The Institution of Engineering and Technology

Ecosystems: shaping the future

UK Industry needs strength, resilience and sustainability

Business as usual post COVID-19 and BREXIT is not a sensible option

A Manufacturing & Supply Ecosystems Strategy Paper

by the

Institution of Engineering & Technology

Midlands Manufacturing Network

Contents

The research and data gathering has involved many people but the report has primarily been put together by four IET colleagues : David Archer (Chair of the IET's MMN), Ian Williamson (Chair of the IET's TPN), Marcelle Batson-Warner (Incoming Chair of the IET's Coventry & Warwickshire Network) and Colin Davis (Past Chair of all of them & past Chair of IET Council).

1. Foreword

Early in 2018, I was delighted to take part in key meetings held by the IET's Midlands Manufacturing Network, including one right in the Midlands Engine at Rolls-Royce. The issue, which had been linked with our Midlands Engine strategy as far back as 2016, is a pressing one, made even more urgent by the European Union exit and the pandemic; how to tackle the lack of cohesion of manufacturing supply chain processes and create a new ecosystem in the UK.

UK manufacturing is at a pivotal moment. Covid-19 and the supply of PPE has focused more attention than ever on our supply chains, and it is clear that among UK manufacturers there has sometimes been a short-term attitude to relationships with suppliers. Our organisations also face challenges to the future supply of critical materials, which has the serious potential to limit key industries and growth. Now is the time for drive and innovation: in product design and the use of new and emerging materials; in supply systems to support future technologies; and in the acceleration of digital transformation and decarbonisation as enablers of revenue growth and new product or service delivery.

We need to move away from traditional supply chain models and make greater, closer links between industry, original equipment manufacturers (OEMs) and SMEs - all can benefit from greater understanding and collaboration, and common processes, requirements and standards with the potential to streamline supply and boost economic growth and the positive societal outcomes that come with it.

And so I welcome this report and its recommendations. First, that the All-party Manufacturing Group should support the creation of a central authority to unite the UK's disparate manufacturing and supply ecosystem, both physical and digital. This will lead to higher, universal standards of practice, transforming the way all businesses in the ecosystem operate, including SMEs and OEMs, and driving economic growth. Second, that there should be a post-Brexit review of support schemes for the ecosystem encompassing everything from training and development to what the circular economy means for this sector. This will result in upskilling all tiers of supply systems and improve collaborative working between businesses.

Right now, we have an opportunity to transform the manufacturing and supply ecosystem in the UK. As an industrial powerhouse, the Midlands has a critical role to play. We have the potential to strengthen trade within the global economy and define our country's competitive position on the world stage, while simultaneously supporting economic recovery and levelling-up in the UK.

Sir John Peace
Chairman, Midlands Engine

2. Executive Summary

This report concludes that there is an urgent need to address the confusing and conflicting plethora of organisations and bodies in the UK that are involved with the many traditional supply chain models for operating and practising manufacturing and logistics networks in the UK.

The All-party Parliamentary Manufacturing Group (APMG) in the UK is in the best position to take an independent overview of the complexities and the opportunities for manufacturing and supply systems in the UK. It is independent of the many bodies and organisations involved and so best placed to help develop and encourage change, improvement and better cohesion.

The availability of digitally enabled manufacturing and supply ecosystems has heralded a new era that will see sustainability at its heart with a focus on conservation of the materials and energy deployed in those systems. Multiple cycles of disaggregation of components and materials with reworking and repurposing followed by reaggregation will increasingly become standard processes in an evolving circular economy.

Change and evolution is a difficult enough process for an OEM but it is multiplied many times for a SME. OEMs need encouragement to harmonise more of their manufacturing and supply systems with industry Standards and Codes of Practice but SMEs will need far more support to broaden their understanding and help them with the necessary upskilling that will be required.

According to House of Commons January 2021 Economic Indicators, manufacturing during 2019 represented 9.7% of UK economic output and 8% of UK jobs in March 2020. This is a significant base from which strategically vital UK manufacturing and supply ecosystems could be encouraged to evolve with stronger, more resilient, more sustainable and higher value adding systems.

3. Recommendations

The APMG is offered this report with a recommendation to review the major potential for improving productivity and efficiency in the manufacturing and supply ecosystems of the UK.

We also recommend that the APMG, as the best placed body in the UK, in partnership with industry, encourages and supports the development of the necessary Codes of Practice to help bring about the desperately needed cohesion of these disparate manufacturing and supply systems in the UK.

The APMG is also best placed to bring about the development and support of a much needed overarching Authority in the UK to help unify digitally based UK Manufacturing and Supply Ecosystems. An internet portal entry to a centralised repository of best practise methodologies, education, training, technologies and systems is needed that supports and underpins the Codes of Practice that would be at the heart of unification.

The primary role for such an Authority would be the continuous monitoring, regulation and ‘certification’ of content provided by third party institutions, training & educational companies & organisations accessed by the portal in order to ensure the proper relevance of such provisions.

A secondary, but just as important, role for such an Authority would be the monitoring of change as Ecosystems evolve and ensuring that the latest ideas and approaches are encompassed by the

portal. Equally, Codes and interlinked provisions will need regular update and adaptation to keep pace.

Existing associations & networks of industrial and sector companies need to be encouraged to recognise the enormous opportunities arising from commonising a greater proportion of their manufacturing and supply ecosystems and to seek ways in which they can take maximum advantage.

Based on a review of industry support schemes post BREXIT; national training, development and upskilling support schemes should be considered to address the implications of a circular economy and the opportunities to evolve better company manufacturing and supply ecosystems.

4. Introduction - Origins, Overview & Timeline

In 2013 the Institution of Engineering and Technology (IET) sponsored Prof Colin Davis to sit on the steering group of the UK Parliamentary Inquiry into manufacturing run by the All-party Parliamentary Manufacturing Group (APMG). The Inquiry recognised the importance of regions of the UK that are strong in manufacturing and held the first APMG evidence session away from Westminster in the Midlands. The APMG subsequently published its report “Making Good” which highlighted a number of issues in the sector including the needless multiplicity of common UK manufacturing & supply systems reflecting lack of standards and codes of practice and in turn leading to poor efficiencies and effectiveness.

In 2016 the Chairman of the APMG Inquiry invited the IET’s Midlands Manufacturing Network (MMN) to contribute ideas into the Government’s Industrial Strategy Green Paper which linked with the development of the Government’s regional policy and the strategy of the Midlands Engine. In June of that year the UK voted to leave the European Union (BREXIT), triggering Article 50 at the end of March 2017 with a two year count-down to 2019 (subsequently extended several times).

In 2017 the Chairman of the APMG Inquiry similarly invited the IET’s MMN to contribute ideas into the Government’s Industrial Strategy White Paper and in support of that, the MMN ran an Evidence Session led jointly by the Chair of the APMG and the Chair of the IET’s MMN, David Archer.

The Session focused on the lack of cohesion of manufacturing supply chain processes – what can now be a largely integrated digital process from product concept through design & engineering to best practice manufacturing processes and integrated manufacturing & assembly systems. Part of that discussion included increasing awareness of the opportunity to integrate recovery of surplus material, used materials and used components into a more cohesive circular economy approach to manufactured goods.

Large corporations have traditionally driven their own linear supply chain standards & processes which understandably cover specific requirements. However, a large number of such processes could be more broadly standardised across industry to the benefit of Original Equipment Manufacturers (OEM)s, First Tiers, Small and Medium-sized Enterprises (SMEs) and to the benefit of UK industry as a whole. But at the moment, there is no UK home for such things and in particular no support for UK SMEs faced with the multiplicity of needlessly differing requirements and standards.

BREXIT has served to highlight these needs even more, but this approach is looking at a much longer horizon and addressing more fundamental issues.

In February and March 2018 members of the IET's MMN held meetings at Rolls Royce (who were leading one of the manufacturing groups within the Midlands Engine) and at the IET's Savoy Place to explore ideas and concepts with the Chairman of Midlands Engine, Sir John Peace.

In June 2018, the IET's Head of Strategic Engagement & Partnerships met with the MMN in the Midlands and subsequently provided IET sponsorship to fund a Supply Chain project that included :

Researching best practice; accessing & supporting relevant MSc & PhD studies

Identifying tools, techniques & methods that assist in achieving World Class

Publishing IET best practice and developing guidelines

Partnership with KCL Institute for Industrial Strategy (Former Chair of APMG)

Partnership with MX Manufacturing Awards Scheme

IET Events with OEMs & SMEs to gather views & data

In November 2018 the IET's MMN ran a related Round Table event at Austin Court in Birmingham launching the project and focusing on the views of Midlands based SMEs & SME related organisations. The event was closely co-ordinated with the IET's national/international Manufacturing Technical & Professional Network (TPN) Chaired by Ian Williamson.

In February 2019 a project group met with the IET's northern Networks who were collaborating across the areas designated by the Government strategy as being included in the UK's "Northern Powerhouse" to explore the level of interest in taking the project forward in these areas.

Whilst there was some enthusiasm to take the project forward in the northern areas, it also became clear that significant involvement would be needed from members of the IET Midlands group (limited in number) to help drive and support related activities and events.

Throughout the year it also became increasingly difficult to engage with the major UK manufacturing companies on anything that was not directly focused on their strategies to cope with the implications of BREXIT and/or the implications of a general election.

By May 2019, the UK Prime Minister had resigned, triggering a leadership election.

In December 2019 the project group took advantage of an invitation to introduce and debate some of the issues at a 'Supply Chain Collaborator Forum' hosted by the Supply Chains in Practice group based at the University of Warwick and including selected OEMs among its members.

Also in December 2019, there was a General Election which confirmed the leadership of the current Prime Minister.

Also in December 2019, overshadowed in the UK by post-election issues and seasonal celebrations, the COVID-19 virus had begun its domination of affairs throughout 2020.

By March/April 2020 the lack of strategic thinking about UK supply chains for critical products and services became all too evident. Whilst there were stock piles of food available as a result of BREXIT planning, the UK Government struggled to cope with a lack of understanding of the manufacturing capabilities or capacities in the UK for such products as Personal Protective Equipment (PPE).

By April 2020, the MMN supply chain project members had switched focus to the pandemic and how the group could help with the crisis. Members rapidly began identifying local and regional companies who already had PPE products in manufacture or who had equipment and skills that could changeover to PPE output. Many of these were being ignored by the UK Government who were focusing on a small handful of supply organisations. In one case a UK company, unable to make

contact with UK Government, was manufacturing PPE at maximum rate and shipping everything they could to customers in the USA instead.

The MMN members set up a partnership – the Warwickshire Manufacturing Alliance (WMA) - with the University of Warwick (to provide an automated internet database to log companies with PPE manufacturing capabilities and capacities) and with Warwickshire County Council (WCC - to provide payment capacity and logistics to deliver PPE to local NHS district nurses, GP clinics, Care Homes and many other front-line users who were unable to access the PPE supplies that they needed).

Whilst the UK Government had focused on "scale" to seek supplies irrespective of manufacturing location, the MMN members realised that their "County" level approach had many advantages when it came to understanding the likely hotspots of local infection, the likely transmission at local level, the most vulnerable people in their area, together with the manufacturing capabilities and capacities to address those needs with very short supply lines.

In July 2020, the Midlands Engine linked with the Association of County Councils in the UK for a webinar event at which the WMA presented its approach and activities. This was followed by a webinar presentation to the APMG attended by many UK MPs.

By the Autumn of 2020, some of the pressures had reduced and the regular meetings with the WCC were extended to fortnightly. The agenda also changed and increasingly turned to the issues of a post pandemic economic recovery.

December 2020 heralded increased focus on BREXIT by year end and the increasing likelihood of a "No Deal" scenario. It also heralded apparent reversion of the NHS to old supply practices with little or no recognition of the new roles that UK manufacturing could offer and no recognition of the way that an enlightened economy could address the mountains of single-use PPE waste.

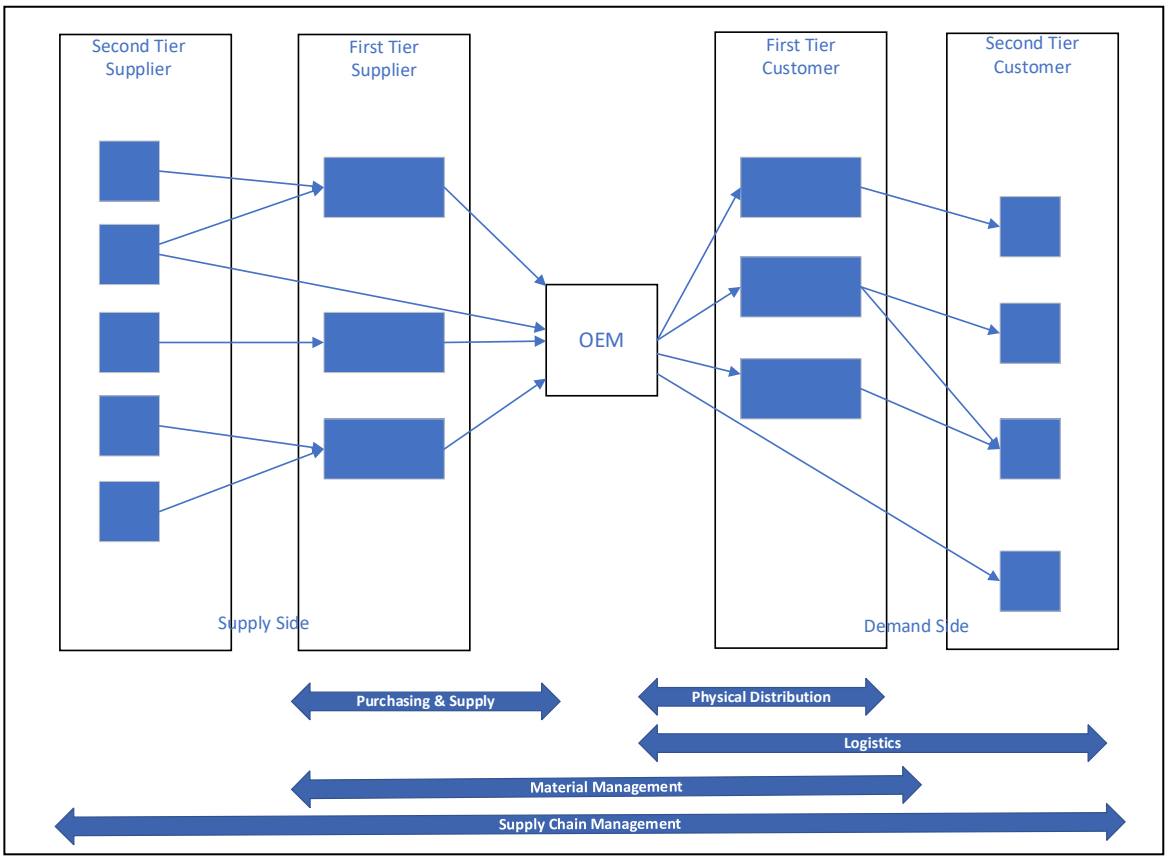
December 2020 highlighted, more than ever, the opportunity for the UK economy to embrace the concepts of a circular manufacturing & supply economy at a strategic level: to innovate products, processes and practices that have at their heart the integration of recycling and re-purposing of components and materials.

The growth of global populations, economies, resource consumption and man-made climate change, flags more than ever, the need for the conservation of materials and energy deployed in products and services.

The opportunity is there for a new approach to the manufacturing & supply ecosystem in the UK.

This report provides a summary of the findings from the activities, events and debates carried out and also an overview of the very real example of the massively negative issues of a manufacturing and supply economy that does not adopt a circular economy based on integrated manufacturing & supply ecosystems.

5. Past and Current Supply Chain Models



Pictorial representation of a typical traditional supply chain

Supply processes have been developed over considerably long periods, requiring consistent attention to detail aimed at removing variability and unplanned events from the process.

Control over them has evolved from an initial focus on managing and improving relatively simple, but very labour-intensive processes to the present day where we have the challenges of managing vast and complex industries with digitally enabled global manufacturing and supply systems.

> ***"A supply chain is a system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer. Supply chain activities involve the transformation of natural , raw materials, and components into a finished product that is delivered to the end customer. In sophisticated supply chain systems, used products may re-enter the supply chain at any point where residual value is recyclable. Supply chains link value chains"***
>
> ***Source: Wikipedia***

Traditionally, supply chains have linked vertically, and linearly, through legally contracted layers or 'Tiers' of companies from raw material to components and sub-assemblies to the finished product and its 'customer'. There may also be several layers of 'customer' as other services are added to the basic product to increase its value. OEMs may control all or some of the customer interfaces and usually all of the product concept, design and 'Bill of Materials', with Tier 1 companies controlling Tier 2, controlling Tier 3 etc.

Evolution Stage	Time Period	Philosophy	Key Driver	Key Business Performance Metric
1.	Early 1980s	Product driven	Quality	• Inventory turns • Production cost
2.	Late 1980s	Volume driven	Cost	• Throughput • Production capacity
3.	Early 1990s	Market driven	Product availability	• Market share • Order fill rate
4.	Late 1990s	Customer driven	Lead time	• Customer satisfaction • Value added • Response time
5.	Early twenty-first century	Knowledge driven	Information	• Real-time communication • Business intelligence
6.	2020s	Sustainability Circular Economy	Conservation of materials & energy	• No. Re-purposing cycles • Agility - innovation response time • Market response time

The power to negotiate the legal supply agreements at any interface in the system can quickly become a very complex affair but it is key to the growth, profitability and the innovation ability of any of the companies involved.

In the automotive sector, many of the 'OEMs' have become financial and management corporates, altogether remote from the manufacturing and supply systems that deliver some of their financial inputs. For them, the change from petrochemical motive power to hydrogen or electric vehicles will be far less traumatic than many of the Tier companies that have traditionally supplied them.

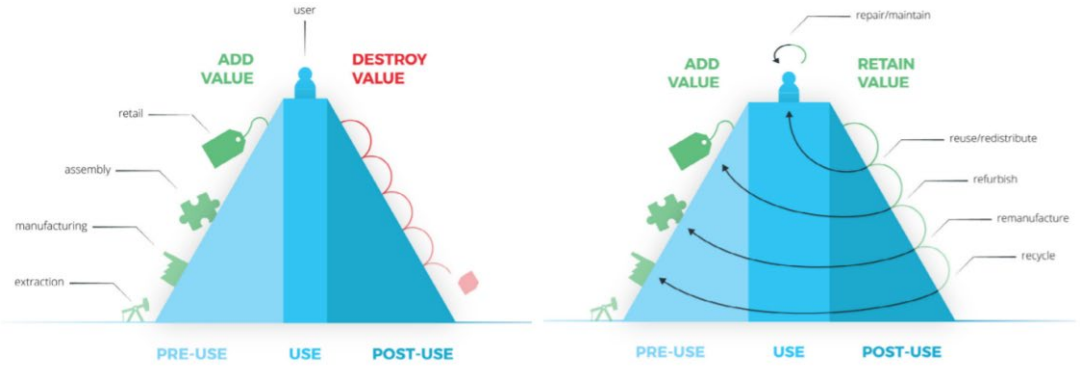
Some of the automotive Tier 1 companies have become larger and more powerful than their OEMs, giving them more negotiating power than the OEM – which can be a major issue if there is an end user warranty dispute for example.

There are a multitude of examples where lower tier SMEs have patented their innovations and have developed business opportunities for products and services outside of their traditional supply links. In some cases the OEM recognises the potential opportunity for them to incorporate the developments into their offerings. Unfortunately, it is also the case that a sluggish and 'conservative' OEM may think it is easier for them to buy the SME and stop any forward development of a competitive innovation.

So, supply systems management should not be viewed just as an activity that combines manufacturing and physical distribution, but an ecosystem of multiple business networks working in collaboration, comprised of multiple stakeholders, including suppliers, manufacturers, distributors, third-party logistics and many others.

More than that, with a circular economy approach, the entities needed for disaggregating, disassembling, re-working or re-purposing components and materials may be very different to those used for the creation of the initial product / service package.

The concept and design stage will become more important than ever to be able to encompass whole life and multiple re-purposing of components and materials. Financing businesses incorporating whole life costs will be viewed and accounted very differently and the ability to understand the most profitable ways to conserve materials, energy and other resources will become a key to success.



A move from destroying value in a linear economy to retaining value in a circular economy
Source: Achterberg et al. (2016)

Success will also depend on the agility with which complex manufacturing and supply ecosystems can standardise, handle and manipulate organisational linkages to deliver the response times expected by the marketplace. Digital and compatible data systems will be mandatory and sequentially thinking businesses will be replaced by an ecosystem of businesses and organisations networked in parallel.

The global response to the COVID-19 pandemic is a case study example of how traditional sequential concept, design, manufacturing and supply processes can be telescoped into a radically foreshortened time frame.

6. Standards and system structures

Although manufacturing operations differ, it is important that companies have a consistent approach for determining how the ecosystem should be designed to meet the demands of particular market sectors.

The consequence, of having no general consensus and agreed supply chain models, and no standards, is that SMEs find themselves having to service a number of supply system models that are based on variants of early works. This has been identified as a causal factor inhibiting growth of market opportunities and business expansion. Within the UK we have no standardisation of supply chain practices and principles. The time has come to re-balance our supply systems and gain industry acceptance to achieve generally agreed practise and principles.

The adoption of formal and consistent supply system processes and procedures can be challenging in SMEs with the limitations that they have on staff and skills. Successful systems need to be straightforward to use and as automated as possible. Upskilling our SMEs is a key factor to enhance and promote supply system excellence but the onus is on the OEMs to make better use of modern digital ecosystems in the first place.

Upskilling all tiers of our supply systems will improve the ability of companies to work more closely with one another under a variety of business arrangements including strategic alliances, joint ventures and long-term supplier relation schemes.

The success of companies and supply systems has depended on its managerial ability to integrate and coordinate the supply chain partners (Drucker, 1998; Lambert and Cooper, 2000) and the same will apply to other forms of manufacturing and supply ecosystem. They refer to a supply chain as an *integrated system* that synchronises a series of interrelated business processes in order to: (1) create demand for products; (2) acquire raw materials and parts; (3) transform these raw materials and parts into finished products; (4) add value to these products; (5) distribute and promote these products to either retailers or customers; (6) facilitate information exchange among various business entities made up of suppliers, manufacturers, distributors, and logistics providers / retailers.

Managerial skills will be similarly vital to the evolution from traditional linear systems to the integration and co-ordination of the far more complex interactions required in a circular economy approach with its built-in complexity of re-working and re-purposing decision matrices. Upskilling OEM personnel will be just as important to the success of manufacturing and supply ecosystems in the UK as upskilling SMEs.

A survey of 602 financial executives conducted by FM Global and Harris Interactive found that supply chain disruptions were the biggest threat to a firm's revenue drivers (Yang and Gonzalez, 2006). Considering the enormous impact of supply chain disruptions on a firm's financial status, today's firms are increasingly pressured to manage their supply systems in better ways.

The importance of supply system management has been escalated into the forefront of a company's competitive strategy. The discipline of supply chain management, however, is still undergoing an evolutionary process.

The use of Supply Chain Performance Measurement Systems (PMSs) has been associated with the necessity to obtain accurate information for the management of Supply Chains so as to achieve performance efficiency within and across organisations (Gunasekaran & Kobu, 2007).

Substantially, PMSs provide the required tools to identify weaknesses in organisational processes, monitor the work progression against targets, provide benchmarks for employees at all levels of the organisation and promote a better understanding of the operational aspects of the organisation (Laihonen & Pekkola, 2016).

However, these tools will need significant development to encompass the concepts and decision trees of a circular approach to manufacturing and supply ecosystems. Obtaining accurate information represents a critical process for organisations to align with defined performance targets and respond to the changing dynamics of the industry (Gunasekaran & Kobu, 2007). Similarly however, these performance targets will need adaptation along with the different metrics.

PMSs are frequently linked to making strategic decisions, elaborating long-term plans and improving communication channels with coordination across all areas of the organisation (Simons, 1994). The efficiency of a PMS is a requirement for manufacturing industries to achieve higher performance, streamline processes, provide better services to customers and eventually raise profits.

The necessity to investigate the validity of PMSs originates from the inability of industries to exploit them to their full potential and maximise their utility. Many manufacturing industries operating supply

chains have been unable to capitalise on the benefits of PMSs as they lack the knowledge and expertise to implement and utilise them effectively (Akyuz & Erkan, 2010; Laihonen & Pekkola, 2016). Moreover, research efforts aimed at developing models and strategies to help organisations incorporate and operate PMSs efficiently are limited by stumbling blocks that hinder the optimal progression and development to state-of-the-art approaches (Maestrini, et al., 2017).

To minimise these issues, manufacturing industry in the USA has been assisted in the last six decades by the American Production and Inventory Control Society (APICS), which is an official Institution that provides training, guidance and certification for professionals and organisations.

The aim has been to develop knowledge and practices to improve the use and implementation of PMSs, as well as providing resolution to other industry-specific issues (APICS, 2019). However, the scope and coverage of the services offered by APICS are confined within the boundaries of the country where it operates, leaving other countries facing these issues independently (APICS, 2019).

The UK is among those countries that suffer from a lack of sufficient Institutional support to enable organisations to operate efficient supply systems (Reynolds & White 2013). Playing a significant role in this are the economic and political conditions underlying the country's manufacturing landscape as well as the ongoing struggles in overcoming the stagnant situation that sees industries unable to improve their productivity and utilisation of resources. UK manufacturing industries are still a major component of the UK economy accounting for roughly 44% of UK exports and 10% of national GDP (Rhodes, 2018) (Williamson, et al., 2019).

The research in the area of PMSs has been generally devoted to developing models, strategies and approaches to suit standardised scenarios without considering the specific environmental and operational aspects of each organisation.

These are obstacles for UK organisations to apply the developed theories effectively and acquire the required knowledge to benefit from them. It is unclear the extent to which the developed theories supporting the implementation and utilisation of PMSs are effective for UK manufacturing industries. Also, considering the conditions and characteristics of the UK manufacturing landscape, there is little knowledge about the specific factors that contribute to helping British organisations achieve global competitiveness.

UK manufacturing institutional and private bodies differ from APICS in that they are not jointly regulated as a single governing entity, and many of them have no affiliation with the government. The lack of official representation in the UK, as opposed to the US, exacerbates the efforts to minimise the issues in advancing research in supply systems and transforming new theoretical approaches into practical and functional practices.

One of the aims of this research initiative is to prompt the need to establish a unified solution to respond to the issues surrounding manufacturing and supply systems in the UK. Gathering information from within the industry can help identify work dynamics, rooted and ongoing issues, performance requirements and the level of satisfaction within organisations. All of which will serve the purpose of helping the initiative to prioritise the most critical objectives and tackle the issues with informed decisions.

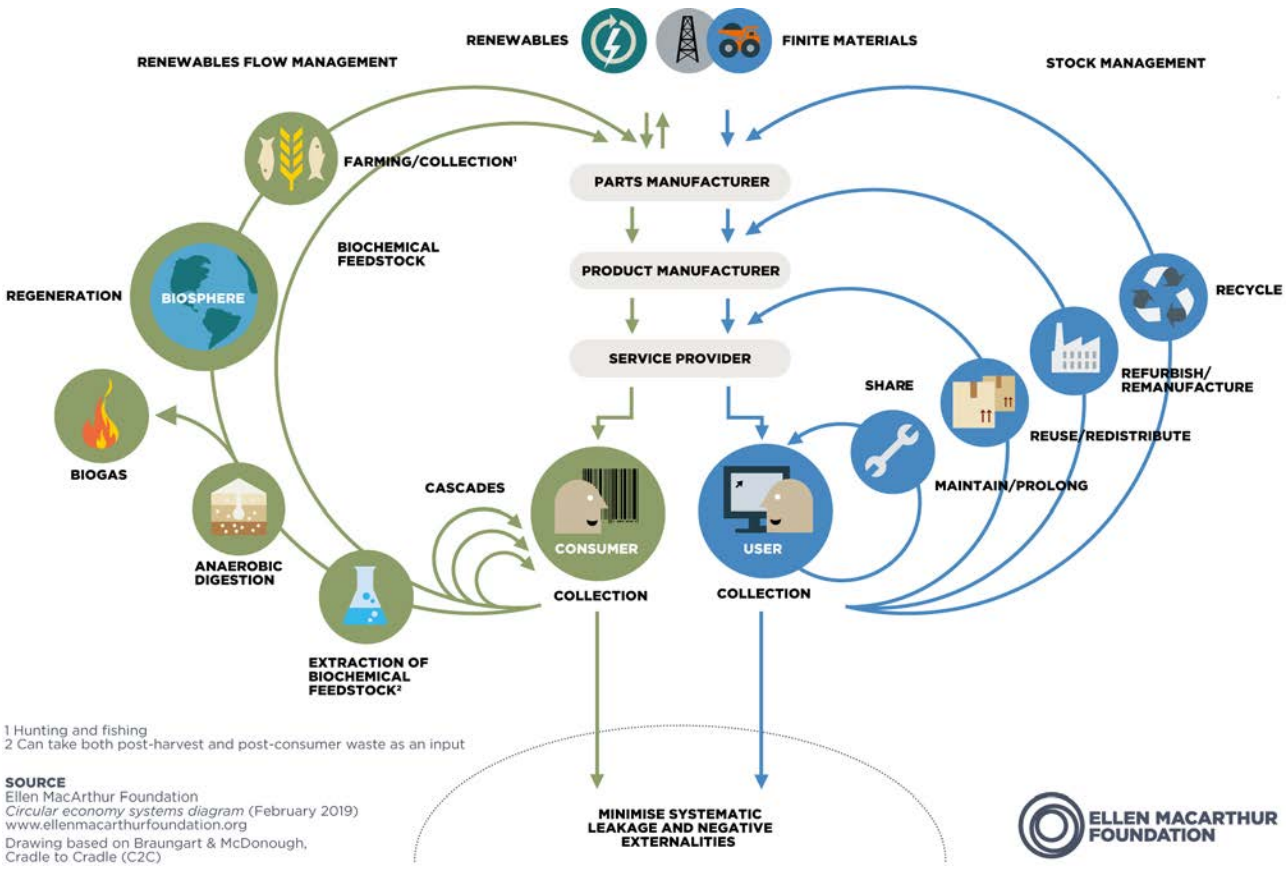
7. Opportunity for new thinking

A New Approach to Manufacturing & Supply Systems ?

The research has identified that the United Kingdom requires a leading authority to support the development of generally agreed supply system management practices and principles. It needs to advocate end-to-end system excellence, including reworked and repurposed components and materials as part of a circular economy. It needs to foster the advancement of supply system management through a body of knowledge, innovative research, systems, and methods to assist all parts of a Manufacturing and Supply Ecosystem to maximise their individual and collective potential to create better value.

The world of supply system management never stops advancing — and neither should supply system professionals or their organisations whether OEMs or SMEs. Within the global trading arena supply systems both enable and inspire human and economic possibility. There is more to supply systems than supervision, more to performance than process and more to people than position job titles. However, for companies to reach their potential they require knowledgeable people at all levels of the supply system.

What is needed is a UK body, perhaps with some comparability to the Association of Supply Chain Management (ASM) in the United States as far as the structure goes, to develop and promote generally agreed practices and principles, that promote manufacturing and supply systems excellence, that recognises the need for repetitive loops of reworked and re-purposed components and materials. The economics of manufacturing and supply systems will increasingly depend upon the economics of locally conserved materials and energy.



Fostering the advancement of the management of manufacturing and supply ecosystems will be a key enabler to elevate business potential. A higher level of common standards and practice is needed that is universal between businesses within an ecosystem; between OEMs and SMEs; transforming the way people do business, driving growth within the global economy. In time a global supply ecosystem model would make it significantly easier to trade within the global economy.

The formation of a primary portal for certification and training for supply systems is needed in the UK - offering provision and access: to education and certification, to benchmarking and best practices, setting the industry standards, to developing people, to improving ecosystem functions. This will be a key enabler to driving innovation in our industrial sectors with new products, services, and partnerships to advance and propel companies to further optimise their manufacturing and supply systems, securing their competitive advantage. Significant business growth does not happen by accident.

Supply professionals can no longer be seen as mere extensions of a purchasing and logistics department.

Supply System Professionals need to have a thorough background in the circular economy and what that means to develop designs and components that can easily be disassembled, disaggregated, re-used, repurposed or recycled. They need to be familiar with the rapidly changing requirements for alternative environmentally friendly materials and energy efficient processing techniques not to mention the use of energy efficient solutions and devices.

A UK body is needed to provide frameworks along with provision of / access to: sector-based research information, education, training and to provide industry focused education and professional certification; all of which are key enablers for individuals and companies. SMEs and OEMs need the development tools to become effective ecosystem leaders. This will help organisations stay competitive and provide the bedrock of economic possibility in the UK.

8. Potential evolution of Manufacturing & Supply Ecosystems

The report has highlighted the issues with traditional supply chain methods and principles. Businesses, OEMs and SMEs, may have not recognised or realised the benefits of long-term supplier selection and supplier development and the benefits that this could deliver to businesses within an ecosystem. Encouragement of UK based long-term supplier relations needs to be addressed and new approaches of industrial thinking adopted to optimise our future manufacturing ecosystems.

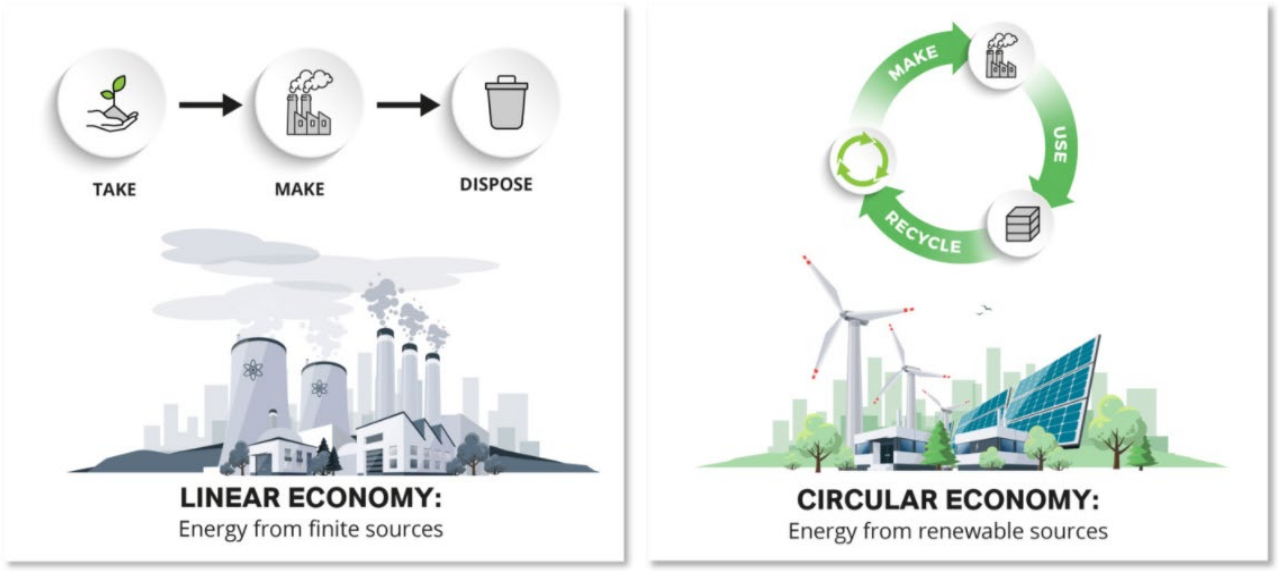
Currently within the UK, none of the major institutions are driving evolution and there is no entity responsible for advocating best practice, industry standards, working practices, supplier selection criteria and performance measures. There is no standardisation, and this is a vital ingredient to the success and future prosperity of UK manufacturing; challenging the current approaches to our management of supply chains will be an essential catalyst to developing our future eco systems.

UK manufacturing faces challenges to the future supply of critical materials, which may threaten availability in the future, constraining key industries and growth. We have the dawning of a new age with our post Brexit transition. We have an opportunity to redefine and strengthen our industrial

sectors. We need to be innovative with new products & designs in the use of new and emerging materials, reducing our susceptibility around materials scarcity in the future.

Perhaps more importantly, we need to be thinking about how we can re-use existing products, components and materials; how we can refurbish, how we can re-condition, how we can re-purpose, how we can completely re-work as necessary. Design thinking needs to change to reflect the whole life opportunity for materials and the issues involved in multiple disassembly and re-aggregation of materials.

Similarly, we need to understand and measure all of the energy transfers and consumption required throughout the life of materials, their processing and re-processing. Only by considering whole life energy consumptions will trade-offs and alternative process comparisons be meaningful. Equally, it will only be by whole life thinking that true comparisons can be made between alternative products and solutions.



Source: LANXESS website Circular Economy (lanxess.com) https://lanxess.com/en/Responsibility/Societal-Added-Value/Circular-Economy

Considering industrial conventions beyond the current take-make-waste extractive industrial model, a circular economy aims to redefine growth, focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite materials / resources and designing waste out of the system. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural, and social capital. It is based on three principles:

1. Design out waste and pollution
2. Keep products and materials in use
3. Regenerate natural systems

Industry needs to consider and embrace the evolution and development of our manufacturing ecosystems creating closer links between original equipment manufacturers and SMEs, changing our traditional approaches around fostering business relationships. We need to move away from traditional supply chain models and understand more fully the evolution of manufacturing ecosystems. We need to embrace longer-term relationships between facets of manufacturing ecosystems including joint ventures, strategic alliances and partnerships as opposed to traditional

supplier / buyer relationships that tend to be focused on short-term thinking and driven by unit costs rather than the value to the whole-life integrated system.

Despite representing a significant and profitable opportunity, SMEs face financial exclusions that leave them unable to compete with the bigger players. Lack of access to affordable banking solutions limits SMEs' potential and hampers their growth. In turn, because SMEs play an important role in economies around the world it has a negative approach globally.

That SMEs struggle to access suitable and affordable banking is nothing new. In times of trouble, like now, and with little cash left in the accounts, government support does not always go far enough. SMEs need additional funding to pay rent, utility bills and payroll, not to mention stock orders for anticipated customer demand. They also need cost effective payment and foreign exchange services. However, as most are unable to provide a long credit history or report consistent revenues, many SMEs find their usual bank can't (or won't?) help and they are left unable to gain access to the services they require.

When banks first started, market requirements were very different, and no one could have imagined the cross-border, digital, international trading landscape in which we currently find ourselves. The once pioneering systems and in-house servers on which banks are built, now present a significant challenge in deploying new software and the application of best practice. Similarly, the linear supply chain model also is no longer fit for purpose and requires replacing with a Supply Ecosystem fit to serve a 'circular economy' in an ever-changing world.

Key enablers to prosperity: -

- There is a limited understanding of the manufacturing capabilities in the UK at the time that the Government was turning to industry in the national interest to produce critical products. Regional/national collaboration would assist in building trust and confidence in areas of mutual interest between partner organisations, trade bodies and the partners for the long term. This would also allow the assimilation of ecosystems at a national and regional level.

- Engagement and training achieved long-term configuration of our manufacturing ecosystems. If UK based supplier selection and regional/national collaboration can be achieved for UK based manufacturing businesses, the impact would be enormous. Long-term business arrangements within ecosystems would ensure there is pollination and education from OEMs through the subsequent tiers of the ecosystem. This would be reciprocated with knowledge from SMEs, also educating our OEMs; also instilling business trust and confidence.

- Intervention providing skills inputs at all levels from OEM – T1 – 3 of our industrial eco-systems. This can be achieved through better education, recognition of standards, principles, models; and best practice that would be achieved through shared knowledge within manufacturing ecosystems - optimising the effectiveness of an ecosystem.

- The UK has a challenge that needs to be addressed to develop better linkage between businesses operating within eco-systems. Fostering long-term business relationships within ecosystems would promote the dissemination of best practice with better mutual support within the business community, including the finance sector and industrial ecosystems.

- Manufacturing ecosystems are accelerating digital transformation and results, with early adopters achieving twice the revenue growth, digital maturity and new product/service delivery as their peers.

- We also need to consider growth and future development of brownfield developments in areas where we want to introduce manufacturing. This may be influenced by suppliers, materials availability, skills and affordable infrastructure.

- When setting up new plants and facilities, consideration should be given to creating supplier parks around the periphery of an OEM providing scales of economy, reduced transport time and cost and this will allow closer working relationships to evolve on a regional and national level. Connectivity of transport rail, air and road networks will also be key enablers.

9. Pandemics and evidence to support the need for a UK Manufacturing & Supply Ecosystem

Case Study: PPE Demand and Warwickshire Manufacturing Alliance

Background:

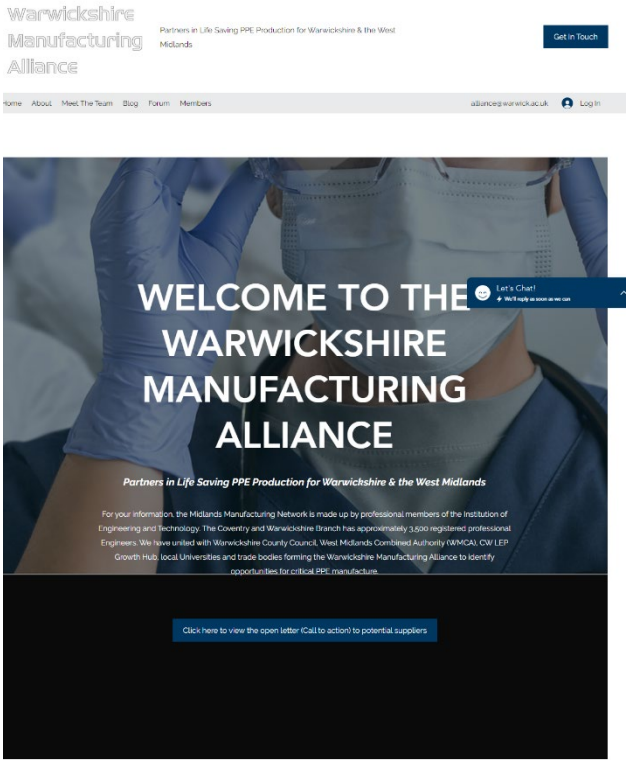
The Warwickshire Manufacturing Alliance (WMA) came into existence in March 2020, as a result of a shortage of all levels and types of PPE (Personal Protection Equipment) across the nation resulting from the COVID-19 pandemic. It was begun (initially) through a local call for help from the Friends of Rugby St Cross hospital for PPE to use in the care sector.

As volunteers of the IET, representing the Midlands Manufacturing Network (MMN), we felt and believed that we were in a good position to assist through our network of people and companies, from OEM's to SME's. We added to this our extensive knowledge of manufacturing industries, processes and contacts covering all areas of production, technologies and materials, as well as excellent connections with the local universities, fellow institutions, MP's, councils and other recognised bodies.

Action:

Utilising this network, we established contact with Warwickshire County Council (WCC), head of procurement (buyers, standards, volume, type, demand & capacity) and Warwick Manufacturing Group based in the University of Warwick (expertise of materials, processes, available technologies and government contacts). This created what has become the Warwickshire Manufacturing Alliance. (See webpage graphic below)

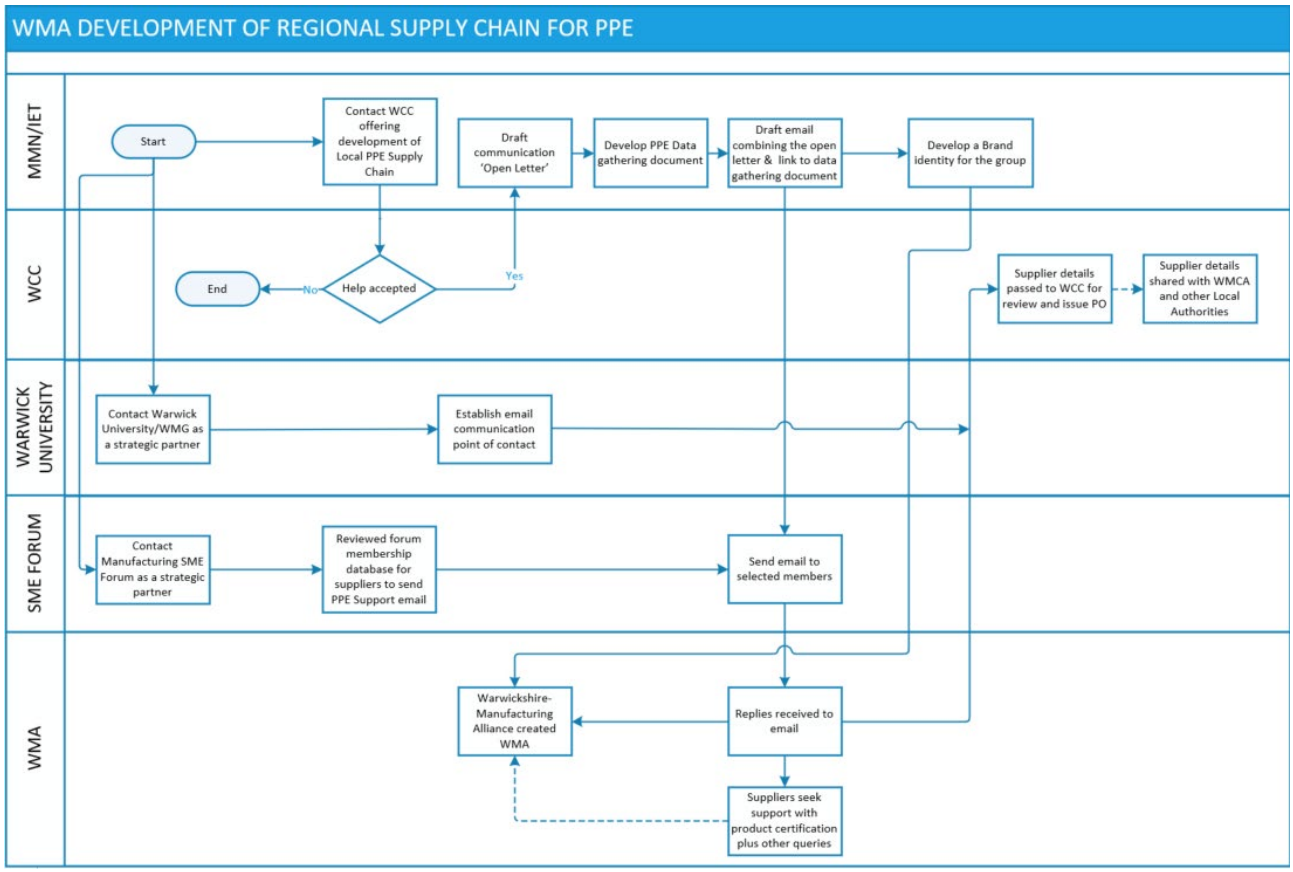
https://www.warwickshire-manufacturing-alliance.co.uk/



We created a website as the focal point and portal for enquiries, information on the exact standards for each piece of PPE required and a place to register. This was fully automated to populate a spreadsheet of data so that the company's products, including volumes, types and costs would go directly to the WCC purchasing department for immediate action.

Secondly, those wishing to know more before registering could email the enquiry through an address hosted by WMG. We, the WMA/IET MMN, monitored the site to answer queries and work with the companies to point them towards any further expertise needed and to help them to contribute. (See graphic below)

WMA 2020 – PPE Manufacturing & Supply Development Process



However, our main task was to stimulate companies to respond. This was achieved by contacting every company within Warwickshire and the West Midlands whom we felt had the right background, capacity, materials or expertise from our database. Due to urgency and the need to respond quickly, we restricted ourselves, initially, to contacting 325 most likely companies (from the PPE materials requirement perspective) out of an initial list of 1200 companies. Our group, IET MMN, met seven days a week for a minimum of 1hr, and once a week with WCC for 1 hour, to monitor progress and respond to product demand, or to seek solutions to PPE that were hard to find - body bags as an example.

Results:

Within a month of setting up the webpage we had created a PPE supply structure with 18 companies registered and a further 28 interested to gather more information (before registering their company's details).

One of the key issues that we wanted to focus on was the circular economy, job creation and maintenance post COVID pandemic and the establishment of a home-grown PPE Supply System for the UK, so that we would not be in the same position again. The latter challenge is one that is still ongoing as the government reverts to type, ignoring the potential of UK companies, the green agenda and the need to reduce landfill.

Some of the companies were already embracing the green agenda and a circular economy approach. One instance is a UK company re-using PET plastic bottles from recycling centres and then remanufacturing the materials into Face Shields. As a result of not only reducing the carbon footprint, reusing materials and creating new products, they are able to produce a face shield at a third of the price of its Chinese-made rival. They are generating and maintaining UK jobs and employment and their product is, of course, fully recyclable. However, at the end of the pandemic's first phase, NHS orders reverted to previous suppliers (mainly Chinese), irrespective of cost, quality or the need to change to a circular green economy - abandoning many of the UK manufacturers!!!!

Conclusion:

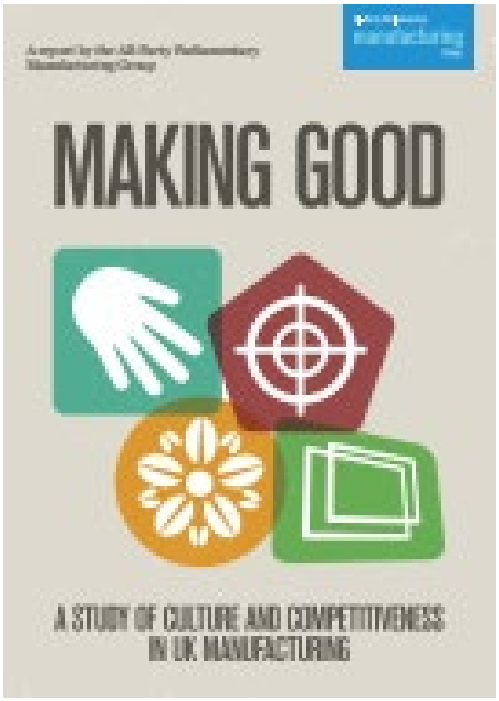
If we had a National Manufacturing & Supply Ecosystem Authority we would be in a better position to meet the government's own objectives, set out in its various papers, as well as meeting the specific needs of the County. This would also meet the needs of future UK job employment and reduce the reliance on long lead and delivery times. We would also be more aware of the UK's capacity concerns and capability and be better able to support any UK government in future crises regardless of its nature!

The key has been developing good communications and network building across a short supply chain from material supply through to end user, via a County level authority, who had access to the local demand needs and cycles and who could respond and pay the suppliers. In this case, the IET MMN acted as enablers: to help understand the available manufacturing ecosystem, identify and relate to the needs and facilitate immediate responses.

The fact that we had a supply system up and running within 30 days is an excellent example of the private sector, public sector and academic sector working in harmony and collaboration. A brief exploration of Local Authorities, Universities and Organised manufacturing groups in other parts of the UK suggests that similar structures to the Warwickshire Manufacturing Alliance could have been replicated in similar fashion across the whole country!

10. Role for regulation and governance

The Need for an Overview Body



The Midlands Manufacturing Network initially started working with the All-Party Parliamentary Manufacturing Group (APMG) led by former Conservative MP Chris White and Labour's Jonathan Reynolds in 2013 when the APMG commenced its first Parliamentary Inquiry into industrial culture and competitiveness between March and September 2013. The main objective was to examine how Government and industry in the United Kingdom can work together, to achieve a resilient and world-beating manufacturing sector coming out of recession. The APMG has shone a critical light on how Government, industry, and business support structures interact with the manufacturing sector to drive growth.

The inquiry obtained evidence from a broad range of organisations in the debate including manufacturers, suppliers, trade associations, civil servants, trade unions, professional institutions and chambers of commerce. On the 21st of August 2013 an evidence hearing was held at Warwick Manufacturing Group at the University of Warwick. This was significant as it was the only evidence session held outside of London. Throughout this inquiry the APMG gained a multitude of perspectives that can offer insight for changes to future UK manufacturing policy. Interaction between stakeholders and Government will be critical in identifying how the UK will need to embrace change to assist our manufacturing sector and aid the future prosperity of the United Kingdom.

The importance of supporting our manufacturing heritage was for a time forgotten, with offshore manufacturing becoming a common commercial option in lower cost economies, fewer people entering a career in manufacturing and less reliance on the sector in favor of our financial services sectors. We now have an Industrial Strategy, underpinned by the manufacturing manifesto, obtaining cross party agreement on long term industrial support.

The United Kingdom has seen unprecedented change since 2016, modifying our economic landscape, creating trading opportunities and recognising challenges ahead. The most significant is the decision to leave the European Union (EU), which will not only alter our trading relationships with the rest of Europe but will also have an impact on the flow of engineering talent into the UK.

Although BREXIT gained much of the attention in the day-to-day national debate, it is not the only issue occupying the minds of employers of engineers and technicians.

As a Country, the UK has a world-renowned reputation for pioneering design and development which we need to capitalise and exploit. We have started to see growth in our sectors and manufacturing being re-shored. As Engineers, we face many significant challenges considering the scarcity and availability of some materials, renewable materials, recycling of materials, improved transportation, and power generation to name a few. We have seen how manufacturing has realised many human aspirations; producing products that have transformed our lives, more affordable products through better design and use of materials and through developing more efficient manufacturing methods.

The pace of technological change is rapid. The digital transformation of production and supply systems in our sector means businesses must think hard about how they prepare for the impact it will have on the kind of jobs and skills that they need.

There are widespread concerns in our manufacturing sectors about the continuing shortage of people with the right skills and capability to do the jobs which are being created in the United Kingdom. We believe employers, educators and government must develop, attract, educate and prepare more diverse engineers and help prepare young people for the demands of working life which will allow the UK to realise the full potential of trading opportunities in a time when the Government is attempting to rebalance the economy in the United Kingdom.

Employers continue to grapple with the challenge of finding and retaining the right people, with the right skills, to ensure they take advantage of the robust demand for their products and services. With the concern around skills supply showing no signs of going away, it is critical that we commit to taking steps which will avoid this becoming an intractable problem. Working collaboratively with Government, Parliamentarians, Professional Engineering Institutions and Educational bodies to address the skills crisis is crucial. There is optimism about new trading opportunities and our ability in the United Kingdom to thrive as a major manufacturing nation in a truly global competitive market.

Engineering is once again a career path for young people with extensive support to train and educate the next generation. Education is important for all engineers, who need to continue to update their knowledge and learn best practices from our global community and it is important that we learn from one another.

However, the manufacturing and supply skill sets at the heart of both the existing workforce, and the educational system updating and supplying it, must drive the change to new processes and practices. The management structures of today must be encouraged to appreciate the needs and benefits of changing to the manufacturing and supply ecosystems that will dominate the evolving industrial landscape and to demand personnel able to develop and work with the new processes and practices.

The UK Government is the only body able to provide the necessary oversight across the multiplicity of current approaches and systems in order to find, support and help regulate the rationalisation needed. The elimination of the current wasteful duplication and the drive towards an environment that will encourage and enable the opportunity for integration in a circular economy network of organisations needs new Codes of Practice with enforceable standards and processes that can be agreed with industry.

Equally, Government is the only body, in partnership with industry, that can help unify the approaches to skills training & development and to introduce the new curricula needed to evolve circular manufacturing and supply ecosystems in the UK.

An obvious start point to bring about the necessary changes is the very APMG that triggered much of this work to begin in the first place.

11. Findings

The Key Questions and Concerns Debated

The cross-section of people that had been selected and invited to participate in the Round Table debate in the Midlands was chosen deliberately to provide a wide mix of views across different industry backgrounds and sectors. The debate had been set in the light of the findings from the

Manufacturing Inquiry and focused on some of the issues that the “Making Good” report had surfaced and raised but not answered.

As with all systems, if the current system is not fully understood, there is a real risk of perpetuating practices and processes that should be eliminated in the first place. The point of change is the point at which everything should be challenged and understood from the viewpoint of the new environment, the new technology and the new practices and processes.

So the questions and points discussed prompted the open discussion that followed, over and above the direct questions themselves:

- Examine the interactions – between manufacturing businesses at all levels of the manufacturing & supply system, Government agencies including the Midlands Engine and West Midlands Combined Authority, Chambers and Trade associations.
- Identify industrial concerns and problems in manufacturing & supply system dynamics and performance
- Understand industrial culture regarding manufacturing & supply systems – what does this mean, what shapes it, and how can it be changed
- Spark dialogue and an honest and open conversation on future manufacturing across the sectors and wider economy
- Develop a more sophisticated understanding of industry expectations to improve manufacturing & supply system capabilities

11.1. Statements and Challenges Posed

- We believe that the UK does not have a body or organisation for manufacturing and supply systems identifying best practice, promoting standards, regulating supply systems or advocating best practice Manufacturing & Supply System Management at OEM or Tier1-3 supplier levels.
- There is limited understanding of processes between OEMs & SMEs which causes SMEs to follow many different supply system models and processes.
- There is a short-term attitude to supplier relations. We need to cultivate local and national long-term supplier relations to develop our world leading sectors.
- We need to start growing supply systems to support future technologies that will define our competitive position.

11.2. The Main Issues Identified

• Treatment of suppliers in all tiers of the supply system needs to be improved

• Procurement needs to be improved with better demand schedules. Technology may be a key enabler with portals and platforms to exchange data

• Long term visibility throughout the supply system (taking account of the span of control and forward and backward integration in the supply system)

• Organisational structures need to be considered, eradicating a bonus orientated culture

• Better metrics need to be used within business to measure the effectiveness and performance of the supply system; these should be split between customer facing, business facing and end user facing

• Better Board diversity with managers that have supply system experience

• SMEs find scale up difficult and daunting with a lack of long-term viability or business relations cited as an issue.

• There is a problem with best practice supply system methods and principles. None of the major Institutions are responsible for advocating best practice, industry standards, working practices, supplier selection criteria or performance measures. There is no standardisation, and this is a vital ingredient to the success and future prosperity of UK manufacturing. Whilst there is a lot of academic work available, this needs to be identified to business.

• Businesses and OEMs have not recognised the benefits of long-term supplier selection and supplier development. Encouragement of UK based long-term supplier relations needs to be addressed. One of the Institutions needs to be responsible for supply system standards, practices and principles.

• New product development

• Risk and Revenue

• Profit sharing schemes

• Engagement and training achieved through cascade training through the supply systems. If UK based supplier selection and regional/national collaboration can be achieved for UK based manufacturing businesses, the impact would be enormous with Tiers 1-3 of the relevant supply systems receiving education from OEMs. Also providing business confidence.

• Intervention providing skills inputs at all levels from OEM to T1-3 of the supply systems. This can be achieved through better education, recognition of standards, principles, models and best practice.

• Dissemination of best practice and better signposting for companies with specific challenges in considering the identified best practice.

• Regional / national collaboration would assist in building trust and confidence in areas of mutual interest between partner organisations, trade bodies and unions for the long term.

• We need to upskill our Project Managers Eg. through the accreditation of the Project Management Institute and Association of Project Managers. To improve project outcomes and time to market for new products.

• To support the development of globally competitive manufacturing businesses through modernisation in key operational areas and through diversification. Capitalising on innovation such as transport e.g. electric vehicles and infrastructure development.

• To develop the performance of individual manufacturing businesses and increase the level of manufacturing enterprise within the West Midlands region through a more responsive and effective business support service.

• Many SME manufacturers in the West Midlands are weak at selling and winning orders. Customers now demand supply of systems and services rather than just products and there is a need for SME manufacturers to collaborate to win business that would otherwise not be available to them.

• The UK needs to close the gap between the worst and best performers on non-labour productivity to make a meaningful difference. (The need to increase productivity in the UK through more robotics and automation was highlighted in “Making Good”)

• Transitioning to a sustainable industrial system depends on the leadership of UK manufacturing companies, and of UK government.

• Business support is lacking

• Public Procurement – there needs to be more sourcing from UK based manufacturers.

• Capital Investment from public procurement in our UK manufacturing industry.

• Exports, inward investment and high growth.

12. Challenges for SMEs

Conclusions from the Supply Chain Collaborator Forum

- The discussions highlighted that the definitions and terminologies of supply chain and supply base are used interchangeably without specific definition, context or meaning.

- The supply chain models that are currently being used by companies in the UK are variants of academic works, which have been tailored by many companies. SMEs find themselves in a position where they must conform to many differing models.

- SME business growth is restricted because they find it hard to access support and guidance in this area and difficult to persuade OEMs to commonise practices to the benefit of all involved. SMEs also indicated they had a lack of knowledge and expertise to expand supply networks.

- The analogy of “A fish rots from the head” was provided by Professor Jan Godsell. This has identified the significance of the relationship between OEMs who work with SMEs and their collective responsibilities within a supply system. If one part of the system fails, this can have a catastrophic economic and business impact, which can be amplified. “Business as usual is not an option”.

- Companies operate supply systems in different ways and SMEs find this time-consuming. Servicing many different models for a variety of different customers can inhibit business expansion and efficiency.

- Companies find building supply systems difficult - identifying compatible potential suppliers and developing a network of UK based flexible and agile manufacturers.

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