.

A voyage of discovery

As Raynor Foods is a large organisation producing 80,000+ sandwiches a day, implementing a major organisational transformation was bound to present challenges.

"The biggest challenge for us is obviously taking this project within the live environment. It's not a nice lab, where everything is done securely and nothing goes out at all. How do you control that?" says Thierry Batarriere, Senior Innovation Project Manager at Raynor Foods.

Tom is also keen to highlight some of the challenges they initially faced around the use of the digital links, notably the negative associations with the "Big Brother" practice of monitoring

employee performance. "We were very careful not to call them tags, and we received comments that 'you tag prisoners and cattle, not colleagues'," says Tom.

Staff had a number of other concerns ranging from "Does it emit harmful radiation?" to "Does it record sound?"

"Lots of questions like this came bubbling up, and we've done our best to address each one of those queries in a reassuring way," says Tom.

But despite the challenges, Tom and Thierry are already impressed with the project and are looking forward to the full gamification process being implemented.

They're also hoping the project will have an impact outside the workplace. Having realised that family was such an important motivating factor for the Raynor Foods workforce, Ergün took steps to emphasise how issues such as climate change could affect them personally and how adopting sustainable practices in their day-to-day lives could mitigate that.

Turning carbon champions on the shop floor into carbon champions at home can only make everyone involved a winner.

Becoming a "National Demonstrator"

Raynor Foods are hoping to become a "National Demonstrator", highlighting how others could use the combination of smart people, smart factories and smart practices to tackle their own sustainability goals.

"We have to be a microcosm of where the industry needs to be, because we can't do it by ourselves," says Tom. "We want to inspire people to follow us, showcasing how some of the technology we're using can help engage the workforce."

You can find out more about the project and ways to engage through their website: <https://www.s3project.net/>.



Dr Ergün Güngör,
Research Associate,
Centre for Industrial Sustainability

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IT'S NOT ALL ABOUT MONEY. IT'S ABOUT ACHIEVEMENT, RECOGNITION, DEVELOPMENT AND WANTING QUALITY TIME WITH FAMILY.



Watch the webinar

Project leads from consortium partners, including Raynor Foods, the IfM and Software Imaging, cover how the project is delivering real-time carbon monitoring and motivating the workforce through demonstrating carbon reductions.



UNDERSTANDING INDUSTRIAL SCOPE 3 EMISSIONS: WHAT, WHY, HOW

Although initially seen as secondary by most corporate-level standards, Scope 3 is now an important focus for corporations in the push to net zero, as new evidence points to its significance.

Here, Cambridge Industrial Innovation Policy's Dr David Leal-Ayala explores the meaning of Scope 3, its relevance and how businesses can approach this challenge. He draws upon the White Paper, The "No-Excuse" Opportunities to Tackle Scope 3 Emissions in Manufacturing and Value Chains, published by the World Economic Forum's Industry Net Zero Accelerator Initiative.

More than two decades ago, the Greenhouse Gas Protocol (GHG Protocol) defined emissions scopes as a way of classifying carbon sources. According to the GHG Protocol, Scope 3 emissions encompass all indirect emissions not included in Scope 2, which occur throughout the value chain of the company reporting them, including those from upstream and downstream sources.

In other words, most of a business's Scope 3 emissions are the Scope 1 and 2 emissions of another business/individuals. While these emissions are

not fully under a firm's control, that firm may be able to affect the activities that result in them, influence its suppliers and/or choose which suppliers to engage with.

The GHG Protocol corporate standard classifies Scope 3 emissions into 15 different categories, as shown in Figure 1. Although not all categories are relevant to every organisation, they provide a structured framework to understand, measure, report and monitor Scope 3 sources of emissions across a value chain.

Why does Scope 3 matter?

Scope 3 emissions can account for more than 70% of a business's carbon footprint, based on data from the UN Global Compact. Figure 2 highlights that different industries face different Scope 3 situations and challenges.

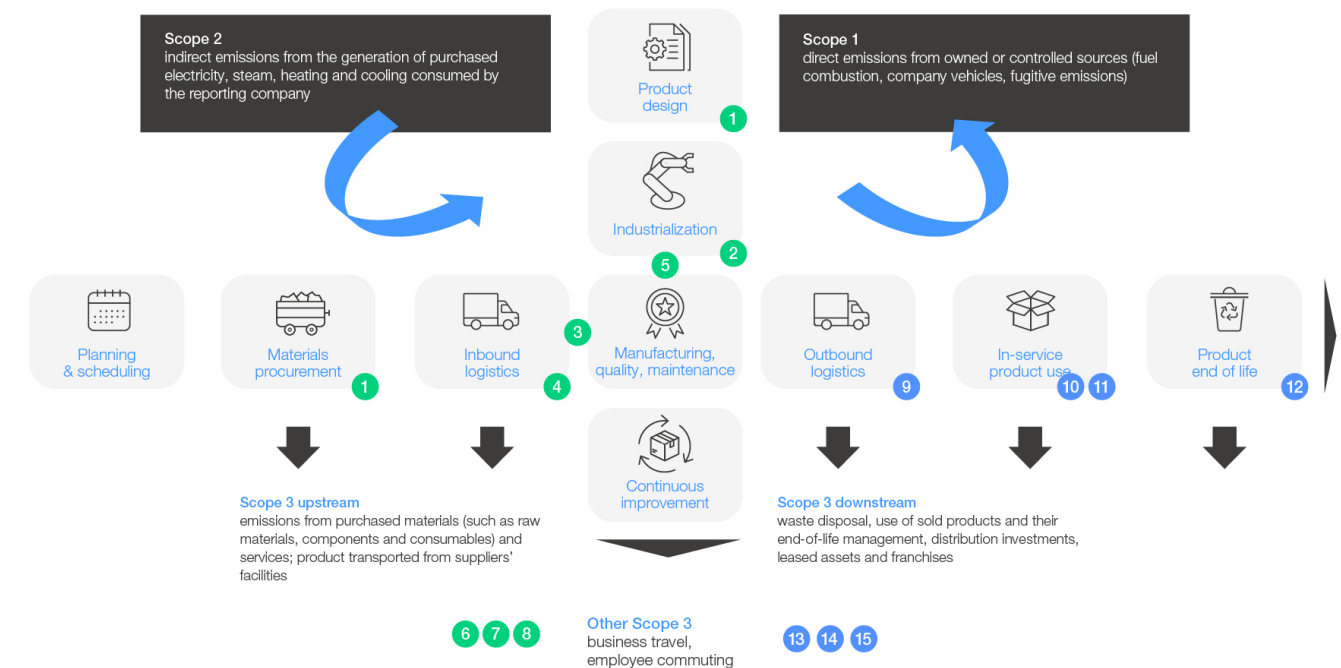
While industries such as cement and concrete, and transport services and logistics, have lower Scope 3 emissions, this category becomes significant for other industries, including chemicals, electronics, automotive and food. Consequently, any decarbonisation

Industry Net Zero Accelerator Initiative

The "No-Excuse" Opportunities to Tackle Scope 3 Emissions in Manufacturing and Value Chains



Scope 3 categories



Scope 3 categories

Upstream	Downstream
1 Purchased goods and services	9 Downstream transportation and distribution
2 Capital goods	10 Processing of sold products
3 Fuel- and energy-related activities	11 Use of sold products
4 Upstream transportation and distribution	12 End-of-life treatment of sold products
5 Waste generated in operations	13 Downstream leased assets
6 Business travel	14 Franchises
7 Employee commuting	15 Investments
8 Upstream leased assets	

Figure 1. Extracted from World Economic Forum, The "No-Excuse" Opportunities to Tackle Scope 3 Emissions in Manufacturing and Value Chains, December 2023.

efforts in these sectors are likely to require intense cooperation among original equipment manufacturers (OEMs), consumer brand companies and suppliers.

Based on CDP data, Scope 3 category 1 (purchased goods and services) and Scope 3 category 11 (use of sold products) combined represent 84% of reported Scope 3 emissions (see Figure 3). However, reporting is often incomplete, with many industries omitting several Scope 3 categories. As indicated by the CDP, only 16% of organisations were able to share details of their supply-chain engagement strategy, while only 11% could do so for their portfolio of low-carbon products and services.

How is Scope 3 calculated and reported?

Carbon accounting standards underpin the measurement and reporting of carbon emissions as well as the tracking of organisational performance against abatement strategies and targets.

Carbon accounting standards can be classified into two main categories:

- Corporate carbon footprint (CCF): CCF is the total sum of GHG emissions directly or indirectly generated by a company's activities during a specific period of time.
- Product carbon footprint (PCF) and lifecycle assessment (LCA): PCF is the total GHG emissions generated

by a product from the extraction of its necessary raw materials to its end of life. LCA studies the environmental aspects and potential impacts throughout a product's life cycle, from raw materials acquisition through to production, use and disposal.

The variety of standards available makes it challenging for organisations to select the right one and ensure comparability of results across firms and sectoral, regional, and national aggregation. and PCF.

Other CCF standards include the EU Organisation Environmental Footprint (OEF), as well as the Global Reporting Initiative (GRI) and Department for

Environment, Food & Rural Affairs (Defra) guidance (UK). Additional PCF standards include the EU Product Environmental Footprint (PEF), BP X30-323 in France, and Publicly Available Specification (PAS) 2050.

To estimate emissions, companies use formulas to multiply the volume of their activities (e.g. purchased materials, transport) with emission factors (EF), which are representative values that attempt to relate the quantity of a pollutant released into the atmosphere with the activity releasing the pollutant. Finding the right EF is not an easy task because it is necessary to ensure its geographic relevance and its scale of application (national/regional or site-specific), and that it is well documented.

Several public and private EF databases exist and should be selected depending on their application, as they use either generic or geographic/sector-driven emissions estimates.

Examples of recognised EF databases include:

- GHG Protocol emissions factors databases
- Intergovernmental Panel on Climate Change (IPCC)
- Emission Factor Database (EFDB)
- Institute for Global Environmental Strategies (IGES) List of Grid Emission Factors
- World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD) Greenhouse Gas Protocol Calculation Tools

- US EPA Air Pollutant Emission Factors AP-42 – Life-cycle databases (e.g. ecoinvent).

Why must companies measure Scope 3 emissions?

Although current Scope 3 standards push for voluntary disclosure, this might change, as governments and organisations are increasingly pushing for mandatory disclosure as a basis for climate action planning. Scope 3 reporting has garnered increasing significance in light of new regulations, such as the following:

The EU Corporate Sustainability Reporting Directive (CSRD) is a pivotal European Union directive aiming to standardise sustainability reporting

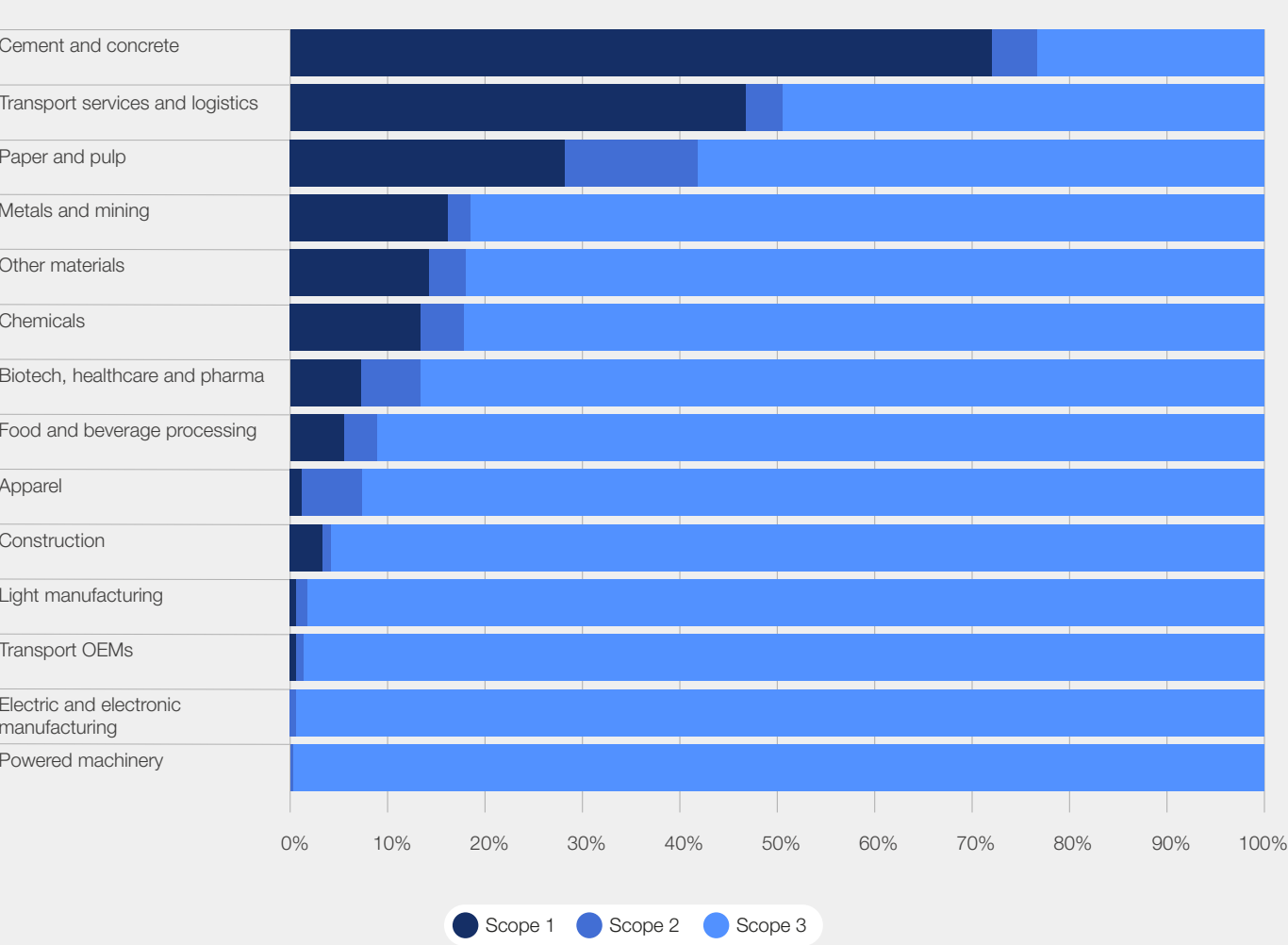


Figure 2. Extracted from World Economic Forum, The “No-Excuse” Opportunities to Tackle Scope 3 Emissions in Manufacturing and Value Chains, December 2023.

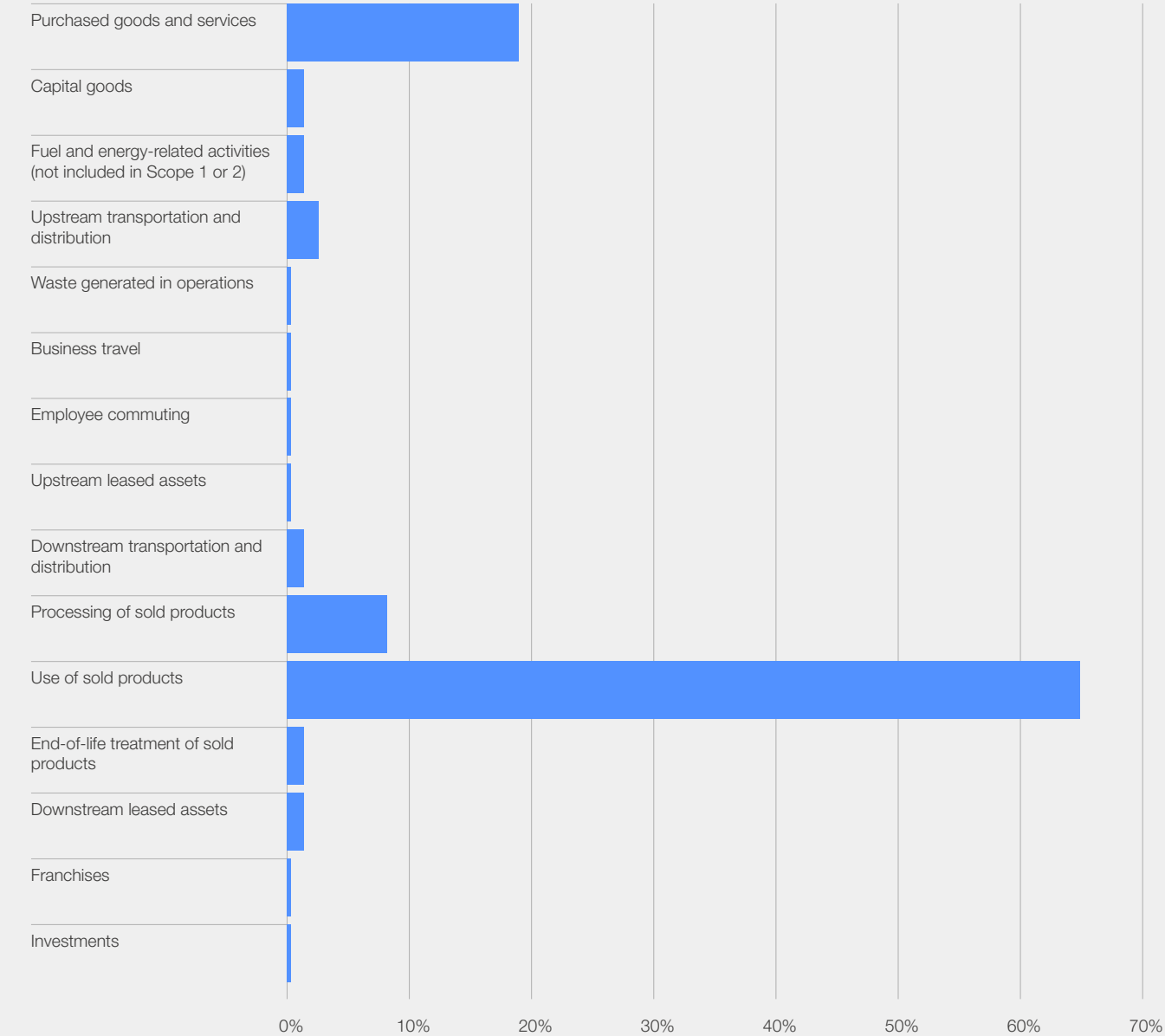


Figure 3. Extracted from World Economic Forum, The “No-Excuse” Opportunities to Tackle Scope 3 Emissions in Manufacturing and Value Chains, December 2023.

Table 1. Actions to reduce Scope 3 emissions

Scope 3 category	Examples of actions to reduce Scope 3 emissions
1. Purchased goods and services	<ul style="list-style-type: none">• Replace high-GHG-emitting raw materials with low-GHG-emitting ones• Implement low-GHG-procurement/purchasing policies, possibly using the Total Sustainable Cost of Ownership (TSCO) as a weighted objective• Encourage Tier 1 suppliers to engage the reporting company’s Tier 2 suppliers, and disclose these Scope 3 emissions to the customer in order to propagate GHG reporting throughout the supply chain
2. Capital goods	<ul style="list-style-type: none">• Replace high-GHG-emitting capital goods with low-GHG-emitting ones
3. Fuel- and energy-related activities (not included in Scope 1 or Scope 2)	<ul style="list-style-type: none">• Reduce energy consumption• Shift towards lower-emitting fuel/energy sources• Generate energy onsite using renewable sources
4. Upstream transportation and distribution	<ul style="list-style-type: none">• Reduce distance between supplier and customer• Source materials locally• Optimize efficiency of transportation and distribution• Replace higher-emitting transportation modes (e.g. air transport) with lower-emitting modes (e.g. marine transport)• Shift towards lower-emitting fuel sources
5. Waste generated in operations	<ul style="list-style-type: none">• Reduce quantity of waste generated in operations• Implement recycling measures• Implement lower-emitting waste treatment methods
6. Business travel	<ul style="list-style-type: none">• Reduce the amount of business travel and encourage online meetings• Encourage more efficient and lower-emitting modes of travel
7. Employee commuting	<ul style="list-style-type: none">• Create disincentives for commuting by car (e.g. parking policies)• Incentivise use of public transport, cycling, carpooling, etc.• Implement teleworking/telecommuting programmes• Reduce number of days worked per week
8. Upstream leased assets	<ul style="list-style-type: none">• Increase energy efficiency of operations• Shift toward lower-emitting fuel sources
9. Downstream transportation and distribution of sold products	<ul style="list-style-type: none">• Reduce distance between supplier and customer• Optimize efficiency of transportation and distribution• Replace higher-emitting transportation modes (e.g. air transport) with lower-emitting modes (e.g. marine transport)• Shift towards lower-emitting fuel sources
10. Processing of sold products	<ul style="list-style-type: none">• Improve efficiency of processing• Redesign products to reduce processing required• Use lower-GHG energy sources
11. Use of sold products	<ul style="list-style-type: none">• Develop new low- or zero-emitting products• Increase the energy efficiency of energy-consuming goods or eliminate the need for energy use• Shift away from products that contain or emit GHGs• Reduce the quantity of GHGs contained/released by products• Decrease the use-phase GHG intensity of the reporting company’s entire product portfolio• Change the user instructions to promote efficient use of products
12. End-of-life treatment of sold products	<ul style="list-style-type: none">• Make products recyclable and implement recycling measures that lead to net GHG reductions• Implement product packaging measures that generate net GHG reductions• Improve traceability of products to optimize their use and maximize recycling
13. Downstream leased assets	<ul style="list-style-type: none">• Increase energy efficiency of operations• Shift towards lower-emitting fuel sources
14. Franchises	<ul style="list-style-type: none">• Increase the energy efficiency of operations• Shift towards lower-emitting fuel sources
15. Investments	<ul style="list-style-type: none">• Invest in lower-emitting investments, technologies, and projects

Extracted from: World Economic Forum, *The “No-Excuse” Opportunities to Tackle Scope 3 Emissions in Manufacturing and Value Chains*, December 2023.



practices among large companies and listed small and medium enterprises (SMEs) operating within the EU. It significantly expands the scope of reporting by requiring companies to disclose detailed information on environmental and social matters, including Scope 3 emissions. This directive came into force on 5 January 2023, with the first companies having to apply the new rules for the first time in the 2024 financial year, for reports to be published in 2025.

The International Sustainability Standards Board (ISSB) is a standard-setting body under the International Financial Reporting Standards (IFRS) Foundation, whose mandate is the creation and development of sustainability-related financial reporting standards to meet investors’ needs for sustainability reporting. The ISSB’s work is underway to develop sustainability disclosure standards, including on Scope 3 GHG emissions, backed by the G7, the G20, the International Organization of Securities Commissions (IOSCO), the Financial Stability Board, African Finance Ministers and Central Bank Governors from more than 40 jurisdictions. Although not mandatory, the new ISSB standard aims to significantly improve carbon accounting harmonisation – including sectoral specifics – to allow investors to make more informed green funding decisions.

Both these initiatives underscore the growing importance of holistic, comparable and auditable reporting to drive sustainability efforts and meet the increasing demand for transparency in the business world.

How are companies reducing Scope 3 emissions today?

Organisations around the world are implementing a range of approaches and actions to reduce their Scope 3 emissions. Table 1 shows selected examples of actions to reduce Scope 3 emissions, as suggested in the GHG Protocol Scope 3 Standard.

A practical roadmap for businesses

There is no shortage of challenges in reducing Scope 3 emissions, and both SMEs and industry giants struggle to navigate the complexities involved in this task.

However, through extensive research and consultations with industry leaders and academic experts, the World Economic Forum’s Industry Net Zero Accelerator initiative identified 12 opportunity areas to help companies in their decarbonisation journey, and these, grouped into four action levels, inform strategic decisions.

Details of these opportunities can be found in the White Paper *The “No-Excuse” Opportunities to Tackle Scope 3 Emissions in Manufacturing and Value Chains*, which serves as a practical roadmap for businesses navigating the intricate terrain of Scope 3 decarbonisation and accelerating their contributions to global climate efforts.



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The World Economic Forum’s Industry Net Zero Accelerator Initiative

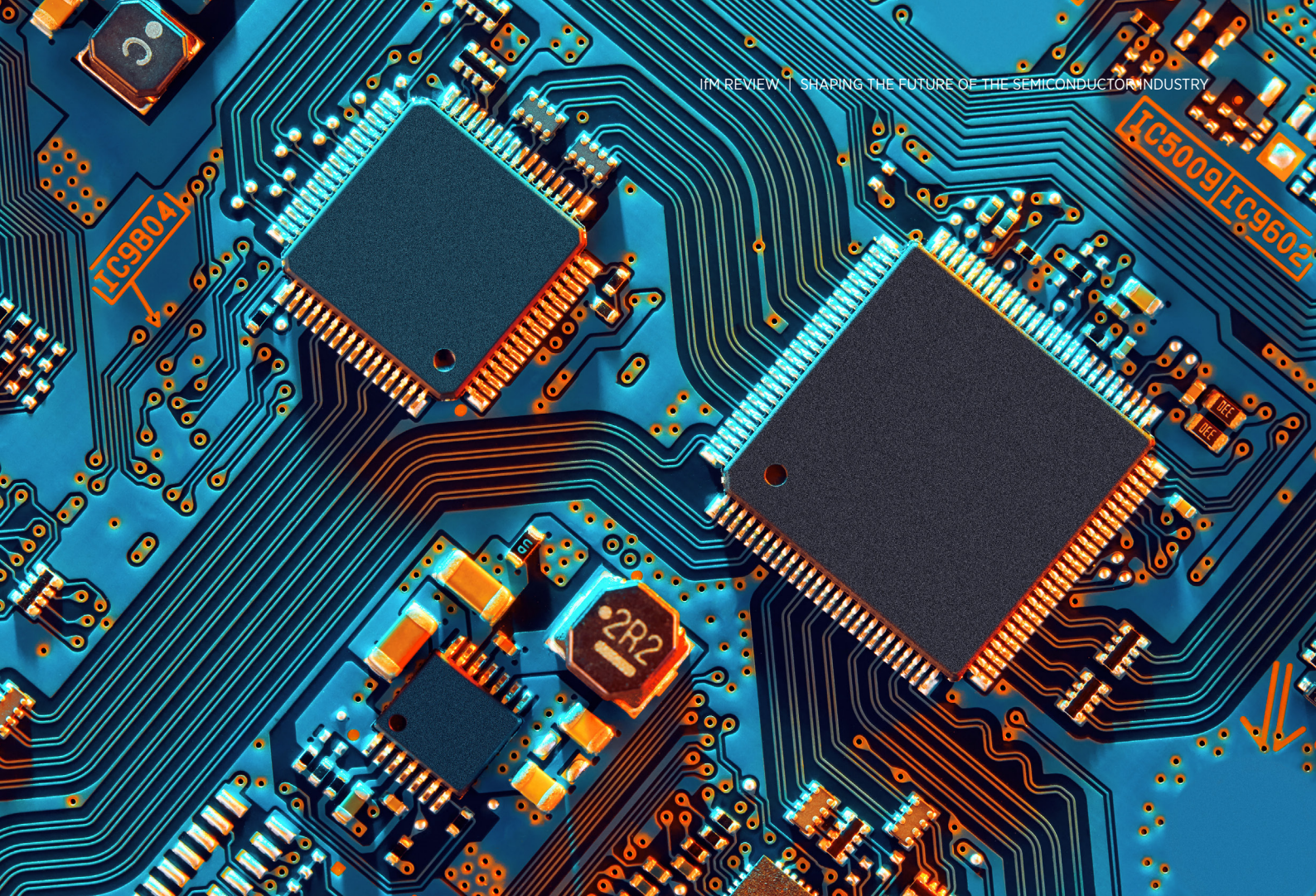
This article draws from the White Paper **The “No-Excuse” Opportunities to Tackle Scope 3 Emissions in Manufacturing and Value Chains**, published by the World Economic Forum’s Industry Net Zero Accelerator Initiative and co-authored by CIIP’s David Leal-Ayala.

The White Paper is part of a series of activities aimed at helping businesses collaborate and speed up the change across industrial sectors. It highlights emerging opportunities and best practices to inspire leaders in both private and public sectors to take action and drive the net-zero transformation of global supply chains without any excuses.

The World Economic Forum launched the Industry Net Zero Accelerator initiative in 2022 in partnership with knowledge partners Cambridge Industrial Innovation Policy and Capgemini, Rockwell Automation, and Siemens. It also involves a community of over 30 global manufacturing companies to help accelerate the industry’s transition to net zero. The initiative provides a platform for a growing community of industry leaders, technology providers, and academic experts to encourage knowledge sharing and actionable solutions towards achieving net zero.

Download the White Paper:





SHAPING THE FUTURE OF THE SEMICONDUCTOR INDUSTRY

The creation of the UK Semiconductor Institute, recommended by **IfM Engage** in a Department for Science, Innovation and Technology-commissioned report and supported by the Semiconductor Advisory Panel, aims to create long-term momentum for the industry.

The report was the result of a ten-month study, during which data and information was collected from over 185 organisations and 400 individuals from across the UK.

Background

Semiconductors are vital components of electronic devices and are widespread in the modern world. They play a vital role in shaping the economy and national security and are present in almost every aspect of our daily lives.

Experts predict that the global semiconductor market will grow annually by 6% to 8% and exceed \$1 trillion by 2030. Consumer products, such as laptops or smartphones, are likely to be the primary driver of this growth. However, the recent pandemic and geopolitical tensions have exposed the sector's fragility, revealing how semiconductor supplies can quickly stall. Maintaining and developing UK expertise and expanding the country's role in global semiconductor supply chains is crucial.

Although it represents only around 2% of the global semiconductor market, the UK is distinguished by its world-leading expertise in chip design, intellectual property and proficiency in packaging and compound semiconductors, excelling in materials and processes across various applications.

The Challenge

In May 2023 the UK Department for Science, Innovation and Technology (DSIT) released a national semiconductor strategy outlining the UK's 20-year vision to establish a strong foundation in semiconductor technologies. Key aspects of the strategy included plans to build on UK strengths in IP and design, compound semiconductors and R&D, while also focusing on increasing supply chain resilience and protecting national security. Initiatives included the UK Semiconductor Infrastructure Initiative, a pilot incubator programme for start-ups, expanded investment in R&D, talent development through apprenticeships and doctoral training, and support for semiconductor-related education.

The DSIT commissioned IfM Engage, the knowledge transfer arm of the IfM, and its consortium partners to assess the feasibility of establishing infrastructure to support commercial R&D and strategic coordination functions within the UK semiconductor industry. The goal was to investigate the current provision of semiconductor infrastructure in the UK, the industry's needs and any gaps in the innovation ecosystem, focusing on how to address them to boost both the industry and the UK economy.

Collaborating with organisations in the UK semiconductor industry, such as the Compound Semiconductor Applications Catapult, the Photonics Leadership Group, Silicon Catalyst UK, Techworks, Semiwise, Imperial College, the University of Leeds and Future Horizons, IfM Engage oversaw a 10-month study to tackle the complex landscape of the industry.

The Approach

The project aim was to gain a deep and holistic understanding of the UK semiconductor industry and its complex challenges.

Led by Dr Nicky Athanassopoulou, Head of Solution Development at IfM Engage, the project adopted a systematic methodology that involved extensive data gathering from various national and international sources, data validation workshops with industry and academia, a comprehensive gap analysis, and a series of open presentations of preliminary findings across major UK semiconductor clusters. Central to the study's success were its principles of impartiality, transparency, inclusivity, collaboration and a commitment to incorporating multiple perspectives.

The study was organised around five distinct work packages, each focused on essential aspects of semiconductor development, ranging from manufacturing capabilities to strategic coordination frameworks and the econometric analysis of various options.

"What set this study apart," said Nicky, "was its comprehensive engagement strategy, which involved a wide range of stakeholders, including commercial entities, academic institutions and government bodies. Over 185 organisations and 400 individuals contributed their insights, ensuring both a diversity of perspectives and identification of the most important requirements across the sector."

The project began with a refined methodology, carefully crafted surveys and strategic planning to ensure comprehensive data collection. In May 2023 the first survey was launched to capture user needs, with invitations sent to over 180 UK organisations, marking the start of an extensive information-gathering effort.

Building on this foundation, a second survey in June 2023 focused on mapping the UK's existing

semiconductor infrastructure. This phase targeted over 40 organisations and encouraged broad participation, highlighting capabilities within universities. This data was supplemented with reviews and analyses of a variety of market research and numerous industry and other national and international reports.

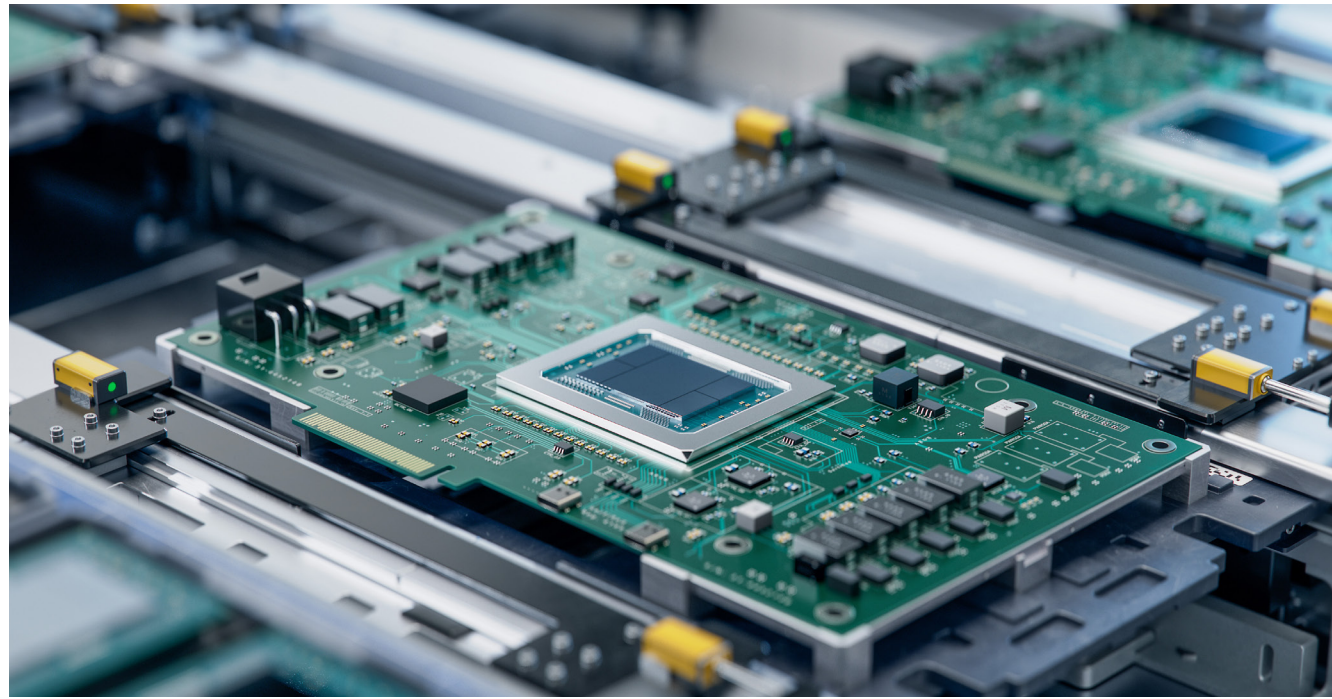
To structure and validate these findings, the project leveraged S-Plan Strategic Roadmapping, a proven method developed by the IfM over 25 years. Through a series of workshops, the team analysed identified needs and capabilities, validated market gaps and failures, and laid the groundwork for targeted interventions to strengthen the sector.

In September 2023 the project team visited the six major UK semiconductor clusters: Northern Ireland, Scotland, the North East, Bristol, South Wales and Cambridge. These visits led to in-depth discussions on intervention scenarios and stakeholder preferences. In October 2023 we consulted additional major UK end users, exploring potential support for the infrastructure initiative, which resulted in prioritising intervention scenarios.

Initial findings and recommendations were brought together in a detailed report and shared with the DSIT to guide government analysis, decisions and future actions.

The study:

- Identified the benefits and feasibility of developing different capabilities, including understanding the industry needs and user base, what is required to meet those needs, and options for institutional models that could deliver these requirements.
- Recommended options to set up a new national institute to coordinate the UK semiconductor sector, support R&D priorities and provide access to infrastructure to boost commercial innovation in areas where the UK has, or could have, strategic advantage, such as CMOS post-processing, chip design, compound semiconductors and next-generation packaging technologies. This included investigating the economic and financial case, options for sustainable financing, estimated set-up and running costs, and potential benefits to the UK, such as the impact on GDP and employment.



IfM Engage and its partners have led a national study on a crucial aspect of developing our domestic semiconductor sector: the necessary infrastructure for R&D translation and scaling up production. Our findings, which reflect a multitude of perspectives and strong collaboration across the industry, have played a vital role in the founding of the UK Semiconductor Institute, ensuring a robust future for the UK semiconductor industry.”

Dr Nicky Athanassopoulou,
Head of Solution Development,
IfM Engage.

The Impact

By identifying the benefits and feasibility of the required capabilities, the study offered a clear understanding of industry needs and potential coordination models. The study yielded important insights and recommendations for the UK Semiconductor Infrastructure Initiative and led to the decision to create a new independent UK Semiconductor Institute.

Key impact outcomes were:

- **The decision to create a new independent UK Semiconductor Institute.** Following a key recommendation from the study, the new institute, announced in June 2024, will spearhead efforts to grow the semiconductor sector as part of the government’s £1 billion strategy. Operating independently from the government, it will amplify the industry’s voice and serve as a central hub to attract investors and boost foreign investment in British semiconductor companies.
- **Collaborative approach and industry alignment.** Through roadshows involving more than 80 participants across key UK semiconductor clusters, the study ensured that its recommendations reflected industry needs. IfM Engage promoted collaboration between government, industry, academia and finance, laying the groundwork for a cohesive and strategic plan to grow the UK semiconductor sector.

“The involvement of over 80 participants during roadshows across various UK semiconductor clusters ensured that the recommendations were aligned with industry needs. IfM Engage played a pivotal role in facilitating collaboration among government, industry, academia and finance, contributing to a strategic plan for enhancing the UK semiconductor sector,” stated Nicky Athanassopoulou.

“IfM Engage was well positioned to unite industry and academia for this study, and we are excited that our efforts will support the growth of the UK’s domestic semiconductor industry, promote innovative UK developments and maintain a secure supply for critical national infrastructure,” said David Lott, CEO of IfM Engage.

Learn more about IfM Engage
and the UK Semiconductor
Infrastructure Initiative:



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