The UK’s composites industry employs over 40,000 people and has an estimated turnover of £1.6bn a year. Over the coming decade, global demand for composite products is set to reach £50bn as the need for lightweight and energy-efficient components and structures grows. Yet familiarity with composites, particularly in end-product markets compared to other traditional materials, is still very low in the UK. Will UK manufacturing be left behind as others seize on international opportunities to manufacture and supply composite products and materials? Or will industry make a concerted effort to ensure that the UK continues to be a leading player in the composites sector?

In 2009 the UK Government and composites manufacturers recognised that commercial barriers and a lack of ‘joined-up thinking’ in understanding industry requirements were impeding national competitiveness. The National Composites Centre (NCC) was established in 2010 to address the Government’s strategy by tackling skills shortages and supply chain weaknesses, and to better align the composite industry. The NCC has made considerable strides in the last four years in increasing engagement with new sectors, and the recently created Composites Leadership Forum (CLF) has collated significant evidence of the current state of the industry and defined actions to update the strategy in 2014. However, the foremost obstacle remains the wider UK manufacturing industry, which struggles to engage with composite materials and processes compared with international competition.

The Institution of Mechanical Engineers recognises that the UK could once again miss out on benefiting from UK-invented technologies and urges the wider industrial community to:

1. **Identify where composites could be used in their sector** and engage with composites research organisations, manufacturers and material suppliers to develop new applications and cross-sector standards.

2. **Address where gaps exist in their knowledge and skills base** by working with the CLF, so that appropriate knowledge transfer and training can be provided.

3. **Work with the composites industry to identify supply chain gaps and create a supply chain network**, enabling improved capability and quality to meet UK and global demand.
Composite materials, also referred to as composites, are made from two or more materials with appreciably different physical or chemical properties. It is possible to identify a composite, as the individual materials contained in it remain separate within the new material. When these materials are combined they produce a new material with a unique set of characteristics (often tailored to suit a specific application), different from the constituent materials. Composites are often favoured due to their inherent strength, light weight, corrosion resistance or relatively low cost when compared to traditional materials[4] and are found in many everyday objects.

One of the earliest engineered composites was fiberglass, which is still widely used in boat building and sports equipment. Engineered composites today cover everything from cements and concrete to one of the most commonly recognised composites, carbon fibre. There are also metallic and ceramic composites such as glass-fibre reinforced aluminium laminate, which has been used on the new Airbus A380 and is 25% stronger and 20% lighter than conventional aluminium[4].

**UK COMPOSITE INDUSTRY – 70 YEARS OF DEVELOPMENT**

While composites have been around for hundreds of years, their mass application began only in the 1940s, as a result of the need for lightweight materials for military applications during World War Two, and the emergence of polymers and glass fibres. As the space race took hold during the 1960s, the market for high-performance composites grew rapidly. Additive and resin development grew throughout the 1970s and carbon fibre also began to make its mark through the 1980s. Metallic composites and silicon-based ceramics made an appearance in the 1990s, enabling the development of artificial hips and joints.

Carbon-based composites have become the more popular choice for engineers and designers today, being most synonymous with Formula 1 and other high-performance sports. There are however a myriad different metallic composites now emerging, some utilising nanotechnology to enhance their thermal and electrical properties, as well as increasing stiffness and tensile strength[10]. As the world considers how to sustain population growth with dwindling natural resources, several composite manufacturers are taking an environmental approach by incorporating renewable materials and fibres into their composites. Flax and hemp are now being investigated and applied to ‘pre-impregnated’ products as a viable alternative to glass fibre[10].

The development of hetero-structures (separate layers of atom-thick materials such as graphene and boron nitride) will expand the use of composites beyond our present understanding. However, the danger is that composites will become known more for their scientific curiosity and application to niche markets, than as the core of a resource-efficient modern society.

**GLOBAL LEADERSHIP**

Currently, the total global aerospace market is valued at £102bn with the UK aerospace industry generating approximately £24bn in revenue in 2011 (75% from exports), making it the second largest global supplier. In comparison the global composite product market for aerospace, mainly carbon-based, is worth approximately £5.4bn[10]. The UK aerospace sector continues to develop new designs and manufacturing techniques using composites for both wings and engines; BAE Systems produced about £100m of composite structures in 2011. Rolls-Royce, GKN, GE and Bombardier are all utilising composites in their products; 25% of the Airbus A380 was produced using composite materials and 52% of the new A350, but the UK’s position in aerospace composites structures has not changed significantly in the last few years. The UK’s world-leading position, however, is under growing threat from overseas competition as foreign governments strategically target their composite industries, opening the doors for greater private investment. France, Spain, Japan and Malaysia have all undertaken programmes to improve capability in the composites sector through government-led incentives and this could see the UK market put under more pressure as manufacturing is shifted to lower-cost economies[10].

The construction market accounts for 13% of the world’s industrial output (approximately £4.5 trillion), employing 7% of the world’s total workforce. In 2011 the construction industry was the largest user of composites, consuming 24% of the world’s supply[10]. The UK’s construction industry (annual turnover of £100bn) has been at the forefront of developing innovative uses of materials to reduce carbon impact, driven by the introduction of the Climate Change Act of 2008. The Startlink project for Lightweight Building Systems has recently constructed a house using composite materials to demonstrate their energy-saving potential. Additionally, Network Rail and London Underground have been recognised among some of Europe’s leading experts with their use of composites in tunnel repair. However, the UK construction sector is predominately made up of SMEs (of the 2 million people employed in the sector, 800,000 are self-employed) and in an industry dominated by strict codes and standards, there has been a slow uptake in the use of composites due to lack of knowledge across the sector, poor skills base and cost-sensitivity of the market. The UK could potentially fail to capitalise on the innovative technologies it is developing and a share of the vast global market.

The world’s energy consumption has grown by 70% in the last 30 years and the global gas and oil industry is now valued at £1.9 trillion with demand set to increase by a further 50% by 2030[10]. 70% of the UK’s energy comes from oil and gas and in 2011 the UK was still the third largest gas and second
largest oil producer in Europe (producing 656 million barrels of oil equivalent). The processing and delivery of oil and gas from ever more hard-to-reach places requires new and innovative technologies and materials to be developed, and the corrosion resistance and low cost of composites make them ideal for use in this industry. The UK is a world leader in the fabrication of equipment for the petrochemical industry. GE Wellstream, for example, have developed a new spoolable pipe technology, which has allowed it to move from traditional pipe materials to composites, improving the pipe’s life and performance characteristics. Yet regulatory controls on the use of composites in the UK continue to hamstring the pipe-making industry.

While the UK led the way in the 1990s, there has been a slow and steady decline compounded by lack of research funding, poor skills development and obstructive codes and standards. Now overshadowed by growing competition from overseas companies in places such as China, Germany, the Middle East and India, commercial barriers in the UK (detailed below) must be overcome to enable the UK composites sector to maintain its place in this rapidly growing industry.

**DRIVING GROWTH – OVERCOMING COMMERCIAL BARRIERS**

In 2009 the Department for Business, Innovation & Skills (BIS) launched the UK Composites Strategy, setting out how the composites industry could best engage the wider manufacturing community by raising awareness and establishing a forum to engage stakeholders. BIS acknowledged the need to increase manufacturing capacity in an ever more competitive market, particularly in skills and the supply chain. This initiative led to the establishment of the National Composites Centre (NCC), an open-access facility and the UK’s centre of excellence for composite innovation. Along with a number of other composite organisations, the NCC is part of the High Volume Manufacturing (HVM) Catapult, encompassing safety, regulation and research to promote and develop the UK composites market.

The establishment of the Composites Leadership Forum (CLF) in 2012 provided a single voice for the industry and a base from which a strategic plan could be developed. The CLF recognises this can be achieved only with the co-operation of the wider UK industry. In collaboration with the Materials Knowledge Transfer Network, sector groups and other organisations, a strategic roadmap for the composites industry was defined in 2013, but there remains a considerable amount of work to do. So far, £300m has been invested over the last five years (from EPSRC, TSB and EU funding) to support collaborative research projects. Government must continue to push forward on its 2009 strategy and ensure that greater attention is given to specialist markets such as the composites industry, by continuing to raise awareness of the economic and commercial opportunities to both UK and international manufacturing businesses.

**Engagement with Wider Industry**

There are a number of industrial sectors in the UK using or developing uses for composite materials as described earlier. It is evident from initial investigations by the CLF, however, that there is a distinct lack of cross-sector engagement regarding composites; companies from one sector do not know what methodologies and technical advancements are being made in other sectors. This has resulted in slow commercialisation of R&D, poor understanding of composite applications and manufacturing techniques, an inefficient supply chain and an inadequately trained workforce unable to cross sector boundaries.

The CLF is making strides to address this, but the wider UK manufacturing community must also make every effort to engage with the composites sector to identify gaps in knowledge, reduce duplication across sectors and assist in strengthening the supply chain; capturing a critical mass necessary for the UK composites industry to compete on a global scale.

**Supply Chain and Market Growth**

In 2010 BIS and UK Trade & Investment (UKTI) commissioned a review of the composites sector supply chain. While it was identified that the 1,500 composite businesses in the UK were producing an annual revenue of £1.6bn, 38 of those were responsible for producing 85% of the output. The majority of companies were SMEs in need of support to develop cross-sector business, and enable them to compete in a growing international market. Compared to the metals industry, the market penetration of composites is extremely low (only 10% in aerospace and 4% in construction). With the increasing need for energy sustainability and reduced carbon emissions, global demand for composite materials and products is expected to double by 2015. The composites market is set to grow in value over the next five years to £17bn with the end-product market estimated to reach nearly £50bn, putting increased pressure on the already existing composite suppliers. There continues, however, to be a siloed mentality within the composites community, with companies seeing themselves as part of a particular industry sector rather than a larger composites industry. This fragmented supply chain has been recognised as one of the biggest barriers to growth.

The Composites Innovation Cluster (CIC) led by Cytec has been set up to assist in addressing this crucial problem, with a £23m project from the Advanced Manufacturing Supply Chain Initiative (AMSCI). The CIC brings together materials specialists, academia and industry to create a composite supply chain network to support all UK manufacturing. The aim of the programme is to create £190m of growth and safeguard 200 jobs in the first three years.

Key to this is the engagement of industry. It is vital that cross-industry practices and capabilities be made visible to all manufacturing sectors. This will create a national composites supply chain network that is flexible enough to cope with market shifts and requirements on a global scale.
UKTI should also provide support, working alongside composites manufacturers to increase international exposure and enable the composites industry to compete more effectively in the world market.

**Codes and Standards**

All industries require codes of practice, standards and guidelines to ensure that products and manufacturing processes can be traded; composites are no different. There are a huge number of standards pertaining to composite products, processes and characteristics, but as with all documents of this type, they take a considerable time to update and often lag behind industry best practice. In some cases the standard can itself be the obstruction to improving best practice, requiring that any new process or material be assessed and evidence gathered to provide a case for change. It has been identified that the lack of appropriate guidelines and standards is having a significant effect on the composites sector.16

The National Composites Network (NCN) carried out a status review in 200712 on polymer composites, and concluded that a consolidated standard for qualifying a product would substantially reduce the cost for both suppliers and end-users. Some investment has been made via the EPSRC-funded Centre for Innovative Manufacturing in Composites (CIMComp) which has received £5m over five years to develop TRL 1–3 stage manufacturing processes and develop greater understanding of composite manufacture. The CLF has set up a working group in early 2014, to determine what the regulatory barriers are within the industry. This brings together standard-setting bodies with composite businesses and the wider composite-using community to ensure that state-of-art practices are reflected within UK, European and ISO standards. If the UK is to maintain a competitive position within composite production and application, it is vital that the UK composites industry be in the vanguard of international standard setting. The Institution calls upon manufacturing businesses and the wider composite-using community to ensure that state-of-art practices are reflected within UK, European and ISO standards. The Institution recommends that additional Government funding should be made available to bodies such as the CIMComp and also through the British Standards Institute (BSI) to guarantee the UK’s position as a world-leading position. Investment from UK Government is needed to find more cost-effective recycling methods as well as a collection and separation infrastructure. Additionally, applications for recycled composite materials need to be developed to provide a longer life cycle for these materials. The use of bio- and natural composite materials should also be encouraged across the manufacturing industry. This should be supported by the Government’s existing environmental programme with Waste and Resources Action Programme (WRAP) funding.

**Environmental Concerns**

The sustainable management of waste forms the backbone of the Government’s environmental policy and the composites industry is particularly keen to ensure that the amount of composite materials that find their way into UK landfill sites each year is reduced. However, the recycling of composites in the UK to date has been relatively small due to its low economic viability. There is approximately 130,000 tonnes of glass-fibre reinforced plastic (GRP) produced in the UK each year14 and it is estimated that of the 67,000 tonnes of GRP waste produced per annum, 98% is likely to end up in landfill11,14. It is therefore essential that as the market for composites grows, methods of recycling and recovery are developed.

To ensure the UK composites industry maintains a world-leading position, investment from UK Government is needed to find more cost-effective recycling methods as well as a collection and separation infrastructure. Additionally, applications for recycled composite materials need to be developed to provide a longer life cycle for these materials. The use of bio- and natural composite materials should also be encouraged across the manufacturing industry. This should be supported by the Government’s existing environmental programme with Waste and Resources Action Programme (WRAP) funding.

**Co-ordinated Skills and Training Programme**

It has been recognised by the composites industry itself that the training for manufacturing composite materials has been very inconsistent for many years.13 At operator level, the workforce is usually semi-skilled labour, taught on the job for the task related to the sector the individual works in. At the professional end there has been a reduction in the number of universities offering composite-related degree courses and content over the last ten years, resulting in poorly trained engineers and material scientists. If education and training remain unfocused in this way, the UK composites industry and indeed the wider manufacturing community will soon be unable to compete on an international level.

Complexity of the sector is a problem. The CLF has begun a “roadmapping” process to identify the technology needs of the UK manufacturing industry and determine what types of composite are required or are currently being used. This process will enable composite types to be categorised and enable more directed training and education to be created for the industry. However, this cannot be successfully achieved without the participation of the wider UK manufacturing community. The Institution calls upon manufacturing businesses to develop a closer relationship with the composite industry to identify its needs and emerging markets, and to enable the most appropriate training and education programmes to be put in place.
RECOMMENDATIONS

Global development, application and need for composite materials are set to grow rapidly in the coming decade, but it is clear that without significant engagement between the composites industry and wider UK manufacturing, the UK will fall rapidly behind other composite manufacturing nations in both material supply and end-product manufacture.

The Institution of Mechanical Engineers recognises that the UK could once again miss out on benefiting from UK-invented technologies and urges the wider industrial community to:

1. Identify where composites could be used in their sector and engage with composites research organisations, manufacturers and material suppliers to develop new applications and cross-sector standards.

2. Address where gaps exist in their knowledge and skills base by working with the CLF, so that appropriate knowledge transfer and training can be provided.

3. Work with the composites industry to identify supply chain gaps and create a supply chain network, enabling improved capability and quality to meet UK and global demand.

The Institution also encourages the Government and UK Trade & Investment to continue to work with the CLF to increase international exposure of the UK composites market and enable the composites industry to compete more effectively in the global arena. The key areas are sustainability, environmental management and the setting of international standards.

BIBLIOGRAPHY


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