Coca-Cola Enterprises

Sustainable manufacturing for the future:

The journey to 2050: research on the vision and pathways for sustainability in the food and drink industry in Great Britain.

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Cranfield UNIVERSITY

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Cranfield University

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Coca-Cola Enterprises, Inc. (CCE) is the leading Western European marketer, producer, and distributor of non-alcoholic ready-to-drink beverages and the one of the world's largest independent Coca-Cola bottlers. CCE is the sole licensed bottler for products of The Coca-Cola Company (TCCC) in Belgium, continental France, Great Britain, Luxembourg, Monaco, the Netherlands, Norway, and Sweden. In Great Britain (GB) Coca-Cola Enterprises Ltd (CCE) employs some 4,000 people across England, Scotland and Wales across 6 manufacturing sites, offices and depots.

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This research was carried out over a six month period using the first white paper on Sustainable Manufacturing for the Future from the CCE/Cranfield discussion held in March 2015. The six themes from the first white paper were investigated by three masters students from Cranfield by reviewing relevant literature and by interviewing 43 experts from industry and academia. The interviews with experts were predominantly face-to-face although some conversations were by telephone. Using the initial six themes as a framework an analysis of the information collected revealed five clusters of findings. The clusters with the associated details were subsequently developed into corresponding pathways that are presented in this white paper along with three immediate action points for each.
The authors wish to thank all those who contributed to this research. These included:

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Foreword

History has shown that those who are fully prepared to acknowledge and engage with the future shape and prospects of their sector will not only be better prepared to address challenges and reduce risks, but will also be able to capitalise on new business opportunities.

It was with this in mind that we first embarked on our research partnership with Cranfield University in early 2015 to explore the future of sustainable manufacturing in the food and drink industry in Great Britain.

Sustainable manufacturing has been defined as 'the creation of manufactured products through economically-sound processes that minimize negative environmental impacts while conserving energy and natural resources. Sustainable manufacturing also enhances employee, community, and product safety.' (US Department of Commerce's Sustainable Manufacturing Initiative). It was this definition that we based our initial roundtable discussion on which we held with our industry and academic peers and subsequently launched our first white paper in June 2015 investigating the current and future landscape across the food and drink industry. Six major themes were identified for more detailed analysis, which we believe must be addressed in the coming years to achieve rapid and fundamental change – People, Big Data, Technology, Collaboration, Value and Resilience.

It is with great pleasure that I now introduce the findings from the next phase of our research, the result of a dedicated six month study by Cranfield University to delve deeper into these core themes. The results offer valuable insights into how sustainability will evolve within manufacturing and what a sustainable factory may look like as we future-gaze towards 2050.

This research has established five expected pathways for the food and drink industry that lead towards a vision of sustainable manufacturing for the future. These pathways are **Anticipating the future**, **Providing nutrition**, **Sharing the benefits**, **Inspiring the next generation** and **Joining forces**.

Within each of these, specific initiatives are identified that the food and drink industry can and should adopt to accelerate the journey towards sustainability. The research shows that manufacturing businesses must constantly evolve in order to create new opportunities and respond to the pressures we face. As an industry we have done this for many years already, however a more sustainable future requires practical, radical and disruptive thinking beyond the lean manufacturing focus of the last few generations.

At CCE we have long recognised that the environmental impact of our activities, the stewardship of our resources and our reliance on local eco-systems are considerable challenges for the decades ahead. Globally, the industry must work together to better utilise materials and resources such as energy and water responsibly so that future sustainability is assured and waste does not have a long term impact on the environment.

But manufacturers can, and must, go further. They should also positively contribute to communities and society at large, starting with the prospects of current and future employees, extending through to all of those impacted by their operations. Community is one of the core pillars of our corporate responsibility programme at CCE, seen through actions such as our long-term investment in local partnerships including our education centres and our Real Business Challenge national enterprise competition, aimed at 13-15 year olds, and open to all secondary schools in Great Britain. This goes way beyond the drive for profit and I am pleased to say it features heavily in this white paper.

While the findings presented here represent some significant challenges for our sector, those manufacturers who lead the way will in turn strengthen the economic sustainability of their own business. Pioneering companies and inspiring individuals will be critical in driving the industry forward.

The manufacturing of products has benefited billions of people, and this is something that CCE is deeply passionate about. But we also recognise that to continue to support and improve the quality of life of those we serve, we must continue to look forward, challenging ourselves and others to do more in securing a sustainable future for all.

Steve Adams
Group Director of Supply Chain Operations
Coca-Cola Enterprises Great Britain

Executive Summary

This white paper presents the outcomes of a six-month research partnership between Coca-Cola Enterprises (CCE) and Cranfield University on sustainable manufacturing for the future. The first stage of the research, published in June 2015, brought together experts from CCE and Cranfield University, as well as wider industry and academia, to discuss challenges and opportunities for food and drink manufacturing businesses in Great Britain. Six major themes of People, Big Data, Technology, Collaboration, Value and Resilience were identified and provided the foundation for the second stage of research presented here.

A programme of quantitative and qualitative research took place over a six-month period, incorporating face-to-face interviews and workshops with industrial and academic experts in the field of sustainability. The findings were collated alongside evidence from academic peer reviewed literature and industry publications. By uncovering examples of forward-thinking innovation and hypothesising on the potential this creates within manufacturing and the supply chain, the research team were able to map out a vision of the future.

Five key pathways emerged from the research: **Anticipating the future**, **Providing nutrition**, **Sharing the benefits**, **Inspiring the next generation** and **Joining forces**. Combined, these pathways present a roadmap towards sustainable manufacturing for the future, and begin to offer a picture of what the 'factory of the future' may look like in 2050. Within these pathways, specific initiatives are identified that the food and drink industry can and should adopt to accelerate the journey towards sustainability. Some of the findings are applicable globally whilst others are unique to the heritage of Great Britain. The pathways can be summarised as follows:

Anticipating the future

The food and drink industry will benefit from increasing innovation in big data and the Internet of Things, not only to improve financial performance and business efficiency but also to improve the efficiency of the broader supply chain. The research found evidence of this technology leading to more automation and real-time visibility of the whole supply chain, as well as innovations like using sensors to ensure optimum soil quality at all times. In future, it is recommended that industry shares more information with customers, uses rich data to optimise the production process and exploits sensors to focus on land health and energy consumption.

Providing nutrition

The industry is facing greater scrutiny of all aspects of its business, from the healthiness of ingredients and organic produce to the ethics of food labelling and animal welfare. Food producers will need to focus on resilience and delivering the greatest value to customers, not just financially but in the broadest, social sense. Industry has already seen businesses making more efforts to reduce waste and a growing number of new services offering increased emphasis on personalisation and nutrition. The research found that this is likely to continue, along with greater focus on eliminating waste by using more local resources and improving efficiency with real-time monitoring technologies.

Sharing the benefits

The sharing economy is a powerful trend that is affecting all industries and driving increased collaboration, with the need to engage with and benefit society overriding competitive advantage in many cases. For example, companies like P&G and Unilever plan to collaborate on new product development, while Nike has been allowing customers to co-create shoes online. The food and drink industry should work towards engaging society and sharing benefits when creating products. Well-being must be put at the centre of delivery and shared IP considered as a way to protect the environment.

Inspiring the next generation

With growing automation of both hard technology and soft information technology, fewer people will be developing, managing and improving complex businesses but these people will remain vital to tackling the challenges of sustainability. The manufacturing industry also faces a growing skills gap as a generation of experienced employees retire. In future, companies will need to do more to integrate with universities and, to reach learners as early as possible, in schools. Companies such as Volvo are already doing this. Businesses will need to find role models to inspire future engineers to put their skills to work in the food and drink industry.

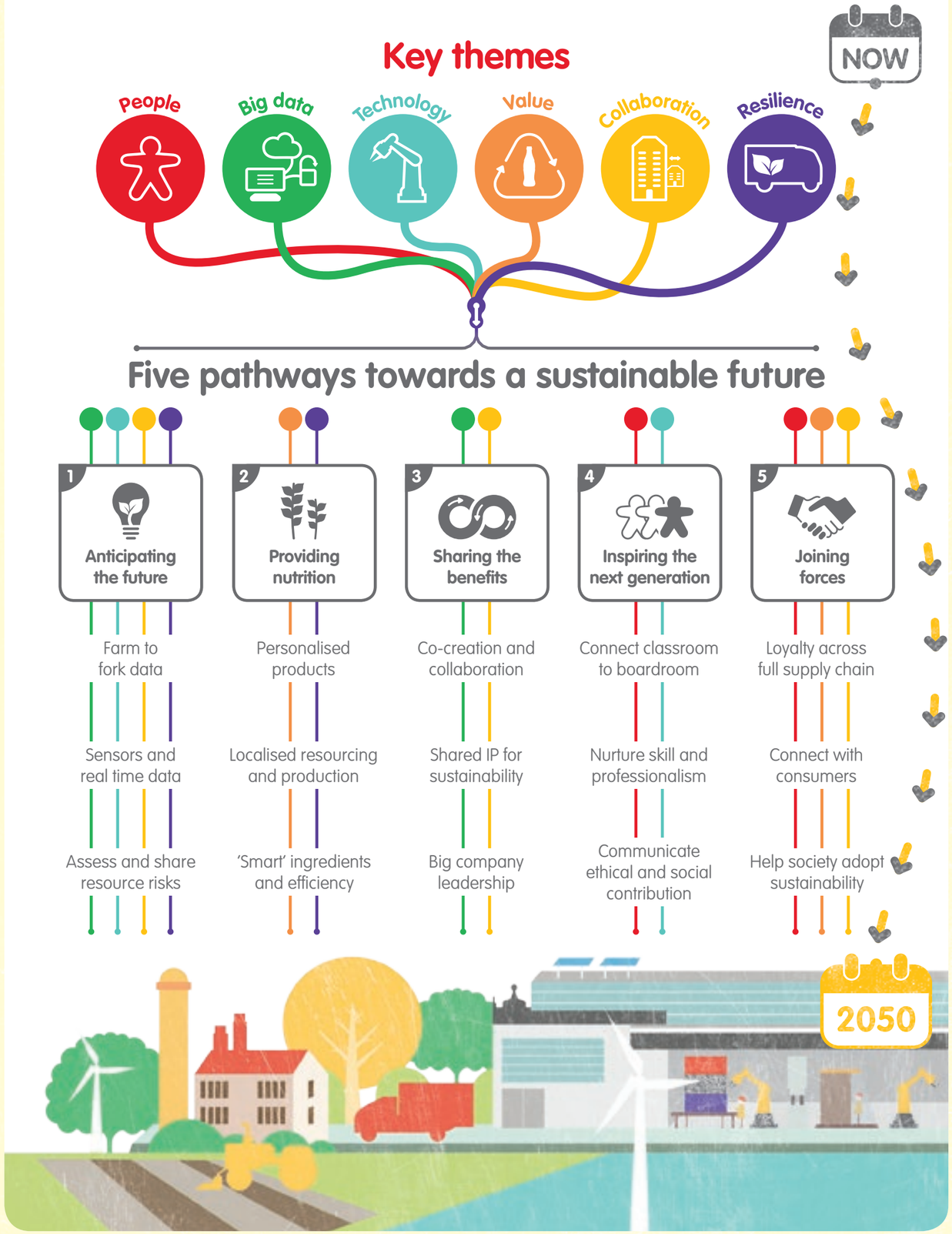
Joining forces

How value and leadership is understood will change dramatically as companies join forces with each other, and with customers and society. This will become accepted as the only way to grow positively whilst reducing impact and footprint. It will require manufacturers to be key agents of change, as they have the capabilities and insight required to help educate and strengthen different aspects of the value chain.

Leadership by both individuals and organisations features strongly as a core theme throughout the research. The extent to which the British food and drink industry takes ownership of the debate and innovates, will set the pace by which we move towards more sustainable manufacturing. Companies that take the lead will reduce their costs, be more resilient to changing conditions and develop greater trust with consumers and society.

Sustainable manufacturing for the future - the journey to 2050.

The vision and pathways for sustainability in the food and drink industry. Within each pathway, the research team has presented a number of key actions and guidance on how these can be undertaken.



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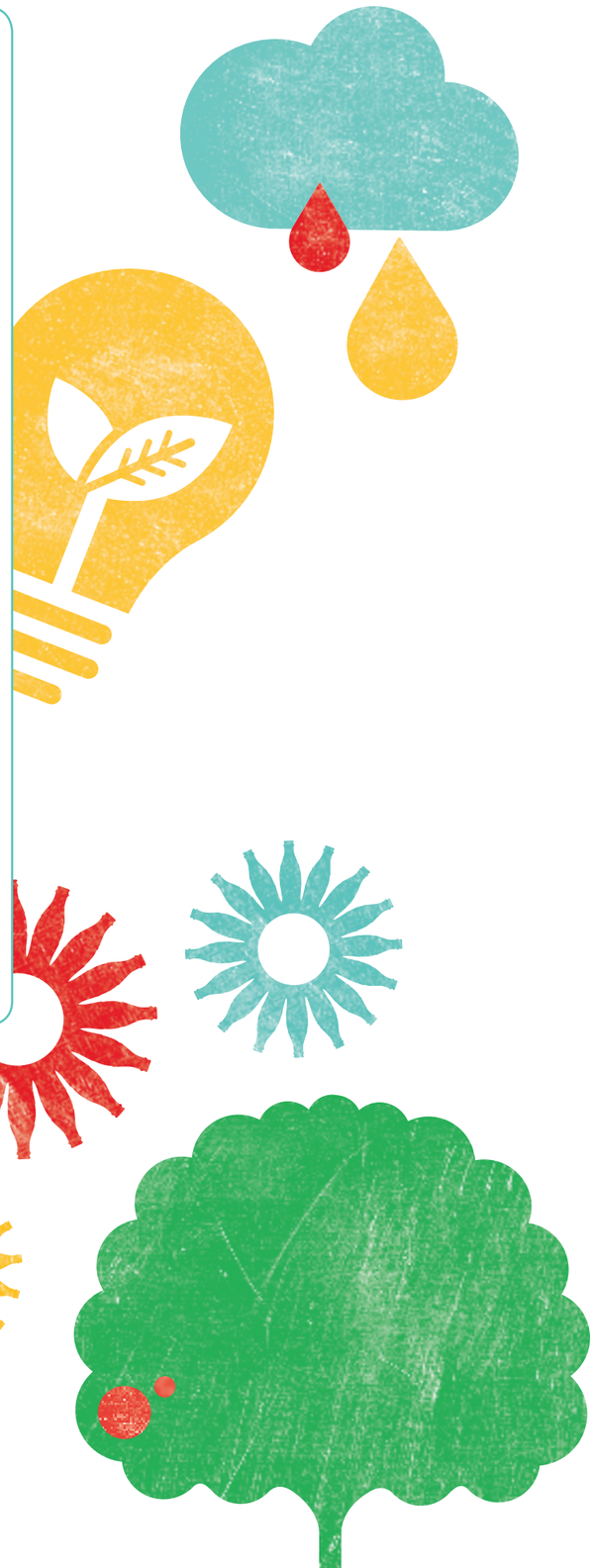
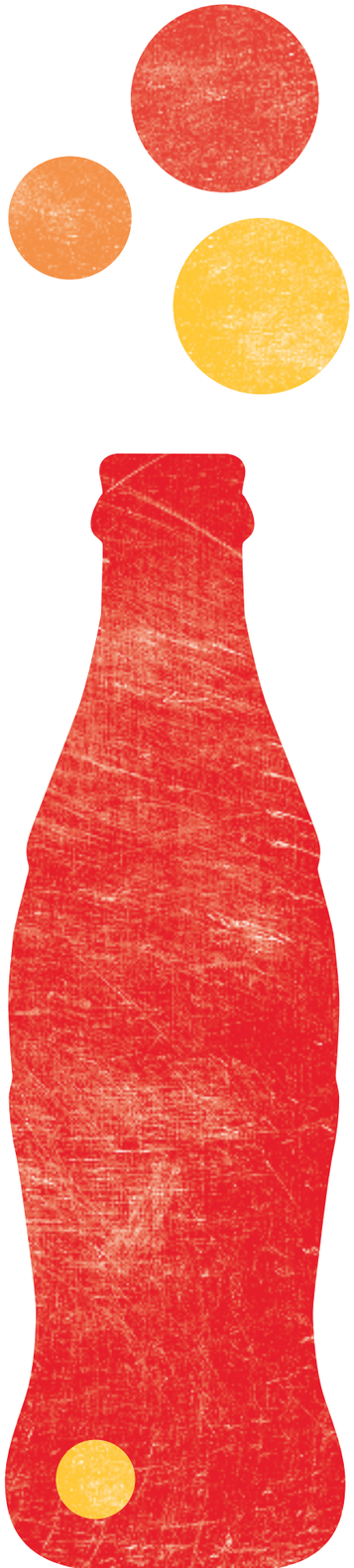


Introduction



Since March 2015, Coca-Cola Enterprises (CCE) has been working with Cranfield University to unlock the future of sustainable manufacturing in the British food and drink industry through a research partnership entitled 'Sustainable Manufacturing for the Future.'

The six month study has investigated the current sustainability landscape across the supply chain, investigating topics such as resource security, the circular economy, sustainable technologies and waste management. It also looks to the future and to what a sustainable factory could look like in 2050.

A first white paper was presented following a roundtable event on key topics affecting the sustainability landscape today which identified six major themes of People, Big Data, Technology, Collaboration, Value and Resilience. These provided the foundation for the second stage of research presented here.

This research into the vision for sustainable manufacturing for the future used academic peer reviewed literature, industry publications, workshops and face-to-face interviews with industrial and academic experts in the field of sustainability. The research was carried out around the six major themes and derived quantitative and qualitative results on potential practices that the food and drink industry should undertake.

Five key pathways emerged - **Anticipating the future**, **Providing nutrition**, **Sharing the benefits**, **Inspiring the next generation** and **Joining forces**. Within these pathways, specific initiatives are identified that the food and drink industry needs to adopt to accelerate its journey towards sustainability.

Pathway 1: **Anticipating the future**

The challenge

As **technology** develops the Internet of Things [or internet of everything] has led to an information explosion, with more and more data being collected every day, hour, minute and second. This data illuminates the manufacturing process in previously impossible ways, exposing the complexity of decision-making and revealing the opportunities to minimise society's environmental impact. Methods are being developed to exploit this data, be more transparent and to **collaborate** more with customers, suppliers and even competitors. This will help manufacturers to maintain a **resilient** business while meeting the needs of markets in general and, eventually, the needs of specific individuals. Business decision-makers strive to 'do the right thing' for the environment and the visibility provided by **big data** will give manufacturers greater confidence that their process means a 'win-win-win' for their business, the supply chain and the environment.

The findings

The research offers a vision of the future in which sustainable manufacturing will have pervasive sensing technology, feeding big data sources to deliver improved analytics that will provide real-time visibility of, and communication across, the supply chain. Some parts of the supply chain will use data to operate autonomously. Sensing technology will, for example, monitor the quality of farmland in real-time, ensuring that problems can be fixed immediately, keeping the land operating at maximum productivity and more sustainably. The graphic below highlights evidence found to support this vision.

Pervasive sensing	Real time visuals	Autonomous operation	Big data analytics	Productive land
The vision for 2050				
In the future, manufacturers will have sensors to monitor all activities, from the nutrients in the soil in farmland to food safety. This will result in the creation of 'smart farms'.	In the future, food chains will be transparent to all, giving consumers more detailed information about the provenance of their food.	In the future, parts of the food chain will operate without human intervention. There will be 'smart tags' on food products and 'smart kitchens' that help manage the food available and reduce waste.	In the future, big data in analytics will suggest actions to optimise the manufacturing process. The ever increasing ability to analyse will continue.	In the future, industry will work together to ensure sustainable harvests for generations to come by using technology to better maintain land.
The evidence				
The research identified sensor technology as a tool for monitoring quality and supporting real-time decision-making to keep manufacturing operating efficiently.	Industry experts cited the value of sharing information to cut food waste and improve energy efficiency. For example, companies and consumers do not always have visibility about the use of fertilisers and their impact to the land and surrounding environment.	'Smart-tags' that monitor food and indicate when it is no longer safe to eat was one of the examples that experts gave of an autonomous solution for cutting waste in the food chain.	The research showed that real-time analytics can for e.g. identify oncoming bottlenecks in the manufacturing process which can be fixed before they reduce efficiency. Privacy concerns such as anonymity and personalisation of personal space will continue to be of importance as big data analytics grow.	Interviewees frequently cited the need to protect and enhance land already in use as being vital to the future sustainability of the food and drink industry.

Industry case studies

Siemens envisages a future, known as Industrie 4.0, in which virtual reality technology is used to increase productivity and engage all staff in innovation. Having replicated their whole factory in the digital world, Siemens' visualisation capabilities allow new products and processes to be designed, tested and securely shared, globally. This capability leads towards mass customisation / personalisation. The technology improves cross-business engagement, decision-making and optimises performance in the virtual world - resulting in a culture that expects to see continuous innovation in the real world.

A British farmer in the Midlands, whose company grows crops on 4,000 acres uses hi-tech tractors and combines together with GPS satellite technology to map fields and identify what part of a field needs spraying with fertiliser to within a few inches.

The way forward

These findings have been collated into three key actions, centred on technology that gives manufacturers greater potential to anticipate the future within their processes and broader supply chain. The evidence suggests that the following can, and should, be undertaken by manufacturers to achieve truly sustainable operations.

1. **Show flow of ingredients and materials 'farm to fork'**
   Share data on the flow of food from farm to final destination to build trust.
   Use this increased transparency to educate consumers on how their behaviour could minimise waste.

2. **Visualise real time risks to product quality and supply**
   Use analytics to provide rich, visual, real-time data on the flow of nutrients to identify potential issues at any stage in production, from raw material supply to final product quality.

3. **Share information on land health, land productivity and energy consumption**
   Assess the use of land and monitor farms to enable entire supply chains to see how their actions impact on others. Seek opportunities to reduce overall cost but increase overall quality.

Pathway 2: **Providing nutrition**

The challenge

The foods that industry grows and makes, and that people consume, are understood as 'ingredients' that are combined into products. This contrasts with how nature is understood and described. The growth of plants is supported by nutrients, not ingredients – for example, plankton is a food for whales but not a product and unlike the industrial society, nature does not waste food. This contrast highlights challenges to the value of processed food in society, how that value is captured and how modern humans find the nutrition which is necessary to support a healthy and fulfilling lifestyle. New concerns are being raised about our food, from ethical questions about clear labelling, to an increased desire for organic produce and worries about animal welfare. In the future product ingredients will be examined ever more closely, and industry will be held responsible. Food and drink manufacturers have to find ways to remove or alter ingredients that are considered unhealthy while still producing popular products. Given the pressures on global food supply, industry and society will focus on resilience and become increasingly vigilant about food over-supply and food waste. We are moving into an era in which society values the collective good but it also expects personalisation of goods.

The findings

The research offers a vision in which sustainable manufacturing in the future is service based and personalised to deliver convenience and value. This will be achieved by small, local facilities that use technology to synchronise supply and demand. Overall the benefits will focus on health from farmland to the general population. The graphic below highlights evidence found to support this vision.

Service based	Personalised	Small and local	Technology enabled	Synchronised	Population health
The vision for 2050					
In the future, value will be provided to consumers as a primary offering rather than via a product focus.	In the future, industry will move away from mass production towards making personalised products to order.	In the future, companies will be a combination of large and small operations that are better for the environment because they are more local to the consumer.	In the future, technology will aid the study of plant diseases to reduce the variability in crops and food processing and reduce waste and financial loss.	In the future, companies will change their business models to synchronise resource availability and demand particularly for small localised operations.	In the future, 'Smart' ingredients will emerge, with the potential to replace or alter other content such as sugar, fat and salt. E.g. Stevia, a natural, calorie-free sweetener made from the stevia leaf.
The evidence					
The research found that companies will shift current business models to a value one, and will incorporate value as part of their DNA.	The research found that specialist manufacturers that currently make personalised products will move from niche enterprises into the mainstream as advances in technology progress.	Experts suggested local manufacturing sites closer to the point of use will increase. This will be facilitated with the use of smart, concentrated production processes.	A number of interviewees cited agriculture as one of the top four topics that would most benefit from technological innovation.	Interviewees cited studies, such as electric car manufacturer Riversimple, that show changing business models leads to growth of potential sustainability.	The research found that health was one of the top four targets for technological innovation. Social media was seen as a way to identify health and consumer concerns and anticipate changes to ingredients that may be required for food and drink formulations.

Industry case studies

Graze snacks trades on the focus on personalisation and nutrition. The company provides products on-demand and delivered to any address. Nutrition information is provided through a well-established visual language with low calorie and healthy options promoted through simple graphics.

A study by the Sustainable Lifestyles Frontier Group, polling brands such as Nike, Ebay, Unilever, Coca-Cola, M&S and Whole Foods, revealed that changing business models will be one of the key ways to unlock growth potential from sustainability. The results showed that only 2% of consumers were 'very interested' in sustainable lifestyles, but predicted this to rise significantly by 2018. There was a strong belief that this would create business value, with the ability to help increase market growth. Respondents believed the food and beverage sector had done the most to support the shift towards sustainable lifestyles, and that it has the greatest potential to do so in the future.

The way forward

The following actions indicate how food and drink manufacturers can adapt their processes, and those of their networks to focus on delivering valuable service-based operations that deliver sustainably to the end-user.

1. **Deliver nutritious and personalised products**
   Question the current large, centralised, mass production approach in order to deliver personalised products that are nutritious and tasty according to individuals' needs.

2. **Use local resource and obsessively banish waste**
   Producing locally with local resources (both agricultural and industrial) minimises transport and connects consumers to food sources. Information and production technologies enable low cost mass customisation.

3. **Actively monitor efficient performance**
   Real-time monitoring, used to identify faults with planes and trains, can be adopted by FMCG. The capabilities of farms, food processing and consumers will be (ethically) monitored to maximise nutrition and maintain long term productivity and vitality.

Pathway 3: **Sharing the benefits**

Revisiting the challenge

The sharing economy is changing the way consumers behave. Over the last 10 – 20 years there has been a real shift toward collaboration when it comes to transportation, entertainment and accommodation. Industry too is now sharing across sectors and organisations – for example several automotive manufacturers have **shared** intellectual property to help advance the industry rather than just retaining knowledge within their own organisation. This would have been unthinkable a decade ago, but will continue as a trend in the future. As **collaboration** increases, expect more debate about the trade-off between, on the one hand, keeping data and intellectual property private and, on the other hand, the opportunities to minimise environmental impact by sharing **big data**.

The findings

The research carried out on sustainable manufacturing for the future delivers a vision in which new business models are supported by co-creation and collaboration. This has the potential to change relationships with customers, and provide resilience in the way the business operates. It is imperative that big companies take responsibility for leading the debate and acting ahead of consumer opinion. The graphic below highlights evidence found to support this vision.

Collaboration	Resilience	Co-creation	New business models	'Big company' responsibility
The vision for 2050				
In the future, collaboration amongst businesses, organisations and suppliers will be a key enabler for supply chain sustainability.	In the future, companies will need to show resilience to environmental change and show leadership to build trust.	In the future, co-creation and open innovation approaches will be used to develop new offerings that benefit the environment and consumers.	In the future, industry will challenge business models by sharing data and providing a superior level of service.	In the future, companies will demonstrate responsibility and lead the debate and take action, rather than waiting for consumer pressure.
The evidence				
The research found that 90% of executives strongly support the need for collaboration across industry.	Experts predict there will be greater competition to work with sustainable farmers as manufacturers seek to collaborate to secure quality resources.	Industry leaders and academics expect to work more closely with customers to truly collaborate beyond just initial planning and product development.	The research found that there is a prominent need to change business models from selling at volume to selling more individualised products.	The research found that industry will move from being pressurised into action by consumers to leading change.

Industry case studies

P&G and Unilever intend to develop new products through collaboration and co-creation. The companies publish their challenges and encourage individuals and companies to submit ideas that could progress to industrialised products or processes. Mechanisms are clear and successes are celebrated publicly. Social and environmental concerns feature strongly in the needs statements.

Embracing co-creation, footwear manufacturer Nike has allowed consumers to customise shoes for performance, style and fit using NIKEiD – an online and instore tool. Nike has also recently been exploring a new patent, allowing consumers to design their own shoes using virtual reality.

The way forward

Three key actions can be taken that set aside competitive advantage to some degree, in order to develop a sustainable supply chain that brings broader benefit for society at large. These are proposed as follows:

1. **Create products by engaging society and share benefits**
   Open up product development processes and challenge the ways that food and drink is brought to market so sustainability imperatives can be met and, simultaneously, consumers can benefit directly.

2. **Develop values of well-being of individuals and society**
   Co-create ways of working that put well-being at the centre of the delivery of food and drink and challenge current thinking.

3. **Using IP / open source to minimise environmental impact**
   Share intellectual property (IP) to support better decision making to protect the environment as well as the long term sustainability of the business.

Pathway 4: **Inspiring the next generation**

Revisiting the challenge

It is widely recognised that **people** are key to addressing the challenge of sustainability and enacting change, whether it is through their own actions or inspiring others. A highly skilled, ethics-led workforce will be required in the future to maintain financial competitiveness, as well as address the pressing need to change the way we use the earth's resources. With growing automation of both hard production **technology** and soft information **technology**, fewer people will be developing, managing and improving complex businesses. However, there are still exciting opportunities to work within the food and drink sector to ensure we deliver nutritious, trustworthy and sustainable products. Those opportunities will increase in the coming decades as a large number of skilled employees retire. This will be particularly evident in the UK's technological skills base.

The findings

The vision of sustainable manufacturing provided by the research will inspire an army of change makers to strive towards greater sustainability. This will include business leaders who are skilled innovators who instil an ethical stance of the business into those around them, as well as nurturing the careers of individuals in the wider community and meeting the expectations of all stakeholders. The graphic below highlights evidence found to support this vision.

Nurturing careers	Nurturing leaders	Innovation agents	Army of change makers	Ethics beyond reproach
The vision for 2050				
In the future, companies will need to support career development, not just for their staff but also in local society through community programmes e.g. local schools.	In the future industry will need to nurture leaders at every level of the business. Leaders will need to be visible not only to employees but also directly involved with local communities.	In the future, manufacturers will need to invest in developing and attracting highly skilled, innovative, tech literate and societal-focused employees.	In the future, businesses must develop staff to drive change towards sustainability and embed this knowledge into their technical competencies.	In the future, instilling moral and ethical values that are beyond reproach will be essential.
The evidence				
Education was in the top four topics discussed by interviewees. In particular education on sustainability issues for e.g. how to defend against waste.	Experts interviewed frequently cited 'leadership' as being a vital quality to accelerate the journey towards sustainability in 2050.	The research found that the impact of the 'skills timebomb' – an insufficient number of skilled engineers – will be felt as early as 2020.	Industrialists said that job applicants often had sustainability awareness, without technical competencies.	Ethics were identified as a more common concern among young people in the research than the circular economy or energy security.

Industry case studies

The "Watch it Made" experience has been created to entice future leaders into science, technology, engineering and mathematics (STEM) subjects who may then enter industry. The objective is to engage school children in the fun and pride of producing a watch to take home. The experience is mobile so connects directly with the local community.

Volvo work with schools in Sweden to help students prepare for their future careers. Volvo Cars' Swedish high schools, Volvogymnasiet in Skövde and Göteborgs Tekniska College in Gothenburg, are centres of excellence for technical education. Volvo is also closely involved with Sweden's leading universities, with initiatives and collaborations with the Chalmers University of Technology and the University of Gothenburg School of Business, Economics and Law.

The way forward

Three key actions are proposed that are already being carried out as industry best practice. However, they can be taken further to inspire the next generation of professionals and consumers.

1. **Integrate with education in schools and universities**
   Seek ways to engage our youngest learners in the excitement of how we produce our food and drink by connecting classroom to boardroom physically and virtually. A learning facility in every company in every community should be the norm.

2. **Inspire professional engineering careers with compelling role models**
   Demonstrate the intellectual challenge of engineering leadership and how technical skills can change the efficiency, safety, trustworthiness and availability of food and drink.

3. **Link careers to tackling sustainability**
   Use the major societal challenges of climate change, aging populations, food supply and energy security as the focus for any interaction with young learners to harness their creativity and enthusiasm for change.

Pathway 5: **Joining forces**

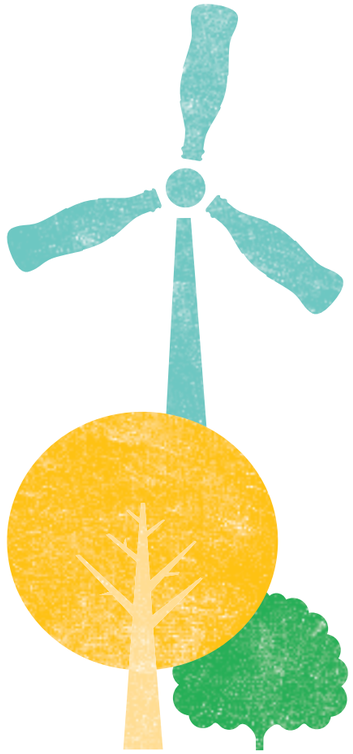
Revisiting the challenge

Over recent years industry has witnessed some businesses move from transactional, cost-based relationships in the supply chain to more **collaborative** behaviour. Designing products to be environmentally neutral, or even environmentally beneficial, is challenging given the diverse **people** skills required to see the big picture. Companies have **collaborated** within their own supply chains to make improvements, but can be wary of doing so in case this undermines their own competitive strength or is seen as anti-competitive even if it offers **value** to consumers.

The findings

The research envisages the food and drink industry of the future as having a positive impact on the environment and serving wider society. The concept of 'loyalty' has to extend beyond a company, into the supply chain and to further connect with consumers and promote the value of resources. The graphic below highlights evidence found to support this vision.

Connected to consumers	Loyalty beyond company	Valuing resources	Positive impact	Serving society
The vision for 2050				
In the future, it will be important for manufacturers to connect directly with consumers at the earliest stage of innovation to ensure their demands are included in the development of products.	In the future, employees will openly consider themselves as members of a wider supply chain to find ways to prevent negative supply chain impact on the environment.	In the future, cooperation will be essential to ensure the 'circularity' of resources, to eliminate waste and allow valuable resources to be reused.	In the future, manufacturers will work beyond the industrial value chain system to educate society on how to achieve positive environmental impact.	In the future, the food and drink industry will have to find 'levers' to improve value to customers that also benefit the environment and society.
The evidence				
The research found that engaging with and understanding consumers will be essential in ensuring true value for consumers.	The research found that connecting global environmental problems such as resource scarcity directly to individuals' personal activities and lifestyles is a major challenge but is an opportunity to encourage collective accountability.	During research helping society to understand waste and the consumer to understand what is available was one of the top four topics of conversation.	Experts repeatedly cited the need for society to understand how they also play a part in industry. Driving this awareness was essential for sustainable manufacturing in the future.	The research found that doing social good is considered integral for manufacturing businesses, to demonstrate that they have society's best interests at heart.



Industry case studies

The apparel industry in Vietnam is committed to positive impact through its "Race to the Top". Collaboration across the supply chain driven by SAC, Levi-Strauss & Co, GAP, Nike, Saitex, IFC, ILO/Better Work, 3GF – plus the Vietnamese, Danish and Dutch governments – aims to incentivise suppliers to operate more responsibly to achieve better working conditions and higher environmental standards.

Anheuser-Busch, during a natural disaster, looked at how it could use its manufacturing process to provide water affected by storms in Texas and Oklahoma.

The brewer produced more than 50,000 cans of emergency drinking water idling the beer production line at their Cartersville, Georgia brewery to produce the canned water and deliver it to the American Red Cross for dispersal to flood victims.

The way forward

Greater inter-industry and cross-sector collaboration is a fundamental requirement in order to achieve a more sustainable manufacturing industry for the future. Adopting some clear actions as follows will support this:

1. **Leaders work seamlessly between companies and society to retain valuable resources**
   Leaders, junior and senior, operate closely without borders with society to educate us on sustainability. In doing so they are inspired by ideas they receive. The agenda is to retain our valuable materials.
2. **Educate all on changing behaviour to reduce impact**
   Find mechanisms to educate and influence the behaviour of consumers so they understand the impact of products they buy and how their buying behaviour impacts on our use of natural resources.
3. **Help society adopt sustainability as core belief through development programmes**
   Promote mechanisms that consumers can use to understand the complex trade-offs in environmental impact depending on what products they choose and when they buy them.

Conclusion

The manufacturing industry in Great Britain has been through many eras of transformation, from its beginnings in the industrial revolution in the 18th century through to the fast, efficient, customer focus that exists today. Manufacturing has brought about massive benefits to society through the provision of products that make our lives easier, more enjoyable and enhance our wellbeing. In the face of major challenges to the price and availability of resources, today it is undergoing another era of transformation. For the food and drink industry to continue to serve the needs of society and to match, even lead, the expectations of customers and consumers it will have had to demonstrate major changes to its operations as it approaches 2050.

The research outcomes presented in this white paper are based on investigations into the themes of **people**, **big data**, **technology**, **collaboration**, **value** and **resilience** that are the subject of significant debate within industry, academia and policy makers. This research has established expected pathways for the food and drink industry that lead to a vision of sustainable manufacturing for the future. These pathways are captured by the words **anticipating**, **providing**, **sharing**, **inspiring** and **joining**.

It is expected that the food and drink industry will make significant use of technology and big data to anticipate the future, to control the flow of nutrients from fork to farm, assure quality and relentlessly address resource productivity.

By addressing how to deliver value to customers in the broadest sense in ways that are resilient to disruption, the food and drink industry will **provide nutrition** by using localised production to deliver personalised products, banish losses in the entire supply chain and actively monitor the capabilities of farms, food processing and consumers (ethically) to maximise nutrition and maintain long term productivity and vitality.

Radical change in the nature of business operations will result from how people are drawn into collaborative ways of developing new products. Companies will **share the benefits** by developing new products together, ensuring that health and well-being are at the forefront of product delivery and sharing intellectual property to protect the environment and underpin the sustainability of the wider industry.

Inspiring the next generation to engage and recruit talent to transform the food and drink industry is critical. This will be achieved by highlighting the excitement of engineering and technology by connecting classroom to boardroom, promoting compelling role models in the profession and linking careers in the sector directly to the challenges of tackling climate change, ageing populations, food supply and energy security. The industry must use this new talent to drive ethical standards ever higher.

How industry understands value will change dramatically as companies **join forces** with other companies, customers and society. Leaders in the sector will form new collaborations to retain valuable resources, provide simple ways to understand the complexity of sustainability and use education to influence consumers and businesses' buying behaviour to reduce impact.

Leadership is key to accelerating progress towards a truly sustainable future. It is not about stakeholders seeking out a compromise that achieves the least negative impact, but requires strong commitment and decisive action. Working boldly on the pathways of **anticipating**, **providing**, **sharing**, **inspiring** and **joining** will not be easy but will reap significant rewards for those companies leading the debate, as well as the communities in which they operate as the food and drink industry approaches 2050. The rewards of reduced cost, increased resilience, improved trust, enhanced wellbeing and faster innovation are available to those businesses who drive the agenda in the decades to come.

Glossary

Industry 4.0:
The 4th industrial revolution in which the organisation and management of manufacturing transforms through the use of virtual models, sensing, analytics and automation.

IP:
Intellectual Property

FMCG:
Fast Moving Consumer Goods

Sustainability:
Being responsible in our activities to ensure generations to come enjoy the same or better living standards as we enjoy today.

Servitization:
The servitization of products describes the strategy of creating value by adding services to products or even replacing a product with a service.

The six themes identified in:
Sustainable Manufacturing for the Future
White Paper 1 - June 2015

1. People
Employees are fundamental to enacting change and must be effectively engaged, well-trained, flexible and skilled at all levels within an organisation.

2. Big Data
The availability of data is set to play an ever more important role in organisations and society as a whole.

3. Technology
By connecting with Big Data and localisation, companies can benefit from some radical innovations in their sector.

4. Collaboration
More symbiotic relationships will emerge between a company, its supply chain and its broader stakeholder network in the coming years.

5. Value
The value of the resources we use will be re-evaluated. For example, the growing servitization and adaptability of products that can be used beyond their intended purpose to deliver 'value beyond profit'.

6. Resilience
The ability to adapt to change, and do this at speed, will be key to future decision-making as our industry seeks to maintain a supply of quality, ethically-sourced raw materials.

The five pathways identified in:
Sustainable Manufacturing for the Future
White Paper 2 - March 2016

1. Anticipating the future
Using emerging technology and big data to provide transparency and real-time visibility of the whole supply chain.

2. Providing nutrition
Delivering value to consumers in the broadest sense to meet their nutritional needs using local sources.

3. Sharing the benefits
Working with customers and society to create new products and services built on trust and resilience.

4. Inspiring the next generation
Enthusing and stimulating action to build new thinking and new skills to tackle the major challenges facing society.

5. Joining forces
Taking a 'big picture' view of the complex issues to enable society to reduce its impact and retain valuable resources.