



Manufacturing and materials week

The green recovery

30 November-3 December 2020

Report



Decarbonisation:
opportunities for the
manufacturing sector
11th National Manufacturing Debate (NMD)

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Foreword



Professor Mark Jolly

Director of Manufacturing,
Cranfield University

Manufacturing and materials week included a mix of live debates, lectures, workshops and pre-recorded videos, looking at the challenges the industry faces right now, as well as how we must adapt and innovate to support future global challenges such as achieve a Net Zero manufacturing sector by 2050.

The inaugural week-long event that built upon long standing events such as the Manufacturing alumni awards, the National Manufacturing Debate and Manufacturing 2075 gave the opportunity explore the pivotal role of manufacturing in everyday life. Taking these events to the next level, the week showcased that society needs to accept manufacturing as part of our lives and how it can support our future. Our digital devices, tables and chairs, right down to our pots and pans – all part of manufacturing! But they use resources, materials and energy, and so as a population, we must be responsible custodians of our planet for the sake of future generations.

Through research and teaching, Cranfield University, alongside industry is working to solve problems of the future. Post Covid-19, manufacturing has the potential to address important psychological and social challenges.

Decarbonisation: opportunities for the manufacturing sector

11th National Manufacturing Debate (NMD)



National Manufacturing Debate

Decarbonisation: opportunities for the manufacturing sector

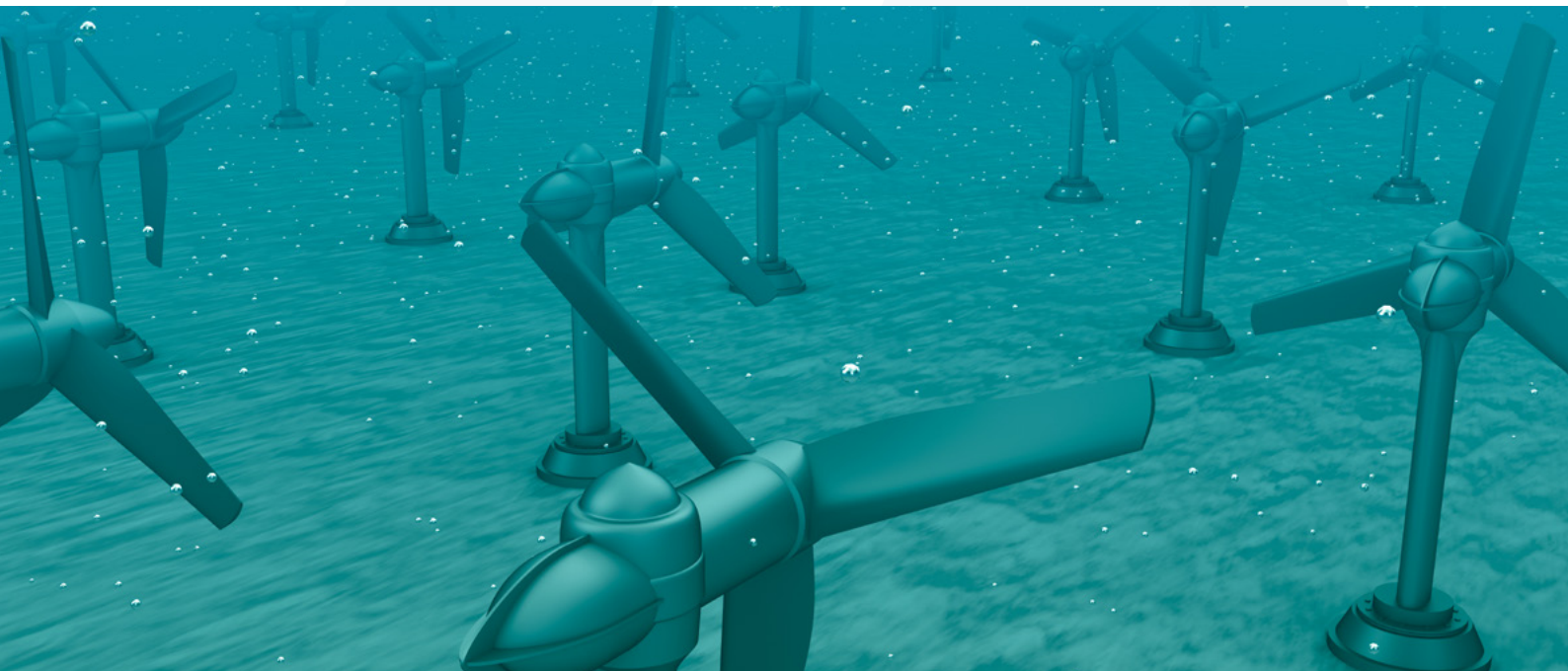
Is British manufacturing ready to seize the net zero opportunities and is it really possible for decarbonisation to enhance the UK's competitiveness?

Who could have imagined that when we postponed this event back in the spring, that we would still have had to remain virtual in December? This, our eleventh year, was set to be bigger than ever before! However we have embraced the online format, with the week-long event allowing us to truly celebrate the work in the manufacturing and materials theme across Cranfield University.



Professor Mark Jolly

Director of Manufacturing,
Cranfield University



Introduction

Rosa Wilkinson is Communications Director at the UK's principle agent of industrial transformation, the High Value Manufacturing Catapult (HVMC). Rosa introduced the debate, proclaiming the National Manufacturing Debate as the centrepiece of this exciting week-long programme.



Rosa Wilkinson

Communications Director,
High Value Manufacturing Catapult

CATAPULT
High Value Manufacturing

Despite the online format, it has attracted a strong audience from industry, academia, Government, and research organisations. The key features of the debate remain the same, with it focusing on the critical issue of decarbonisation, looking at the opportunities and challenges for the sector, and whether it can support UK competitiveness.

Rosa introduced a stellar cast of speakers who, following their presentations, answered questions posed by Rosa and the audience.



Dr Jason Jones

CEO and Co-founder, Hybrid Manufacturing Technologies

In joining the debate live from Texas, Jason proved the immediate value of the new virtual format. His focus is around driving decarbonisation within digital manufacturing with his presentation framed by something that first made him conscious of using resources wisely- a fridge magnet: Use it up, wear it out, make it do or do without.

We all use electricity and energy in various forms, and of the nine (or so) ways of generating energy, five are renewable. It is clear to all that a shift from coal to natural gas is environmentally friendly but the challenge is to make the social and economic elements work together as well. While coal is the least environmentally-friendly way of generating electricity, it remains the cheapest.

We now need to drive manufacturing by digital means - for example CNC and 3D printing - to open up huge possibilities. Additive manufacturing allows us to make unusual shapes that are otherwise impractical, enabling us to use multiple materials and creating less waste. Together with subtractive manufacturing, we create a hybrid manufacturing capability, including processes that allow us to add, subtract and inspect things.

Use it up, wear it out

Using the wisdom of a simple fridge magnet, we need to simply design and make things that last longer.

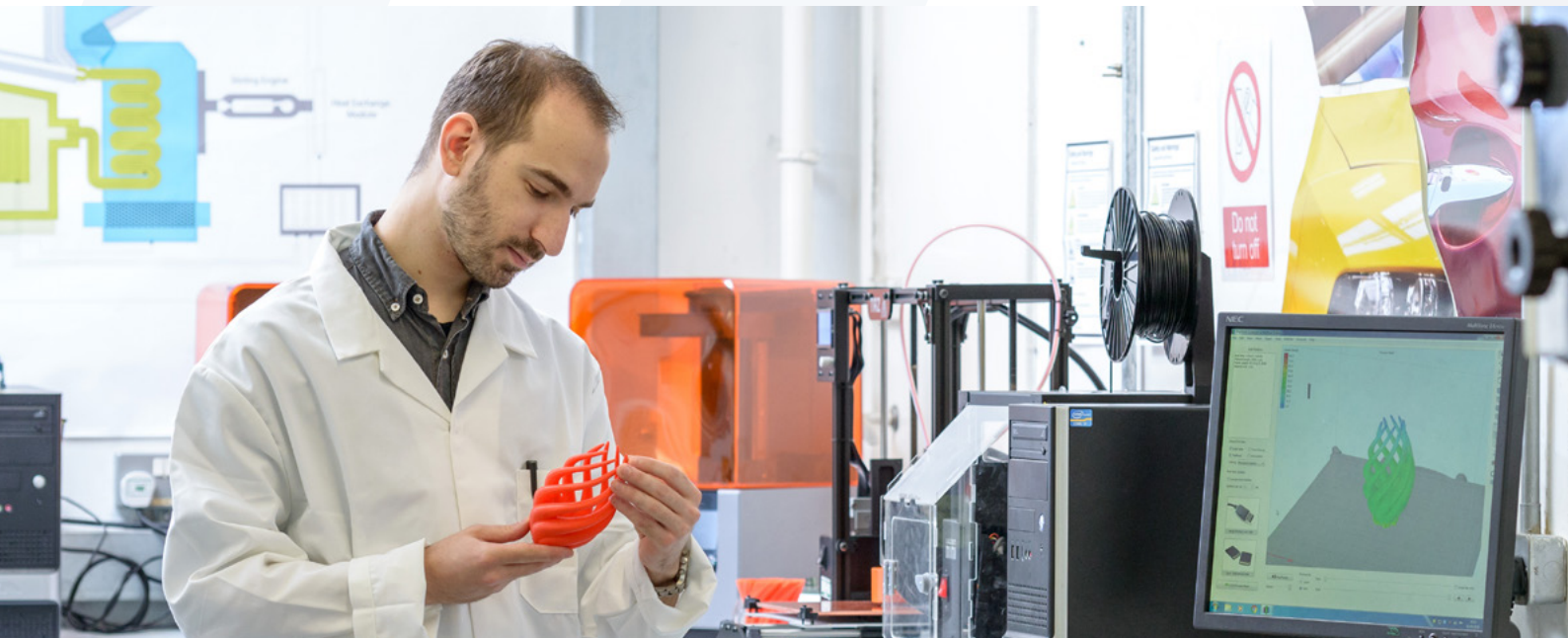
Make it do (more)

We use a fraction of the energy and materials when we rebuild and restore functionality - otherwise known as remanufacturing. Additive, subtractive and hybrid manufacturing allows us to do new things but also to leverage the capabilities we have. As an example, when repairing turbine blades, it is possible to both repair and make changes to the robot structure and efficiency of a turbine, enhancing the functionality and improving the output for each blade in the process. This resulted in an increased electricity output of 90 gigawatts per hour.

Or do without

Here the question is what can we do without? The answer: processes that consume tremendous amounts of energy. We should only heat locally where needed and use less materials. Through distributed manufacturing models we can reduce shipping and operate at much shorter scales. This can also help to avoid exporting environmental issues to less regulated regions and simply moving the problem elsewhere.

We need to take a step back and look at how we shape mindsets in the future. The mantra of the fridge magnet speaks to this - use less materials, less energy, focus on local manufacturing, and avoid exporting the environmental problems elsewhere. This is about longevity and energy conservation. We are looking for the triple win - for the environment, for society and for the economy. If people can be armed with the right information in order to spend their money wisely, they can be part of the decarbonisation solution.



While Jane's day job is focused on recycling and decarbonisation in the resilient flooring sector, the challenges and opportunities they face resonate across the entire manufacturing industry. Her presentation focused on two points: the importance of working with the entire value chain, and the need to look at the end of life of a product from the early design stage.



Jane Gardner
Managing Director, European
Resilient Flooring Manufacturers
Institute

Building and construction accounts for 40% of global CO₂ emissions as well as 40% of the energy consumption across Europe. Construction products, such as flooring, piping, windows and insulation, play a huge role in this. These products, many of them plastic, have a long life span of between 20 to 100 years. This longevity alone is a huge benefit, reducing the need for carbon intensive renovation.

However we need to look at the construction product value chain and examine all the factors contributing to decarbonisation. We cannot look at the manufacturing phase in isolation and must also consider logistics, distribution, building use, refurbishment, and ultimately, demolition. Within this value chain there are opportunities for decarbonisation - through the choice of raw materials, the processes we use, the disassembly design, logistics and backhaul. If we start with end of life in mind, we can consider the provision of secondary raw materials, allowing manufacturers to take back waste to ensure quality input of recycled materials into the next generation of products.



Using the distribution chain for backhauling waste is a prime example of how the resilient flooring industry is working to reduce carbon emissions. Jane shared how companies, Altro (based in Letchworth) and Polyflor (Manchester), have worked together since 2009 to collect post installation waste and uplifted flooring to increase the recycled content in their new products. They established drop off points at 57 distributors across UK, with the fitters able to drop off old flooring when picking up new products. The key success factors for this included collaboration, engagement of all the actors in the value chain, but also educating, incentivising, and rewarding the supply chain.

This example of backhauling is successfully diverting waste away from landfill and into new products. It saves waste management costs and in some cases can even make it cost neutral - backhauling materials in vehicles that would have previously returned empty. Reusing this material can have a huge impact, with Jane citing a hospital in Newcastle in which the recycled content in the vinyl flooring, rather than using 100% virgin material, saved 0.2kg of CO₂ per square metre. With more than 60,000 sqm of flooring provided, it has saved 12,000kg of CO₂ to date.

If we can start by looking at end of the product lifecycle, we will always be considering how we capture materials to use in the next product. To achieve this, as Jason explained in the presentation before, communication is key, with digitalisation and tracking becoming an essential part of the successful process.



Dr Colin Herron CBE

Managing Director,
Zero Carbon Futures

In considering how the unknown will impact on manufacturing, Covid-19 has been one of these massive unknowns and has had a huge impact on the industry this year. Using the example in the UK where some shops were allowed to open during the lockdowns, and others were not, he posed the question, how do we determine what is essential?

Colin also asked questions around how will behaviours change, pointing to the positive impact of David Attenborough's documentaries, on our impact on the environment, but also how will behaviours have to change, whether this be through taxation or through political will?

With a manufacturing career that has spanned 47 years, one which started in the shipyards on the River Tyne, Colin warned of repeating mistakes of the past. We cannot simply replace one product with another. With many Governments keen to pursue electric vehicles, we cannot ignore the issues that will remain. Of course emissions may drop but we will still require materials to build the cars, which will continue to create congestion on our roads. Seeing people using 3-4 litre vehicles for a quick trip to the supermarket, when clearly a 1 litre car would suffice, we shouldn't be wasting our resources based on ego or wealth. What might be great for an episode of Top Gear is not so for society as a whole.

There is also debate around electric vehicles and whether they will really result in zero emissions? While there is no tail pipe in the vehicle, what about the whole emission lifecycle? How do we understand what zero emissions actually mean? Surely this should be more an aspiration to use minimum carbon, rather than zero?

Colin shared his personal pet hate that the Earth's resources are being used in seemingly unnecessary products, including patio heaters and above door heaters. Surely a warm jumper would suffice? On to petrol leaf blowers where a Google search brings up hundreds of fuel-guzzling garden contraptions - why not use a broom? The question is, should we be allowed to make these products? Back to the issue of lockdown shopping, whatever is determined essential is certain to drive the political landscape

Colin reflected on his time at Nissan. When he joined the business, output was measured in Quality, Cost, and Delivery (QCD). This moved to EQCD (adding Environment up front), but has gone even further to become E2QCD; the squared (second) E stands for Ethics, something he feels our industry has not done so well to date. In addition to decarbonisation, we must also consider the ethics around manufacturing - when we see images of children mining for gold in Africa, surely we must also look at the ethical impact of our carbon footprint.



In this increasingly complex world we need to understand how to manage the energy transition. Nazmiye reflected on a conversation a few years ago with a banker about the subject of energy efficiency. Unlike food or health and safety where corrective reactions to issues are immediate, anything with the words 'energy efficiency' are invariably dismissed by the Board if they require more than a one-year payback. This simply must change, not least because the cost of energy is certain to increase due to the increase in use of renewables required to decarbonise the power system.



Dr Nazmiye Ozkan

Senior Lecturer in Energy Economics and Head of Centre for Energy Systems and Strategy, Cranfield University

Nazmiye explained where she sees the opportunities to respond and take action - and where this is already happening:

1. The UK Government's focus on creating industrial clusters (Teeside, Merseyside, Humberside, Southampton, South Wales, Grangemouth) helps to create a better resource efficiency, with cost effective infrastructure being developed (hydrogen or carbon capture) and help for facilities to deal with the uncertainties in market conditions.
2. Linked to this, we can look at Local Energy Systems, using excess waste, heat and onsite generation (solar and wind) to serve local communities. Delivering great economic value, this is also ethically sound, supporting and engaging with the local communities.
3. There is a move from a Single Supplier Hub to a Multi-Gub energy market, with hydrogen set to play key role in meeting industrial energy demand. Traditionally any end user has an agreement with a supplier but in the future, we will see complex, multi-vector, energy systems, operated by separate stakeholders, including prosumers, engaging with different actors to purchase energy needs. We are already seeing large industrial users, such as Tesco and Sainsbury's making agreements with National Grid to shift energy use to out-of-hours.

Echoing the sentiments of her fellow speakers, Nazmiye believes digitisation will play a key role in enabling us to address energy challenges. Data can predict onsite variable generation, taking part in demand side response, optimising the process, and helping to deliver real-time actions in response to market conditions.





Ben Peace
Head of Manufacturing, KTN



This is a period of incredible change across industry and society as a whole. It provides the golden opportunity to make changes to our industry in order to build back better.

of ourselves. Here in the UK our strengths lie in specific areas, including design, the customer journey, business models, and digital technology. KTN itself has recently launched their new brand and are looking at things differently. They have refocused from a purely economic bottom line to addressing how we effect positive societal change. This has become the biggest driver of innovation.

Ben's background lies in arts and engineering...and a love of cars! He sees the car as the perfect synthesis of arts and engineering, and this inspired his career in product design. Ben was even part of the Loughborough University spinout that developed the first fuel cell motorbike, with the industry recognising this as a major breakthrough. Time magazine recognised it as the Invention of the Year as well as the World Trade Organisation identifying the company as a tech pioneer.

Against the backdrop of Brexit, the declaration of a climate emergency by 33 nations across the world, Covid-19, and lockdown(s), the Government announced its ten point plan for a green industrial revolution in November 2020. This opens up the need to ask some hard questions of ourselves, including:

- What kind of fourth industrial revolution do we want?
- Are we making the right things?
- Do we want to work long hours?
- What are we really good at?
- Is a hydrogen economy going to work?
- Is technology the answer?
- What can we learn from past?
- How do we compete globally?



The circular economy is a clear enabler of net zero. We must not lose sight of innovation and implementation and what to do with materials at the end of life. Following Jason's remarks around additive manufacturing, Ben sees remanufacturing as a major route forward. We need to make and design products that retain the value invested in them.

Ben's role at KTN is to look at how we develop the next wave of technology to put the UK at the forefront of manufacturing and establish what Industry 4 actually means for the UK. Made Smarter is a UK movement focused on digital transformation. Part of the Made Smarter agenda is around reducing emissions through supply chains. Over the next four and a half years, Made Smarter will seek to stimulate innovation, joining everything together through research and development competitions, innovation and research hubs - with the aim to make better products using better processes. Joining this up with other Clean Growth Industrial Challenge Funds, and networks including the Circular Plastics Network and Industrial Strategy Challenge Fund this is an investment of more than £1 billion in the next few years. Only by bringing together this range of diverse connections can we drive positive change.

Debate: Is British manufacturing ready to seize the net zero opportunities, and is it really possible for decarbonisation to enhance the UK's competitiveness?



Rosa introduced the debate looking at the themes of the presentations; involving the whole supply chain, managing the energy transition, the importance of digital technology to address challenges, but crucially around changing mindsets and making fundamental behavioural changes.

Rosa: Is British manufacturing ready to seize the net zero opportunity and go beyond easy wins? If it is, will this enhance our competitiveness?

Colin Herron - Colin picked up on Rosa's use of the word British. In some regions such as the North East, very few truly British companies remain. Many are satellite companies producing products at unit prices in direct competition with other companies overseas. The cost of decarbonising will reduce this unit price competitiveness and therefore the industry and the policy makers need to understand and support how it will work.

Jane Gardner - As a nation of innovative entrepreneurs, this will help us deal with change. However in the end the issues are centred around the upfront investment and unit costs. Post-Brexit, British manufacturers selling overseas will face some huge challenges and we cannot ignore this fact. Instead we must use this as an opportunity to investigate if we can decarbonise and innovate and still maintain a competitive advantage. There may be ways of doing this that don't require upfront investment or could the Government provide support?

Ben Peace - At KTN we are seeing a whole spectrum of responses and solutions; blockchain to monitor impact through supply chains, additive and hybrid manufacturing. Some companies are really taking the initiative and using technology to innovate. There has been considerable investment to support innovative companies but what about those who don't know where to start and are not yet ready. We need to see support for both ends of the spectrum.

Nasmiye Ozkan - In some ways we are ready to embrace the future, but we do not yet fully understand the challenge. Digital technology will increase competitiveness. As Ben explained, some companies are embracing digitisation more than others. If we are serious about becoming net zero, there needs to be big step change. Yet there is also little incentive for some companies to do so - we need traceability of emissions and carbon impact for many to take it seriously.

Jason Jones - I don't know anyone who doesn't want to take care of our beautiful world. Some simply lack the knowledge, inspiration, and hope. Decarbonisation will make us more competitive. Small businesses are working with limited time, money, and energy. By using less energy it will be good for society, the environment, and for the economy.

People working in plastics manufacturing have an emotional commitment to support decarbonisation, but on the other hand are faced with demand for product. How can a manufacturer disentangle this and balance competing demands?

Jason Jones - We need a holistic solution. It is not genuine to say we are carbon neutral if we simply farm it out to another country or company. We need to be more creative to get lifetime values, recovering materials and putting these back into the supply chain.

Colin Herron - What is now a problem used to be seen as an asset. Using the example of fresh vegetables wrapped in plastic, this was never seen as a problem before, but now is. Let's give the engineers the challenge and empower them to solve the problem. With that, behaviours will also change.



Rosa Wilkinson - Another challenge is the impact downstream. What happens if we make the shift to electric vehicles or better yet, use fewer vehicles, to local vehicle maintenance services and others in this supply chain. We will be taking away the key building blocks of income.

Colin Herron - This is a problem and also one around the advent of autonomous vehicles. What will happen to the 200,000 taxi drivers in the UK? Society itself has created these problems. As we speak, there are factories in Bangladesh employing thousands of people making clothes we are now being told not to buy. We cannot simply shut off the supply of products as this will result in global poverty. The Government has to transition people away from products.

To this point, Rosa raises the issue of the skills agenda, asking Ben about re-skilling to help their people and supply chains?

Ben Peace - Support is patchy at the moment. The Government want to put more into the skills agenda with Made Smarter. Some businesses will need to make wholesale changes to what they do, whereas some regions can make different things, redeploying elsewhere, and that will require new skills. Ultimately we need investment to stimulate this.

Jane Gardner - Looking across Europe there is a recognition that there will be a need for re-skilling if the transition to lower carbon production removes some roles. Jane sees this as an opportunity to provide more jobs, with the EU positive about re-skilling, with the green deal pledging to provide more green jobs in different sectors. In some ways it has always been like this - we don't know today what type of jobs our children will have in the future. It was the same for our parents.

Nasmiye Ozkan - Data and digitisation will play a big role in the future. At Cranfield we are developing an MSc qualification on digitising and embedding data into manufacturing. We need to up-skill those people at key points in their careers as well as training the next generation of engineers, academics, and policy makers. We need to look at climate change from multiple perspectives including behavioural change.

Colin Herron - We need to understand the difference between academics versus skills, something I feel the UK Government has struggled with to date. A technician in Teeside wanting to learn new skills will find it very hard to get on a course, whereas the Government investment has been going to University research and classing this as skills. This is not right and needs to be reviewed.

Rosa agreed that we need a base level of core skills today and also for future challenges. We need to support all levels new skills across manufacturing - not just at a high level.

Jason Jones - Individuals feel threatened but we must remember the quote, "Great causes are not won in a single generation." We are now looking ahead to 2050/2060. If we spend a generation preparing the next generation, it will not be quite as scary. This is a migration rather than simply saying you'll be out of work tomorrow!

Rosa asked what else should the Government be doing? Should each company be regulated to deliver a statement on their carbon footprint?

Jason Jones - Digital now provides many opportunities to make measurements - whether this is our heart rate or number of steps. Manufacturing is the same; in the next decade the burden to report carbon footprint won't actually be a burden - we will already be doing it.

Rosa is sceptical of this. Her family business, an industrial estate in Doncaster, sees very few companies using digital technology.

Colin Herron - Every project has to go through the Treasury using antiquated measurements of GVA and ROI. How do you measure investment in skills and people against green credentials? The Government has to reassess how it measures investment and this will help make projects with longer term returns more successful.

Rosa reflected on the Spending Review and how the Government is making changes to the way they measure. Are there other ways for Governments to drive decarbonisation?

Colin Herron - The industry responds to money. If we start carbon taxation, people will have to take notice!

Jane Gardner - Our members are pretty advanced in their attitudes and have been looking at resource efficiency for more than 20 years now. They take every opportunity for funding from Government, seeking to reduce the carbon impact and looking at product end of life. The whole industry is already working together and there is no longer a competitive edge to being ahead in sustainability. The Government needs to set up grants in areas such as Doncaster so that forward thinking is encouraged.

Rosa Wilkinson - How can SMEs invest in expensive green solutions? Naturally, we choose the most cost-efficient solutions.

Colin Herron - There are a range of local programmes to help industry in the North East improve performance. The reality is that many SMEs were wiped out a few years ago. The challenge is this: our parents used to save up over a long period of time to buy white goods. Now we get used to the product price coming down so much that it is not repairable, nor recyclable. Is the answer to reverse this and go back to creating higher value and higher specification products that will last longer? SMEs can survive if their products are based on high levels of service and higher value. Otherwise they cannot compete in the global market.

Rosa posed the same question to Ben, who works with many SMEs. "What might help? Tax as a stick, or the carrot as a grant?"

Ben Peace - In the not so distant past, the Government set up a Green Investment Bank - this was sold off after three years. Rishi Sunak has now announced a new similar initiative for the infrastructure sector. We need something between grants and tax to encourage adoption of existing technology. Businesses don't know what is cost-effective. Just last month Chris Stark spoke of how decarbonising is now cheaper than it was at this time last year. Businesses need support to know where to invest. Yes, they must invest in R&D, but Government must also help them to adapt by investing in support and forms of finance like the Green Investment Bank.

Rosa saw this as reassuring and crucial level of support for smaller businesses.

Closing remarks

In this debate we have covered fascinating ground in the challenge to help businesses begin their decarbonisation journey. There are some huge issues to address: where should companies invest, are they able to access the right technology and skills? There are also some difficult questions to consider around what decarbonisation means downstream in our supply chains.

We must remember that there is no quick fix, that this is something that needs to happen over generations. However there is recognition of the existential threat to future generations if we don't start to decarbonise now. If we look at how the manufacturing community came together to support the efforts against the pandemic, building 20 years of ventilators in just 12 weeks, this shows that with a clear aim and the right support, we can make a difference.



Manufacturing data: The 4IR green data challenge



John Patsavellas
Senior Lecturer in Manufacturing
Management, Cranfield University

This year as part of the National Manufacturing Debate, our manufacturing master's students and the academics at Cranfield, have looked at the manufacturing data coming out of the fourth industrial revolution and its green and energy issues. The size of the prize in terms of digitalising the industry is huge. Back in 2016, German colleagues estimated that digitising industry would open up an additional cumulative value of €425 billion in Germany alone, increasing productivity by up to 30%. In the UK's Made Smarter Review in 2017 a similar number was quoted of £455 billion in the next decade. By connecting machines and infrastructure with the control systems and planning methods in factories, manufacturing and its efficiency will be transformed. It will become more flexible and responsive while driving down the use of materials and energy.

Yet at every level during the fourth revolution we need data. This data enables us to see what is happening in our own environment, increasing the visibility and transparency in a way that has never been possible. This enables the prediction of events, of demand, being able to match supply to demand and being able to respond to disturbances. This data takes us towards the creation of a self-optimising manufacturing system where automated responses could match to prevailing conditions in demand in production.



Data is crucial for the fourth industrial revolution - with the whole revolution itself based on sensors which generate data. That data, in large amounts, can lead to techniques such as artificial intelligence, reaching higher levels of maturity for predictability and autonomous responsiveness.

Increasingly affordable sensors coupled with this milestone of producing one trillion semiconductors per year globally, are the data-enablers of the fourth industrial revolution.

Through the digital transformation in manufacturing using industrial Internet of Things sensors, this data is only set to grow. Connected devices will increase exponentially over the next few years. The statistics are rather mind blowing, 90% of all data was created in the last two years - that's two and a half quintillion bytes every day. It must be remembered though that data is not free in energy terms. The estimated 10-year energy needs for 1GB of data is 2.66 kWhr to generate, transmit, store and also retransmit the data. With over 60% of electricity still generated by fossil fuels, John estimates that 1 kWhr of electrical

energy emits around 544g CO₂. Therefore just 1GB of industrial data over a 10-year period would require almost 1.5kg CO₂. Looking at the adoption of industrial robots over the next few years, the team at Cranfield has calculated that for their way-finding sensors and cameras alone, these robots will generate around 200 million tonnes of CO₂ (with the pessimistic scenario more than double!).

In answer to this major concern, John and his master's students propose that green data is needed to support the fourth industrial revolution. With some of the larger cloud computing companies already moving toward this, John proposes value criteria to verify data as green, with one potential answer, the development of a green data assurance and certification scheme, that would include the following key points:

- Minimum data and maximum compression - the minimum possible amount of valuable data transmitted and stored with the maximum amount of compression along the whole lifecycle,
- Data from clean energy sources,
- Energy efficient hardware.

In this way, data can then be seen as an aid to achieving net zero and not an obstacle.

Nuclear manufacturing and net zero



Andrew Storer
Chief Executive Officer,
Nuclear AMRC

In the next 30 years, energy demand is set to increase. While nuclear isn't the only source, it has an important role to play in this journey. Many of the large reactors we have today are due to be decommissioned around 2030-2035 and so we not only need to grow our energy, we also need to replace those reactors.

In the UK we have the SMR Consortium led by Rolls-Royce. So far, the Government has sponsored £18 million, with the companies matching this to reach £36 million in total. The consortium is seeking to build 16 power stations which will generate the amount of electricity required to replace the reactors that will be decommissioned over the next decade. With the potential to create more than 40,000 jobs, it can also be exported overseas.

The opportunity for UK manufacturers is global. There is a worldwide demand for clean energy and if the UK supply chain moves fast enough, we can hold a global position for deploying nuclear reactors. The UKAEA is working closely with developers around fusion technology and the development of the Fusion Step Reactor. Companies such as Tokamak Energy, are developing methods for deploying a fusion reactor. The aim is to connect to the grid around 2040.

As well as SMR and fusion, we also have generation four advanced reactors being developed by companies such as Westinghouse and U-Battery. This would really start to increase the UK's competitiveness in an export market.

Nuclear AMRC's role is to disrupt the market and promote change. Andy shares a recent project to create heat exchangers for a nuclear pressurised reactor for Hinckley Point. In simple terms the product cost was prohibitively high and there was a risk that the company wouldn't win the order and that the contract would go overseas. Through the Nuclear AMRC, and in partnership with Rolls-Royce, 80% of the cost was taken out of the assembly process, enabling EDF and Rolls-Royce to reach an agreement on the contract, ensuring it remained in the UK.

The manufacturing process must also be considered when looking at the creation of clean energy. The Nuclear AMRC is currently manufacturing a reactor pressure vessel for a small module reactor, which is two-thirds the size of the normal vessel. Using the normal manufacturing process, 1,800kg CO₂ is produced during the manufacturing process. However the team is using a range of methods, from Electron Beam Welding to CO₂ machining, to reduce the energy consumption.

The UK has the capability but we struggle with our capacity, the scale of manufacturing, the size of buildings, and the machines that forge, to deliver gigawatt-scale reactors. Given the fact that we aren't talking about a huge volume of products, there is little incentive for businesses to invest in increased capability and capacity. However if we look at small modular reactors it's a different story. The capacity is different and we have facilities in the UK that could hold reactor pressure vessel internals.

The UK has a quicker readiness for smaller reactors if the volume is there and has encouraged investment from the supply chain. All the advanced methods that are being developed in manufacturing can be put into a smaller reactor plant that is not yet even at final design stage. While larger reactors are already designed, for the smaller reactors we are yet to determine that method and so this offers a massive opportunities for the UK supply chain.

In conclusion, while there are capacity challenges, the UK can manufacture small reactors. This will require investment through the supply chain and timing will be key; to develop the reactors against the timescale, to achieve net zero targets and to enable export opportunity. The infrastructure and innovation is already there but we need to work better and smarter towards a shared objective.

Last year 23 companies, eight Formula One teams and 30 suppliers came together for the Ventilator Challenge, producing 20 years of ventilators in just 12 weeks to fight Covid-19. This proves we can work together and overcome seemingly unbelievable challenges. Covid has proven that we have weaknesses in some of our supply chains and we need to strengthen these in the nuclear supply chain. We need to work better, with clear policies from Government that provide confidence to the supply chain. The supply chain must also invest and will do if there is a programme of work. We need a co-ordinated, almost wartime, approach like we achieved with the Ventilator Challenge, to ensure that we deliver on our mission, for us today, but also for our children and grandchildren.



Manufacturing and Materials Week closing remarks



Professor Mark Jolly
Director of Manufacturing,
Cranfield University

No one could have envisaged that in postponing our National Manufacturing Debate we would still be in lockdown in December 2020. A concept that grew out of a forced hand has opened up tremendous possibilities and led to a week of events with international speakers and audience that has benefited from the online format.

Twice this event, we heard reference to Industry 5, first by Dr Ayotunde Coker, winner of our Distinguished Manufacturing Alumni 2020, and during Manufacturing 2075 by Dr Abigail Hird of KTN. The reality is that 2075 will come around very quickly - some of you in this week's audience will be around to see and be part of it we hope! It really is up to you!

Save the dates

Manufacturing and materials week 2021
29 November–2 December 2021

National Manufacturing Debate
1 December 2021

Manufacturing 2075
2 December 2021

www.cranfield.ac.uk/manufacturingweek

Graphene commercialisation conference
15 March 2022

www.cranfield.ac.uk/grapheneconference



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