ESCO
Electronic Systems
Challenges & Opportunities

# IMAGINE A WORLD WITHOUT ELECTRONIC SYSTEMS

## THE ESCO REPORT: A BLUEPRINT FOR UK ECONOMIC GROWTH

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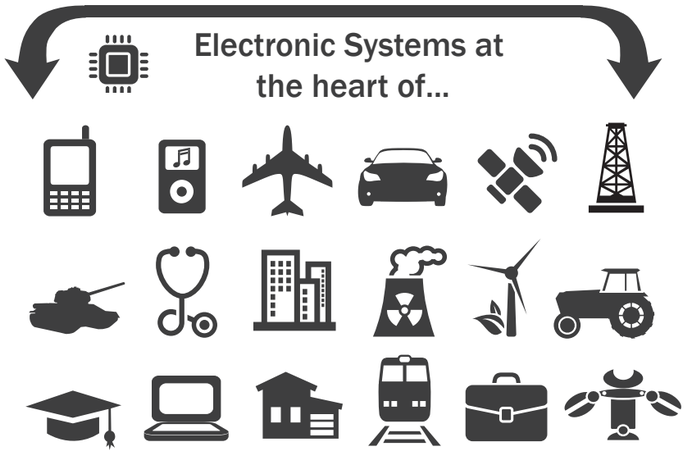
## THE ESCO REPORT: A BLUEPRINT FOR UK ECONOMIC GROWTH

# A blueprint for success

## TODAY




**850,000** people working on Electronic Systems **with 50%** embedded in other industrial sectors

**£80 Billion** annual contribution to the economy


## Ambitions for 2020

**1,000,000**

**£120 Billion**

**7.1%**

## ENABLED THROUGH

>> Building recognition of this strategically important key enabling technology sector
>> Accelerating growth in UK vertical sectors as a result of the use of UK Electronic Systems
>> Developing and exploiting UK Electronic Systems capabilities, nationally and globally

### STRATEGIES

**SMART LEADERSHIP & ENGAGING THE COMMUNITY**

Have a clear structure to provide leadership and a focal point for the UK Electronic Systems community.

**SMART SUPPLY**

Ensure UK verticals can source UK electronics and attract systems integrators.

**SMART INDUSTRIES** DELIVERING **SMART JOBS**

UK at the forefront of creating new Electronic Systems-based industries.

**SMART UK** TO GLOBAL UK

Ensuring the UK continues to create great electronics technology, but striving for more UK-led global players and export.

**SMART BRANDS**, KNOWN BRANDS

Create the environment to grow globally dominant electronics brands from the UK.

DEVELOPING **SMART SKILLS**

Develop a skills base that provides UK industry (horizontal and vertical) with the resources required to take advantage of future markets.

**SMART** SUSTAINABLE GOVERNMENT PARTNERSHIP

To be recognised by government as an important economic and strategic contributor to the UK economy.

### ACTIONS

- Establish Leadership Forum
- Engaging the sector
- Leadership Forum connected to key verticals
- Strategic on-shoring
- Building UK ecosystems
- Markets of Tomorrow
- Electronic Systems Technology Group
- The heart of Smart Healthcare
- The hub of Smart Transport
- Encourage and support university research, development and innovation
- The intelligence in the Smart Grid
- Promoting UK Electronic Systems capability on global stage
- Taxation as a strategic incentive
- Government procurement driving innovation
- Intellectual Property – recognition and protection
- Catapults – recognising importance of Electronic Systems
- Helpline – support through the funding maze
- UK B2C brands study
- Graduates: develop the role of the UK Electronics Skills Foundation
- Increase the range of available craft and student apprenticeships
- Post-Graduate skills prioritisation
- Refining migration policy support needs of UK Electronics
- Setting joint strategic objectives
- Adopting the economic model

# EXECUTIVE STEERING GROUP

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**University of Glasgow**

**JAMIE URQUHART**
Pond Ventures

**CHRIS CARR**
Department for Business Innovation & Skills

**KEITH WILLIAMS**
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"AT THE HEART OF MANY SOCIETAL ADVANCEMENTS IS THE ENABLING TECHNOLOGY OF ELECTRONIC SYSTEMS."

Warren East, Chief Executive, ARM

Image courtesy of Touch Bionics

# 2020 VISION

All around us the world has become dependent on Electronic Systems. There are few parts of our daily lives where we are not consciously or subliminally dependent on them. Our homes, workplaces, transport, finance, communication, music, photography, supplies of food, water and utilities are all reliant on functionality provided by Electronic Systems.

This is clearly illustrated through Figures 1 and 2 which shows the pervasion of Electrical and Electronic Engineering graduates across almost every significant industrial sector in the UK.

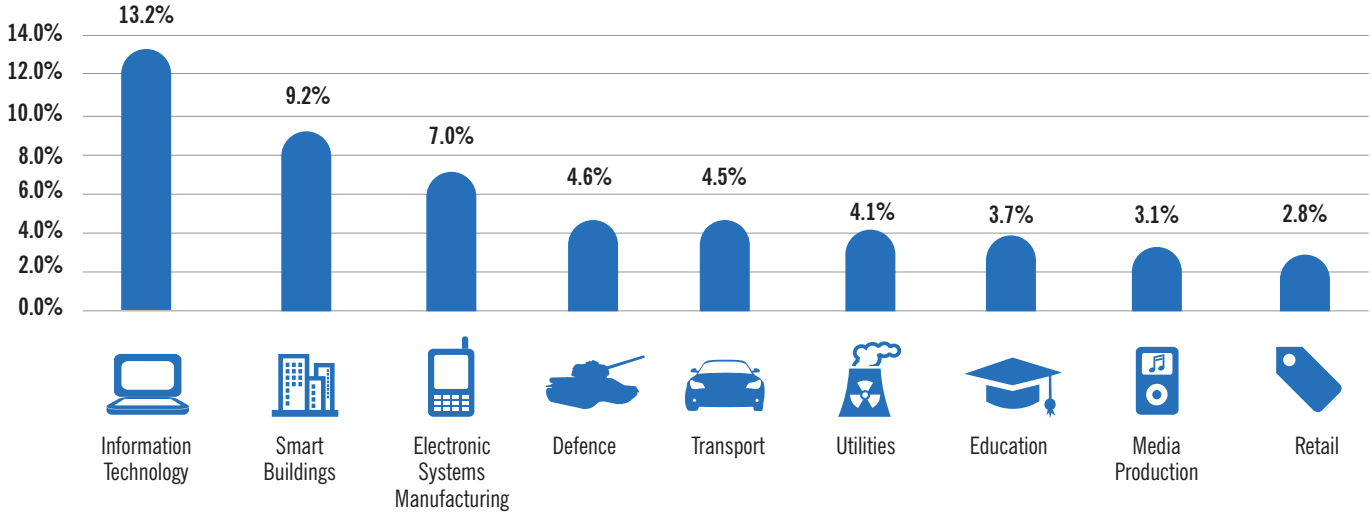
While there is a fundamental dependence today, by 2020 it will be even more so. Technologies will develop to deliver new solutions and this will continue on a global scale. Business opportunities will be huge; we envisage that no single nation will have a global monopoly and we see globally recognised nodes of leading capability and excellence around the world.

We demonstrate through close scrutiny that the UK is one of these nodes today. However, this position is under threat from other locations where the strategic partnership between industry, academia and government is stronger than it is in the UK. In recent weeks we have seen clear recognition of the importance of this from the European Commission and we believe that the UK needs to not only play a leading role within Europe, it must also develop a strong strategy at a national level to maintain and enhance our position. The prize is clear: if we can grow employment at the same forecast rate as the global market then we will generate 150,000 new and highly-skilled jobs in the UK by 2020.

The consequences of failure are perhaps best summarised by the words of Sir Hossein Yassaie of Imagination Technologies: ***"For such a nationally important dependency, offering huge business opportunities, failure to recognise the importance of Electronic Systems would be a very dangerous development for the UK and must be avoided…a strategic and lasting partnership with government is fundamental to our future success."***

This report has been produced by the Electronic Systems community in the UK – the businesses, trade associations and research organisations whose activities are centred around the application of electronics in products and services across the full range of professional and consumer markets. We commend this report to you and encourage all stakeholders to become involved in ensuring we take full advantage of our capability and realise our potential to be a global centre of excellence in the 2020 world of Electronic Systems.

**Figure 1 : UK Sectors Employing Electrical and Electronic Engineering Graduates (HESA[1] , 2013)**




First degree, Electronic & Electrical Engineering Graduates entering graduate level employment by top 10 Standard Industrial Classifications 2010/11

"MANY OF THE UK'S LEADING EMPLOYERS ARE CRITICALLY DEPENDENT ON ELECTRICAL AND ELECTRONIC ENGINEERING SKILLS."

**Indro Mukerjee, Chief Executive, Plastic Logic**


Figure 2: Top 50 Employers of UK-Domiciled Electrical and Electronic Engineering Graduates 2008/09 – 2011/2012

# FOREWORD

## Rt Hon Michael Fallon MP

Minister of State for Business and Enterprise

I should like to thank the ESCO team and the wider electronic systems community for their work in producing this report, especially at a time when all businesses are facing major challenges and pressures on their resources. The report is a timely and welcome analysis of the issues and heralds a new era of working in partnership with government.

Electronic systems underpin many of the world's economic activities across almost all sectors. Control systems for aircraft and automobiles, electrical equipment and machinery as well as consumer electronic goods are all electronic systems, and their UK based researchers, designers and manufacturers form a vibrant community which is supporting much of our advanced manufacturing and service industry.

While electronic systems tend to be invisible to those outside of the industry, they are in fact pervasive and are an enabler in a host of other sectors – from education and healthcare to communications and entertainment. This is an accelerating trend and we will continue to see more and more products and services that rely on electronics.

The case studies in this strategy highlight some of electronic systems' key companies offering world-class products and services. Many have strong links with our internationally renowned universities which have excellent track records of collaborating with businesses both at home and abroad.

The report's conclusions reflect the global challenges that are occurring throughout society, business and the global technology environment on subjects such as innovation, skills and training and advanced manufacturing. This Government's support for the electronic systems sector is already apparent through the importance we have placed on the Science and Research budget, the Technology Strategy Board, our support of high level apprenticeships and the Regional Growth Fund competitions. We also recognise that improved engagement with this sector should result in fine-tuning this support to achieve optimum results for the benefit of the country.

I recognise the challenges presented by the recommendations in the strategy and my Department will be working in partnership with industry to help address these. I have been impressed by the broad collaborative effort on ESCO and that is something I believe will be critical to future progress.

I also look forward to engaging with the new leadership forum for this community and to supporting them as they lead the sector to new successes.

"ELECTRONIC SYSTEMS GIVE US THE SMART GADGETS AND SOPHISTICATED LIVING THAT WE VALUE TODAY. JUST IMAGINE FOR A MOMENT A WORLD WITHOUT THEM."

Jamie Urquhart, Chairman, ESCO Steering Group

# CHAIRMAN'S STATEMENT

**Jamie Urquhart**
Pond Ventures

Mention high tech to the average man or woman in the street and they will probably think of a flashy consumer electronics gadget; these are the icons of our modern world.

***Electronic Systems give us the smart gadgets and sophisticated living that we value today. To appreciate just how much, you need only imagine for a moment a world without them; no power, communications, mobile phones, television, the internet, healthcare or transport. Modern life would grind to a halt.***

Electronic Systems form the foundations on which the 21st century is being built, and this report presents a picture of how our UK sector can take advantage of this. It provides a strategic blueprint for the future development of one of the UK's most promising sectors. Its objectives are to:

- Engage the UK Electronic Systems industry in working together to deliver our long-term future.
- Address the lack of awareness within government and the key "Vertical Market"[2] sectors of the importance of Electronic Systems.
- Present an ambitious vision for our future, supported by a pragmatic Action Plan.

The Electronic Systems sector, sitting at the heart of the high tech revolution, is a commercially astute body of trailblazers and entrepreneurs striving to create new products and services. Their vision is to make life smarter for everyone, to drive commercial success and, ultimately, economic growth.

This report highlights the role that the UK Electronic Systems community is playing today and outlines how it can continue and improve the way in which it plays in the future. We must act now to capitalise on the opportunities and overcome the challenges it faces. Failure to do so will have huge implications, not just for 'electronics' companies, but for the future competitiveness of **every** industrial sector and therefore the **UK economy as a whole**.

**From our work on ESCO, we calculate that, in 2012, the Electronic Systems community employed more than 850,000 people in the UK and contributed more than £78 billion to our Gross Domestic Product (GDP).**

Approximately half of these are employed in Electronic Systems businesses whilst the remainder work in Electronic Systems roles 'embedded' within other industrial sectors such as automotive, aerospace, defence, e-health, marine and security. Electronic Systems are pervasive across the industrial landscape: vital to the UK economy as a sector in its own right, and a technology that underpins every other industrial sector.

**While the UK Electronic Systems community directly contributes more than 5% of GDP, they have an immediate impact over at least ten times that. Furthermore, the sector represents one of the greatest global growth areas today.**

The UK is well placed to capitalise on developing trends such as new electronic materials, increasing miniaturisation, advancing software technologies, the Internet of Things or 'Industrial Internet' and systems integration that will drive the global markets of tomorrow. With many of the world's leading companies located in the UK, there's clearly lots of potential.

**We are setting ourselves two stretch-targets; that by 2020:**

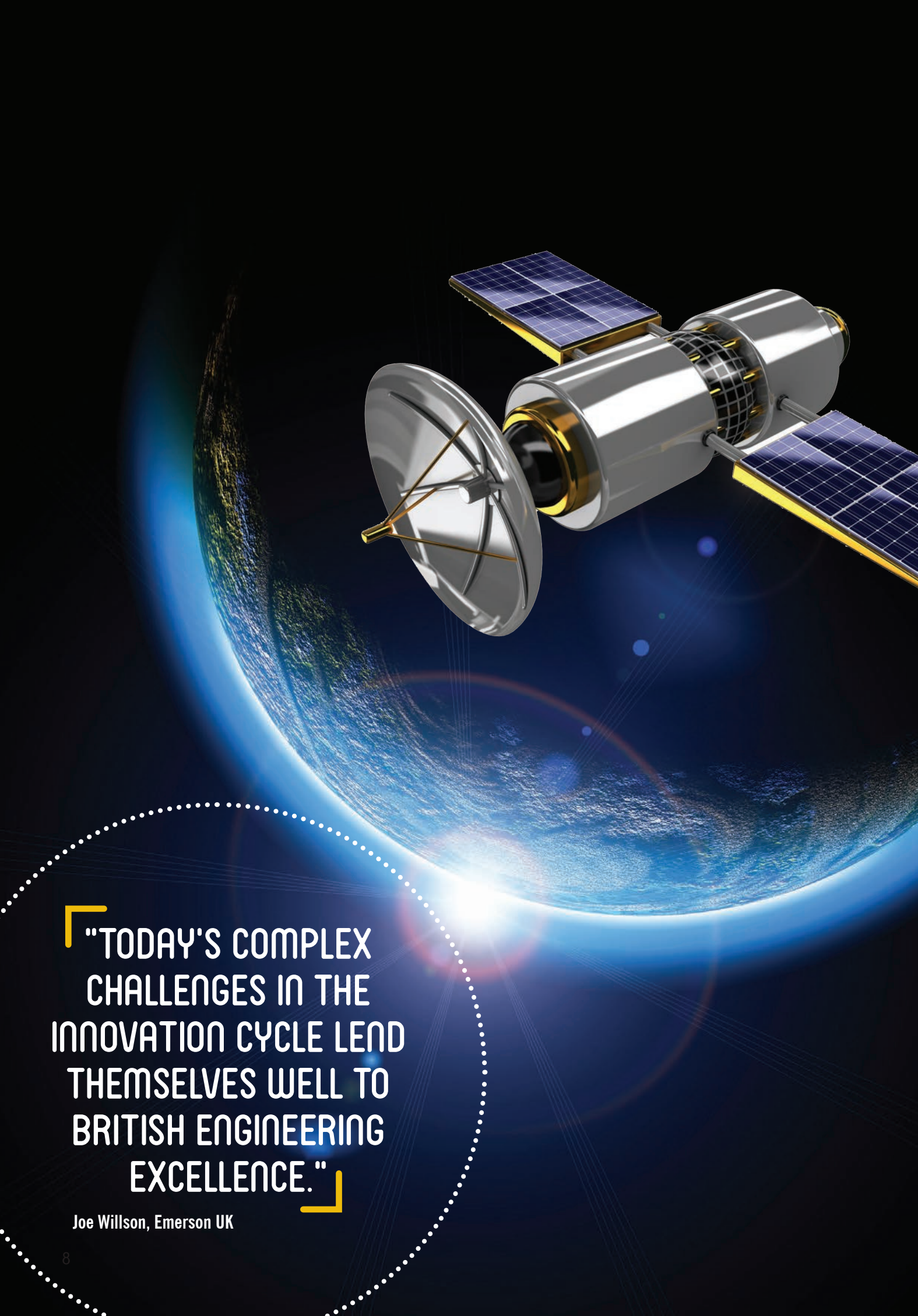
- **Our UK employment will grow from 856,000 today to 1,000,000.**
- **Our UK economic contribution will grow from £78 billion today to £120 billion – an annual growth rate of 6%.**

**We will deliver this by focusing on:**

- **Building recognition of this strategically important key enabling technology sector.**
- **Accelerating growth in the UK vertical sectors as a result of the use of UK Electronic Systems.**
- **Developing and exploiting UK Electronic Systems capabilities, nationally and globally.**

Sustained action and a strategic long-term partnership with government is required. By working together, industry, academia, government and public sector bodies can deliver results. However, it cannot be left to government to improve the future prospects of the industry; that's down to us, the leaders of the industry today, to participate in a discourse, such as this report, to identify where improvements can be made and then take ownership of making them happen. We believe our future is in our hands and I call on the sector to rally resources behind the leading organisations driving developments forward.

I present our ambitions and Action Plan to improve our competitive position and awaken greater enthusiasm about our community. My hope is that you, whether in industry, academia, government or the wider public sector, will engage in driving delivery of the Action Plan to ensure the UK's future as a global leader in innovation and deliver growth.



"TODAY'S COMPLEX CHALLENGES IN THE INNOVATION CYCLE LEND THEMSELVES WELL TO BRITISH ENGINEERING EXCELLENCE."

Joe Willson, Emerson UK

# METHODOLOGY

This report builds on the findings from a number of Working Groups, commissioned to focus in more detail on specific areas relevant to this community. Their full findings and more detailed action plans are provided in a set of five Workstream Reports (shown below with lead Authors) released concurrently with this report [3]:

- Workstream 1 – Economic Footprint of the UK Electronic Systems Community
- Workstream 2 – Research, development and Intellectual Property (IP) creation
- Workstream 3 – Innovation climate
- Workstream 4 – Manufacturing
- Workstream 5 – Skills: Supply, Demand, Provision and Gaps

Each workstream focused on the collection and processing of relevant information and the direct engagement of representative stakeholders. A member of the Executive Steering Group was associated with each workstream in the capacity of 'Sponsor', directing the work being undertaken and reviewing findings.

A series of consultations also took place across the UK to validate suggested actions and gather further information.

Primary analysis of industry information was undertaken using tools and databases not all of which were publicly accessible. The authors of the report would like to thank these organisations for their support in compiling the information presented in the Workstream Reports,especially The Department for Business Innovation and Skills (BIS), The Engineering and Physical Sciences Research Council (EPSRC), The Science and Technology Facilities Council (STFC), The Technology Strategy Board (TSB), Semta and The Higher Education Statistics Agency (HESA).

Fundamental to this report is the definition of Electronic Systems. A summary is included in Appendix 1, whilst the full definition can be found in the Workstream 1 Report.

## Report & Workstream Authors

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Author Workstream 5

"THE REVOLUTION IN SOFTWARE ENGINEERING HAS ENABLED AMAZINGLY 'INTELLIGENT' APPLICATIONS."

Keith Williams, Altran

# ELECTRONIC SYSTEMS - THE GLOBAL VIEW

## The Technology Shaping the Modern Economy

The pervasiveness of Electronic Systems in our daily lives may not be immediately obvious, but consider for a moment the changes we've seen over the last 10 to 20 years:

- Our reliance on the internet in so many aspects of our lives
- The massive growth of mobile cellular communications
- The more sophisticated way we consume television, listen to radio, read books
- The control of emissions from and the safety of the key forms of transport; aerospace, rail and automotive
- The way we take and share photographs
- The advancements in healthcare
- The developments in finance and payment systems
- The ways in which we generate and use energy
- The technology used by the armed forces, who defend the interests of our nation

**Warren East** of ARM remarked *"At the heart of many societal advancements is the enabling technology of Electronic Systems."*

The technology within today's Electronic Systems is truly astounding. Fundamental to delivering the pace of this change has been the advancement in Integrated Circuit (IC) technology. Following the trend identified by Gordon Moore in 1965[4], the complexity of integrated circuits has increased more than a billion-fold in the intervening years.

**Keith Williams** of Altran commented: *"Realising the potential of integrated circuits has been the role of software. The revolution in software engineering has enabled amazingly 'Intelligent' applications to be developed containing tens of millions of lines of code. The open software movement, which has made accessible software components and algorithms that were previously the preserve of multinationals and defence companies, is driving fast-paced innovation. This gives rise to enormous opportunity, and also risk, as we rely on software for our entertainment in our digital life, but also for our safety when travelling or security when banking. The Raspberry-Pi [5] is bringing this software revolution to a new generation.* **Innovation through accessibility is the new keynote."**

Companies that master change are able to achieve market success by getting their products to market in short timescales, while also delivering an improved user experience. Many of today's world-leading products have multiple layers of Electronic Systems technologies 'under the hood':

- Almost all will have microprocessor based control systems
- Virtually all will require a significant software content to manage the control systems and provide an increasing proportion of the product's functionality and differentiating features
- Many will have advanced graphics and a human-machine interface to facilitate interaction and usability
- Most will have power management to interface to and drive external parts of the system
- Internal power management will minimise energy requirements, often providing the ability to work from battery-power and hence enable portability
- Most will have analogue and Radio Frequency (RF) communications to 'talk' to the external interfaces or to enable effective management within a larger system such as the global mobile phone market
- Many will utilise sensors, optics, displays, micro-mechanical actuators
- There is an exciting new trend to use flexible plastic and printed technologies to enable new functionality
- For safety or mission critical applications, safety or security engineering will be integrated

Whilst it is easy and convenient to think of "The Digital Economy", the reality at a technical level is that even seemingly simple products contain a range of complex Electronic Systems technologies.

Joe Willson of Emerson UK commented: *"Today's complex challenges in the innovation cycle lend themselves well to British engineering excellence due to the broad range of technical skills across multiple disciplines. This builds on our heritage of engineering excellence and is a key factor in my belief in a bright future for Electronic Systems in the UK."*

## Global Trends

Amongst the more visible of today's Electronic Systems products are the consumer gadgets that are now part of our daily lives. One brand proudly sports the message 'Designed in California, Assembled in China' apparently dashing the hopes of designers, manufacturers and governments elsewhere. **Yet the truth is far from this simple**. The internal components and sub-systems are designed and manufactured by different companies, globally. These designers and manufacturers all have their own supply chains, tools, consumables and specialist knowledge; these supply chains are global too.

**Warren East** commented: *"Today's Electronic Systems products are truly children of the world, the offspring of global enterprise; and tomorrow's products will be even more so. For the UK to be genuinely successful we need decision-makers who have genuine understanding of the levels of complexity within technology, supply chains, business models and global*

*partnerships that represent the way Electronic Systems businesses operate today."*

Globalisation, combined with the communications revolution enabled by the internet, removed borders and distance as obstacles to trade. This has led to the disaggregation of business and its services. The out-sourced model has enabled host businesses to focus on their core capability, in turn enabling them to optimise their own products and services. These out-sourced provision businesses can be viable, from micro-SMEs servicing a critical niche to some genuine global giants such as TSMC[6] and Foxconn[7], which have thrived not only on technical and operational excellence but on continued innovation in their business and service models. Profitable success may be built on the provision of low-margin, mass-market products, but could equally well be for low volume, high quality products and services in markets such as aerospace (e.g. Aero Engine Controls[8], Ultra Electronics[9]) or niche-focus, low-volume products, supported by high expertise and service excellence such as high-end audio where the UK genuinely excels (e.g. Linn[10], Naim Audio[11] ).

**Keith Williams** commented: *"In the world of Electronic Systems, business model and service innovation plays a role as important as technology innovation."*

Although the development, production and manufacture of Electronic Systems operates on a global scale we should also recognise that some regions of the world have achieved significantly more prominence than others. The economies of countries such as South Korea, Taiwan, Japan and the US all benefit from a strong electronic systems capability. These outcomes have not been a happy accident but the result of strong and long-term partnerships between government and Industry. We must build those partnerships both here in the UK and within Europe if we are to capitalise on the vertical and sector strengths here in the UK.

The role of government is critical and can be seen in the "China 2030" Report produced by The World Bank and The Development Research Centre of the State Council[12]. This paints a picture of China catching up technically, but highlights *"The role of the private sector is critical because innovation at the technology frontier is quite different in nature from simply catching-up technologically. The process becomes essentially one of trial and error, with the chances of success highly uncertain. Innovation is not something that can be achieved through government planning. Indeed, the more enterprises are involved in the trial-and-error process of innovation, the greater are the chances for technological breakthroughs, and the more likely that new discoveries will be translated into commercially viable products. As enterprises take a leading role, the government needs to adopt a more supportive and facilitating role."*

The report goes on to highlight suggested actions for Government closely aligned to the supportive and facilitative actions suggested in this report:

- Enhancing the quality of human capital
- Encouraging participation in the development process
- Utilising public procurement of goods and services as a way to support private sector innovation

**A supportive and facilitative relationship, indeed a Strategic Partnership with Government, is vitally important to achieve the ambitions we outline in this report.**

## UK Overview

Through these changes in the way businesses operate, the UK has lost out in some areas – perhaps most noticeably, the lower-margin highest volume consumer electronics manufacturing. Out-sourcing, however, has not been all bad for the UK. UK businesses that have been established in this global out-sourcing market include companies such as ARM[13] and Imagination Technologies[14] , which dominate the global market for the provision of microprocessor Intellectual Property. It is estimated by Gartner that in 2012, 75% of all devices connected to the internet were ARM-powered.

A key point is that the UK has an attractive ecosystem where new businesses can grow around established players. This phenomenon extends across all parts of the Electronic Systems value chain and includes companies working on emerging technologies, such as Plastic Logic[15], whose business model is dependent on building 'market access' relationships with strategic partners. These businesses all share a common characteristic: international excellence in their own field which delivers performance ahead of what could typically be achieved 'in-house'.

The UK has substantial intellectual influence in a number of areas related to Electronic Systems: in academic research, a number of UK institutions have world-class capabilities and reputations and three of the top 12 engineering and technology universities in the THES listing for 2012-13[16] are in the UK. UK contributions to the standards around which Electronic Systems are developed are also significant e.g. the role of various UK organisations in establishing mobile communications standards, the Motor Industry Software Reliability Association (MISRA) in defining standards for embedded systems programming, and the role of the UK in developing the widely-applied Electronic Systems safety standard IEC 61508.

**James Collier** of Whitespace communications company Neul, commented: *"The UK's role as a thought leader, even in disciplines where it does not have a dominant industrial base, should be recognised, valued and developed."*

UK-based organisations, and UK units of international organisations, represent an internationally valued capability. Built on our strong heritage of innovative engineering, the UK has a large contingent of such organisations and attracts a significant share of global investment. **No fewer than 14 of the world's top 20 semiconductor companies have established design and/or manufacturing operations** [17] **in the UK** and the community extends from creation of the base electronic materials right through to the development of the software and services that realise the capabilities of Electronic Systems. Examples include the SafeRTOS product from Wittenstein High Integrity Systems and the Tokeneer demonstrator programme, carried out by Altran for the US National Security Agency, and recognised by a Microsoft Research Milestone Award.

While the talent and innovation in the UK is recognised and inward investment into the UK remains significant, there is a challenge in growing companies of scale that are headquartered here. Challenging economic

## ELECTRONIC SYSTEMS - THE GLOBAL VIEW

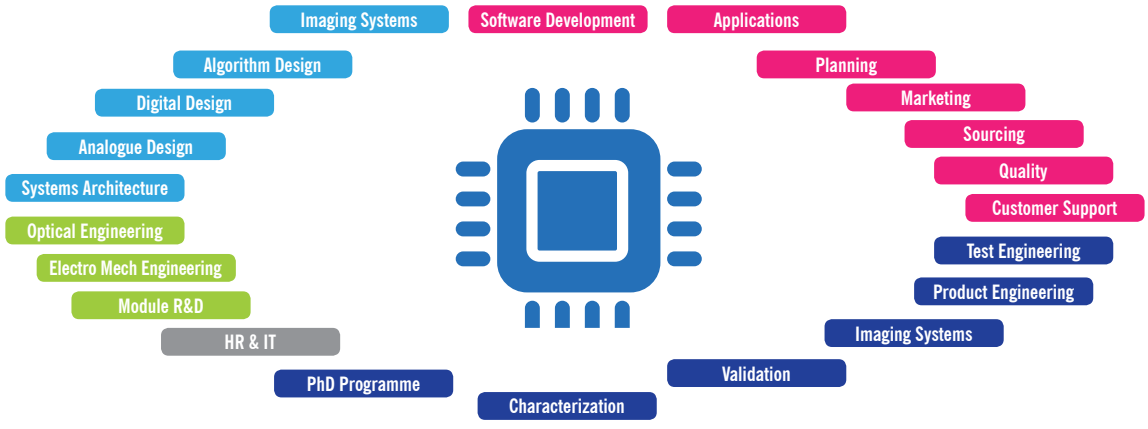



**Figure 3 – Range of Job Roles**

times means that the national operation centres only thrive on the basis of providing a continued unique capability that has a future strategic value to their international parent. Competition is intense around the world and countries are investing heavily in developing skills and attracting businesses to locate with them. **To maintain this competitive advantage, it is vital that the UK invests in skills and innovation whilst reducing business cost and regulation.**

Much development and delivery of Electronic Systems is carried out by businesses that would classify themselves according to a vertical market sector, not as Electronic Systems businesses. The UK is home to a number of world-class companies in this area such as BAE SYSTEMS, Rolls-Royce, Jaguar Land Rover and hosts significant subsidiaries of many others such as Alstom, Emerson, Siemens, Selex, Raytheon, Thales, Safran, Lockheed Martin, Visteon and Phillips. **A strong engineering sector in general is important to the strength and growth of the UK Electronic Systems industry and a strong Electronic Systems community is vital to the continued development of this wider industrial community.**

## Employment and Jobs

Having discussed the complexity involved in today's Electronic Systems, it is only realistic to expect a complex range of job roles within it. This is well illustrated in the example shown in Figure 3, provided by ST Microelectronics Imaging Centre, Edinburgh. This illustrates the number of different competences required to develop leading-edge image sensors. Image sensors are used in multiple market sectors but principally in mobile phones. When we consider that all these job functions are required to support the technology for the camera within a phone, we can start to grasp the complexity within these devices that we typically take for granted today.

Whilst this is only one example, it is typical of the variety of roles required to develop Electronic Systems. It also demonstrates the complex and inter-disciplinary nature of the work and why there is a need to attract the brightest and best talent to our industry.

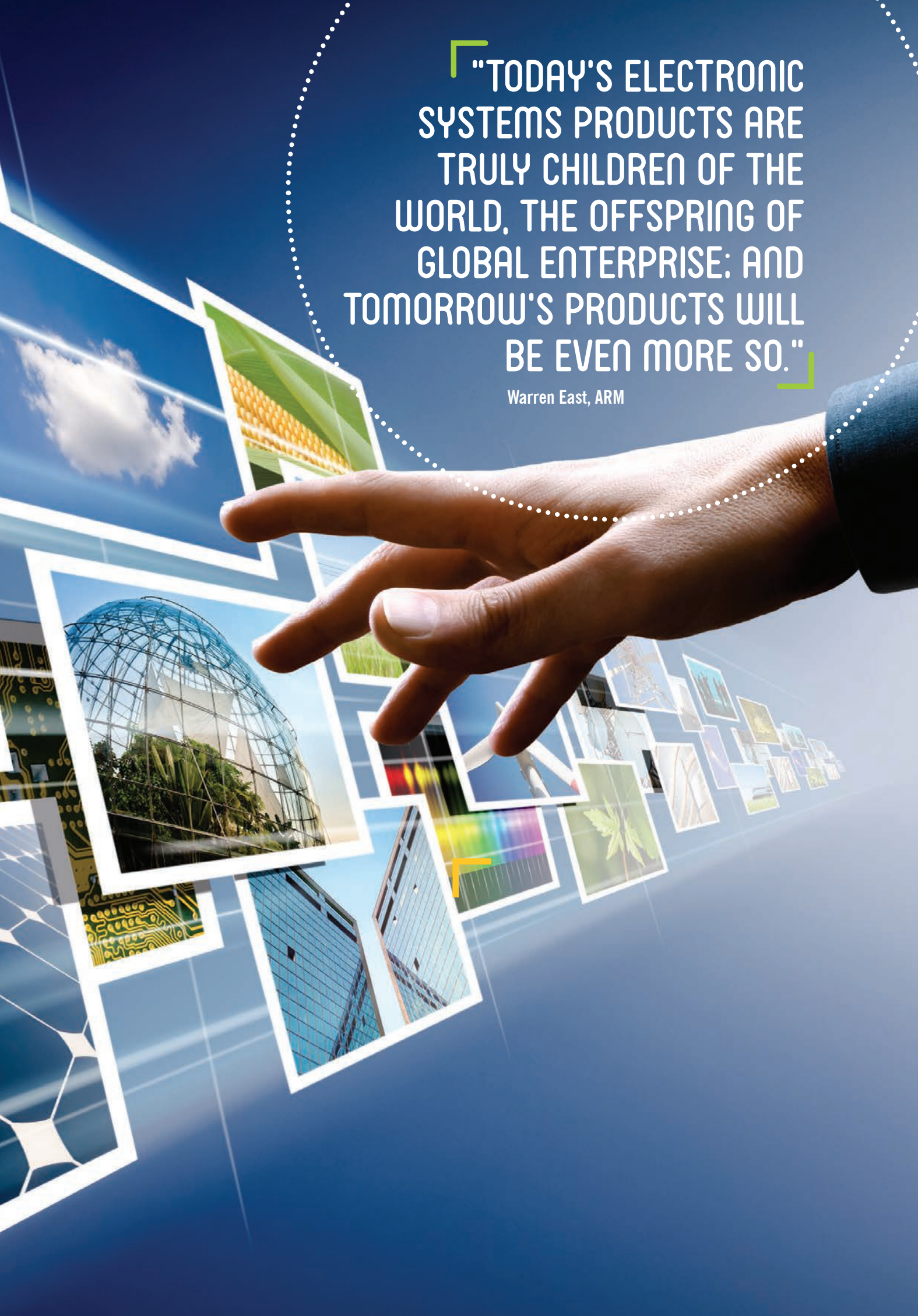
**Indro Mukerjee** of Plastic Logic commented: *"Governments around the world are investing heavily in developing the skills, infrastructure and business incentives to grow and attract Electronic Systems businesses, making the UK highly vulnerable to other regions where the importance of the sector is more actively recognised and promoted. The UK must act more urgently and in a coordinated fashion, otherwise our remarkable potential in this game-changing technology sector will go unfulfilled."*

The UK must ensure that the right ecosystem is in place to encourage the investment and entrepreneurship that will trigger the rise of high-growth enterprises. **Jamie Urquhart** commented; *"Without a long-term, strategic and collaborative approach in the industry, and between industry and government, the UK will be unable to generate the scale required to create prosperity 30 years from now."*

## CASE STUDY

McLaren ELECTRONIC SYSTEMS

**Owing to the under-pinning nature of Electronic Systems, many companies can deploy their products and services across apparently disconnected market segments. For example, McLaren Electronic Systems has been providing control and data systems to Formula 1 for over 20 years. Today, it's translating that technology to urban transportation, improving the quality, efficiency and safety of the Bay Area Rapid Transit railway in San Francisco.**



"TODAY'S ELECTRONIC SYSTEMS PRODUCTS ARE TRULY CHILDREN OF THE WORLD, THE OFFSPRING OF GLOBAL ENTERPRISE: AND TOMORROW'S PRODUCTS WILL BE EVEN MORE SO."

Warren East, ARM

# KEY FINDINGS

## Workstream 1: Economic Footprint of the UK Electronic Systems Community[18]

**UK Electronic Systems Community employs more than 850,000 people in the UK; 2.9% of the UK workforce.**

Around half of this employment is found in the 30,000 enterprises whose business is overtly the provision of Electronic Systems and the technologies and capabilities they need (Table 1).

For these companies the distribution of employment broadly follows the UK norm, with many small operations and fewer large ones. But the 85% of Electronic Systems enterprises that employ fewer than 10 staff account for just 11% of the employment of the sector; compared to the national figure of 20%. Conversely, the 4.4% of larger enterprises that employ more than 50 staff account for nearly 75% of the employment of the sector; compared to the national figure of 50%. These figures correctly account the UK footprint of international companies which have chosen to operate in the UK.

The other half of Electronic Systems employment is embedded within businesses that would classify themselves by vertical market domains: such as aerospace, defence, healthcare, retail, media and education. Here Electronic Systems are a vital enabler to their primary product or function to improve functionality, reliability, reduce cost etc. (Table 2).

Typical of an enabling technology, this employment is not quantifiable by vertical market sector, but merely shows the adoption of Electronic Systems by all businesses as they strive to maintain and enhance the quality and competitiveness of their primary product. Nevertheless, these are real employees and in the larger operations will operate in a department or division with an Electronic Systems type title (Technology, ICT, IT, Technical Operations, etc).

**With an annual wages bill of £34.8 billion in 2012, the direct economic contribution from the whole UK Electronic Systems Community is calculated by the Income Approach[19] to be £78 billion; 5.4% of UK GDP.**

When considering industrial strategy for this sector, it is important that a 'one size fits all' approach is not taken. So whilst we want the UK to enhance its capability to produce high-tech start-ups, we need to recognise that around half of employment within the sector is in companies in the 250+ category (directly employed plus embedded); a significant proportion of which are multinational corporations that continue to invest in the UK in the face of significant international competition. But whilst larger organisations play a key role in creating critical mass, it is the smaller more volatile ones that are

| EntSize | ES Enterprises | % of Total | ES Employ't | % of Total | ES Wages (£m) | % of Total |
|---|---|---|---|---|---|---|
| **0-4** | 22,450 | 74.8% | 30,021 | 6.9% | 1,285 | 7.5% |
| **5-9** | 2,894 | 9.6% | 16,520 | 3.8% | 707 | 4.1% |
| **10-19** | 2,000 | 6.7% | 23,994 | 5.5% | 978 | 5.7% |
| **20-49** | 1,388 | 4.6% | 37,738 | 8.7% | 1,537 | 8.9% |
| **50-249** | 1,050 | 3.5% | 92,740 | 21.3% | 3,581 | 20.8% |
| **250+** | 250 | 0.8% | 234,441 | 53.8% | 9,106 | 53.0% |
| | **30,031** | **100%** | **435,454** | **100%** | **17,195** | **100%** |

**Table 1: Analysis of Overtly UK Electronic Systems Enterprises**

| EntSize | Enterprises | % of Total | ES Employ't | % of Total | ES Wages (£m) | % of Total |
|---|---|---|---|---|---|---|
| **0-4** | 1,718,235 | 67.5% | 24 | 0.0% | 1 | 0.0% |
| **5-9** | 386,096 | 15.2% | 45 | 0.0% | 2 | 0.0% |
| **10-19** | 213,370 | 8.4% | 35,362 | 8.4% | 1,413 | 8.0% |
| **20-49** | 140,533 | 5.5% | 63,890 | 15.2% | 2,553 | 14.5% |
| **50-249** | 74,400 | 2.9% | 161,922 | 38.5% | 6,774 | 38.5% |
| **250+** | 11,562 | 0.5% | 159,277 | 37.9% | 6,852 | 38.9% |
| | **2,544,199** | **100%** | **420,520** | **100%** | **17,596** | **100%** |

**Table 2: Analysis of UK Embedded Electronic Systems Activities**

frequently the source of rapid growth and disruptive products.

**Opportunity:** The UK needs an industrial strategy that provides opportunity across Electronic Systems businesses of different scale.

**Challenge:** UK Electronic Systems businesses are often bought out by multinationals before they have obtained sufficient scale.

For the larger company, this offers a way of harnessing innovation and preventing future competition in key market segments. Amongst the global Electronic Systems corporations that explicitly follow this acquisitive model are Cisco[20] and Broadcom[21]. But the traffic is not entirely one way, with companies such as ARM and Imagination Technologies from the UK, buying up talented teams around the world that have a good fit with their strategic direction.

While corporate acquisition may not be an ideal outcome, it can still be economically beneficial to the UK if the result is the maintenance or expansion of the operation in the UK.

There will always be pros and cons associated with being part of a larger corporation, but in order to survive in the longer term, these national operations must act like highly-innovative SMEs; they need to continue to develop great technology, capabilities and new products in order to maintain or enhance their ongoing value to their corporate parent.

## Workstream 2: Research, development and IP creation[22]

Innovation is "the process by which new ideas are successfully exploited to create economic, social and environmental value". Research & Development (R&D), the creation of those new ideas, is recognised as a central and essential element of this by the majority of businesses in the Electronic Systems sector; and is also supported by a broad academic community and significant public investment.

### Nature of R&D

Most companies involved in Electronic Systems understand the fundamental importance of R&D. Crucially, it is the nature of the R&D that companies are undertaking, the pressures driving this, and the barriers to linking R&D to long-term strategic business growth that are the critical factors.

We also noted that R&D within the Electronic Systems domain spans a broad range of Technology Readiness Levels[23]. In the academic context, research can be focused on scientific discovery and on the development of new and novel concepts. At the business end, companies want reliable technology and capabilities ready to use to create competitive advantage in their products.

**Challenge:** UK government investment needs to be balanced across the innovation spectrum to realise the greatest economic benefit.

### Trends and Behaviours

R&D is a fundamental and growing requirement in Electronic Systems. Broad sectoral analyses (1,2) consistently show that companies involved in Electronic Systems invest at least four times the national average. Of companies interviewed for this report, more than half indicated that their R&D spend is over 10% of turnover, and can be as high as 20-30%.

**Opportunity:** None of the companies interviewed indicated that R&D spend is decreasing and more than half stated that it is increasing in real terms.

### Research Capability and Investment

**Opportunity:** Publicly-funded support for R&D is significant: R&D Tax Credits, The Patent Box, EPSRC and the TSB. The opportunity exists to effectively utilize and guide these investments.

The academic element of the Electronic Systems community includes several world-leading institutions and it is vital in the long term that this capability is maintained. Current EPSRC investment levels (see Figure 4) indicate some £208 million in public investment in Electronic Systems R&D.

However, further analysis summarised in Figure 5, shows the diversity of individual technologies included in this analysis, and also the relative scarcity of funding in some important areas.

### Developing the Return on Investment (ROI)

It is important to deliver a satisfactory return from public investment in Research & Development. Figure 5 shows a typical ecosystem of participants who must be involved to achieve it.

**Challenge:** It is our aim to see a greater number of new skills, technologies, services and spin-out companies reaching commercialisation in the Electronic Systems sector.

**Professor Steve Beaumont of The University of Glasgow** commented: *"It is vital that the Electronic Systems sector fully engages with EPSRC, TSB and European funding to provide clear input to their decision-making processes and seek to align stakeholder interests on funding priorities which are strongly aligned with high innovation potential."*

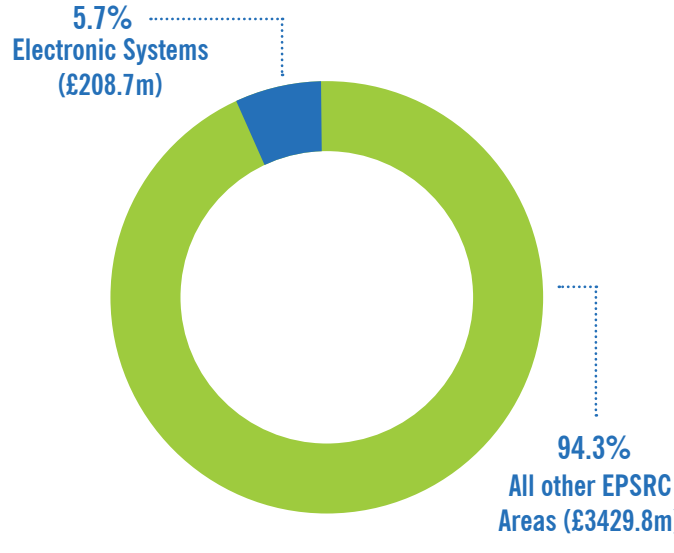
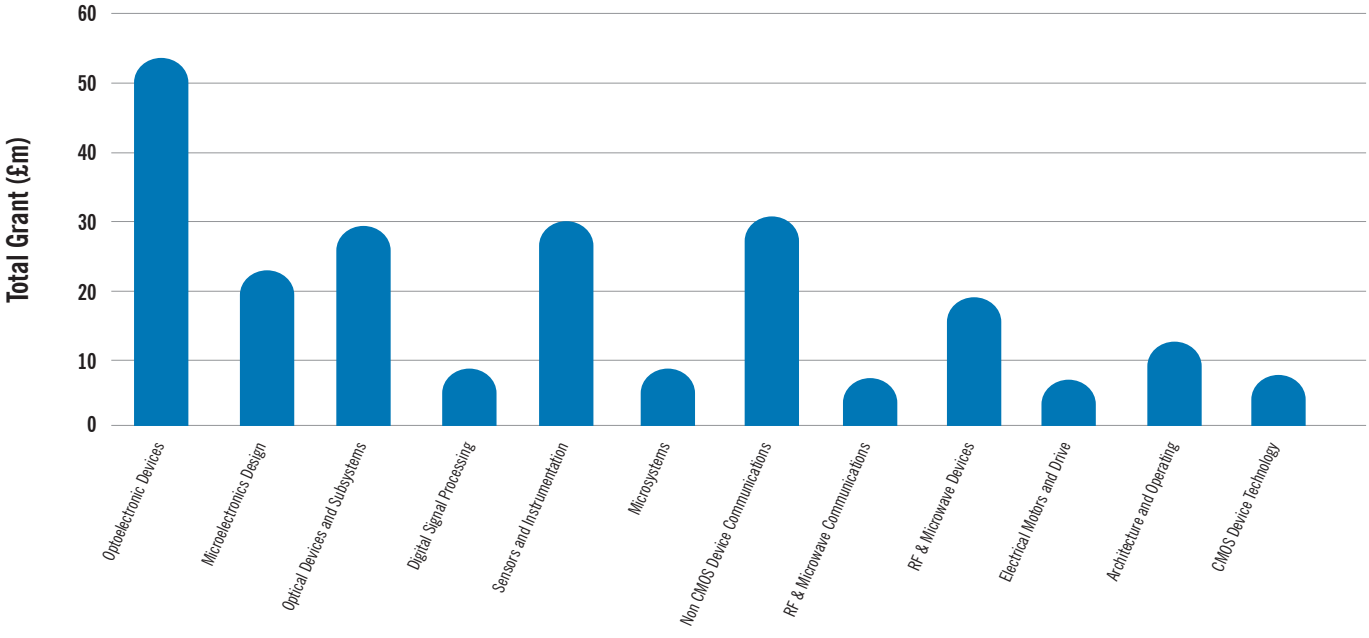



**Figure 4: Current EPSRC Grant Investment Portfolio**

## KEY FINDINGS

**Figure 5: Breakdown of Funding**




### Electronic Systems – A Key Enabling Technology

It is also important to note the dual role of Electronic Systems, as a technology that can enable multiple sectors and a technology that has the potential to create markets for new products and services that simply do not exist today.

For example:

- Power Electronics spans from micro-watts to mega-watts and will be a key enabler for Smart Grid, Electric Vehicles and electrification of aircraft.
- Embedded systems, including microprocessor and applications development enable everything from games to large-scale safety-critical systems where sensing and control applications are burgeoning and the Internet of Things is already a reality.

Business will take place in the provision of appropriate components, sub-systems and know-how and there will also be increased chance of success for those businesses that use this technology effectively to improve the power-efficiency, processing capability, user interface, sophistication, safety, functionality and reliability of their products.

We must also recognise emerging electronic technologies where mass market opportunities are forecast but are only now reaching commercial scale. Examples include plastic and printed electronics, where the UK has both world-leading scientists and some leading formative companies, which are pioneering both new applications for electronics but also new manufacturing ecosystems that could be anchored in the UK. Graphene is another tremendously exciting technology with high exploitation potential.

**Indro Mukerjee** commented: *"One can envisage an exciting convergence of plastic electronics and 3D-printing – globally important trends where the UK is well placed – which would enable the cost effective production of low volume/ high value products, which are thinner, lighter, more robust and low power."*

**Professor Steve Beaumont** commented: *"This is the nature of new technologies; it is not clear how or when the race will be won but if we do not support UK potential through investment then we risk throwing away our investment in the discovery process."*

### Building Businesses that Create Real Value

The UK is one of the world's great 'early adopter' markets for new technologies and products – fertile ground for fuelling innovation. This is complemented by world-class institutions (NHS, BBC, police, airports, transport infrastructure). Growing companies need lead customers – that's what will drive their capabilities to become world-class product and service providers. However, according to the World Economic Forum, the UK ranks a poor 45th of 144 for government procurement of advanced technology products, so there is plenty of opportunity for improvement in strategic purchasing to benefit this sector.

**Challenge:** Leveraging the spending power of the government in a more strategic way.

**Opportunity:** Encourage UK innovation in a direction that satisfies a local need, whilst enabling companies to extend their global reach, benefiting both themselves and UK exports.

The fact that so many UK businesses are bought out by foreign businesses is a challenge, and the wider community would be stronger if more of these organisations were able to grow to become companies of scale in themselves. According to The World Bank [24], South Korea has slightly smaller population and GDP per capita than UK and yet can sustain Samsung and LG brands.

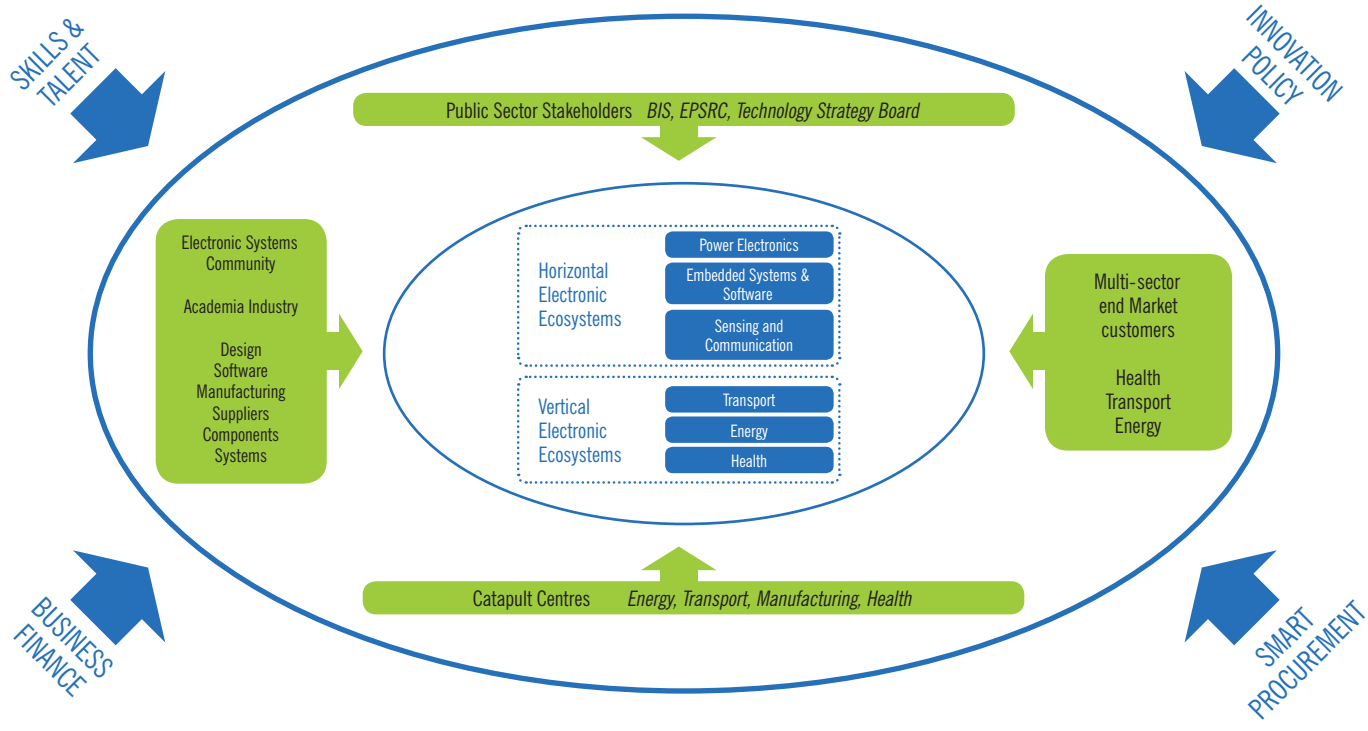



**Figure 6: Ecosystem model for Electronic Systems**

**Sir Hossein Yassaie** stated: *"The UK has many highly successful Electronic Systems businesses but we need 'scale' to overcome the rising costs of design and manufacture if we are to be profitable. That means creating major global Electronic Systems brands here in the UK to extract more value out of UK innovation. More can be done to help UK businesses develop strong roots locally to enhance their international ambitions."*

*For each £100 of retail value in consumer electronics products, £22 goes to the brand while the order of £1 goes to the IP creators. Having a credible presence in the 'IP domain' is excellent, but having a greater presence higher up the food-chain would bring greater economic benefit.*

**Challenge:** We need to create major global Electronic Systems brands here in the UK to extract more value out of UK innovation and establish greater influence in our national ecosystem.

## Workstream 3: Innovation Climate

### UK Innovation Policy

Whilst the term Electronic Systems is not yet widely used, many of the government initiatives and policies already in place are supporting important elements of it. We are therefore greatly encouraged by the words of Dr Vince Cable, Secretary of State for Business, Innovation and Skills[25]:

*"We have identified several fronts on which government action can have a real and early impact. These are: access to finance partnerships with sectors; support for emerging technologies; creating a pipeline of skilled workers; and finally government procurement and the development of supply chains…*

*…our industrial strategy is to build a collaborative strategic partnership with key sectors. The examples I often give are aerospace, automotive, and life sciences, but the list runs far longer, and could stretch from our existing*

## CASE STUDY

**Having found it difficult to break into NHS procurement in the UK, Imperial College spin-out Toumaz is now working with healthcare organisations in the US on technology deployment. Its key product, Sensium, is an ultra-low power platform for the rapid development of wireless Body Area Networks (BANs) that enable medical basestations to monitor multiple physiological signals in the body.**

## KEY FINDINGS

*strengths in creative industries and professional and business services to our early lead in the rapidly changing electronic systems sector."*

Electronic Systems were also identified as one of four priority areas in the recent announcement by government and industry of a joint R&D investment of more than £2 billion in the UK aerospace industry[26] once again highlighting the reliance of the recognised vertical sectors on this key enabling technology.

However there are areas where attention is lacking, in particular the fast, nimble SMEs which show significant future growth potential, but present a number of considerable challenges:

- How might this community be included in the national dialogue on industrial policy?
- How do these businesses unify to develop a common voice?
- How can these businesses develop the scale required to become more significant in their own right?
- What policies should be developed to support growing scale from a diverse community?
- How can the impact of these policies be adequately measured in a timely fashion?

**Opportunity:** ESCO's implementation strategy will be to develop closer ties with the leading UK players in vertical market sectors, developing joint roadmaps for key technology developments ready for investment.

This, however, is not the only answer as many Electronic Systems businesses do not rely on trade within the UK and sell into markets that are highly-geared towards exports; consumer electronics being the prime example where there is a presence in the UK of several of the world's leading technology providers but few of the world's leading brands consuming that technology within the UK.

It is therefore important to recognise that international policies are important to the industry, for example:

- European collaborative R&D provides the opportunity to develop partnerships with leading businesses or universities across Europe.
- UK Trade & Investment (UKTI) provides important support, for SMEs in particular, to participate in international trade shows and to conduct market research in target regions.

### Markets of Tomorrow

Societal concerns such as climate change will stimulate growth in new products and services, creating new emerging markets. For example, in power generation, the DECC/OFGEM Smart Grid Forum estimates the cost of upgrading the UK's electrical power distribution network to be around £27 billion, to be spent between 2012 and 2050.

There is societal pressure towards an integrated transport infrastructure which will require wider development and deployment of Electronic Systems; another strategic opportunity for the UK. There will be an ever-increasing reliance on autonomous systems that outperform humans in terms of speed, control and safety. Greater fuel efficiency will be required from vehicles and cleaner alternatives to travel will need to be developed to go beyond where we are today.

**Dave Moss** of Nissan said: *"Nissan is dedicated to providing innovation and excitement and harnessing the latest Electronic Systems and technologies is essential for us to deliver that. By building closer links with the UK Electronic Systems community Nissan strengthens our vision of the future and the technologies that will define it."*

**Ben Edwards** of Network Rail commented: *"Advanced Electronic Systems are the key to the technology advances in train control systems that are facilitating one of the biggest business change programmes on the railways, delivering improvements in safety, service and capacity."*

### Health and Well-being

Demographic changes leading to greater demands on healthcare provision is a major challenge facing successive governments both here and abroad. Electronic Systems already play a significant and growing role in diagnostics in healthcare, but will significantly increase its role in prosthetics to enhance vision and hearing (such as the cochlear implant), but also improved actuation and sensing for replacement limbs. This will extend into broader applications: from screening and early diagnosis, through treatment, into monitoring and aftercare. **Innovation in all of these areas can improve patient care outcomes while reducing healthcare costs.**

The UK already has the largest medical market in Europe worth £6 billion, which includes the electro-medical market estimated at £400 million in 2012, according to Espicom[27].

**Challenge:** During ESCO consultation several small, innovative UK companies reported that NHS procurement seemed impenetrable.

**Challenge:** Clarity and simplicity in public procurement processes coupled with a road map of future needs will focus the direction of R&D to meet the needs of government whilst stimulating competition.

Government agencies and procurement organisations should therefore consider how they can tap into innovation from UK SMEs, in the knowledge

### CASE STUDY

**Operating at the heart of wireless "Machine-to-machine" (M2M) mobile wireless data service provider Neul has developed the first 'weightless standard' [31] modem chip, which as well as reducing costs and power consumption also supports super-fast multi-channel radios. Projecting the UK to the forefront of a new global standard, Neul's success will have far-reaching implications not just in high tech and IT, but also the creative industries.**

that a purchase order from a significant customer can be of huge strategic value to an SME. If this can be achieved successfully then innovation can be accelerated to the benefit of both the procuring body, and the UK supplier.

**Opportunity:** Procurement of innovative new products and services

The Small Business Research Initiative (SBRI[28]) administered by the TSB, provides some opportunities for innovative companies to engage with the public sector to solve specific problems. However, this opportunity exists on a far wider scale than is being realised today.

**Opportunity:** Improve our sector's engagement in the SBRI scheme.

## Secure, Clean and Efficient Energy

As the drive to use renewable sources of energy continues, Electronic Systems will play an increasingly important role in the connectivity of remote generation[29] and the supporting, condition monitoring and communication systems. The Smart Grid will be a part of this, helping to address the security of supply, sustainability and affordability challenges of our energy future.

**Opportunity:** The Electronic Systems community needs to work together on the co-ordination of the complex new value chain within the energy sector, as well as a need to overcome technological and policy challenges.

## The Internet of Things

The 'Internet of Things' (IoT) is becoming a reality[30]. Intelligence and connectivity is spreading rapidly into more and more of the systems in our lives. This will enable more sophisticated services for the user, but also better data gathering for the hosts.

Ericsson predicts that there will be 50 billion connected devices globally by 2020. Further market research suggests that this could bring direct global revenues estimated between $948 billion and $2.5 trillion by 2020 (source: GSMA).

New products and services will develop as a result of capability enabled through the connecting of millions of previously discrete and disconnected systems together into intelligent platforms. The UK is well positioned to develop this opportunity and be amongst the global leaders in many aspects as the opportunity develops.

## Technologies of Tomorrow

The UK has strengths in almost every part of the Electronic Systems life-cycle, including plastic electronics[32], power electronics[33], Electronic Systems design[34], infra-technologies[35], embedded systems and software… this list could go on.

One area that can be considered as a market in its own right, but is also an important enabler for other key vertical markets, is Automation and Robotics. Automation, which covers such applications as Factory Automation (conveyors, handlers, automated tooling/machines), Home and Building Automation (heating, lighting and air conditioning controls) and Process Automation (the control of continuous processes such as oil and gas production, electricity generation and water provision), is reliant on Electronic Systems and is key to achieving current and future productivity, emissions and energy efficiency targets. Robotics, from the industrial robots used to manufacture cars to the emerging generation of autonomous systems which will potentially transform our domestic lives (vacuum cleaners, washing machines, garden maintenance) and healthcare (disability aids, mobility aids, remote surgery) will continue to permeate into more and more aspects of our everyday lives as technology allows price-points to fall to more acceptable levels.

**Professor Steve Beaumont** commented: *"Funding bodies must recognise the importance of Key Enabling Technologies and balance investment in 'market-pull' with informed investment in technology development."*

## Research & Innovation Summary

- Research & Development (R&D) is a central and essential element for business in the Electronic Systems sector.
- There is significant public investment in R&D applicable to Electronic Systems but it is thinly spread and there is scope for improved alignment and connectivity between industry, academia and funding bodies.
- There is a real opportunity for greater collaboration between the 'Horizontal' technology provision nature of Electronic Systems business and the 'Vertical' market-facing businesses; in particular to develop more and deeper UK supply chains.
- The UK has many of the components of a world-class Electronic Systems ecosystem, but there is scope to improve its integration. Strategic government procurement to support innovation can be a strong influence in achieving this.
- Creating businesses of scale is a key challenge.

## CASE STUDY

Seagate

**Benefiting from the wealth of intellectual talent available in Northern Ireland and strategic R&D investments totalling £1.1 billion, Seagate's operation in Derry-Londonderry is one of the UK's most advanced nanotechnology scale manufacturing facilities, employs some 1,400 people and supplies over one million recording heads each day for the industry's broadest portfolio of hard disk drives, solid-state drives and solid-state hybrid drives.**

## KEY FINDINGS

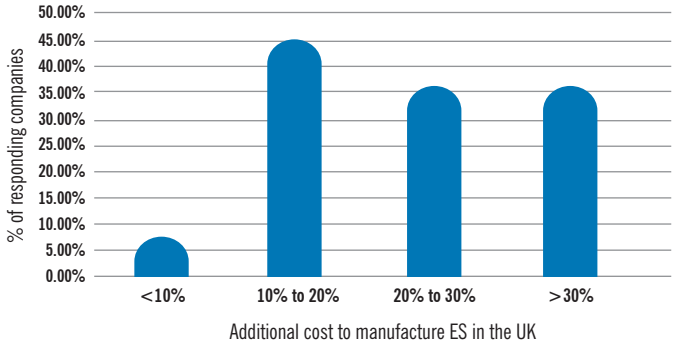



**Figure 7 : Cost Premium for UK Manufacturing**

## Workstream 4: Manufacturing[36]

Manufacturing (see Appendix 1) is still a vital wealth generator for a modern economy, and a key driver for growth and innovation of a wide range of technologies and tools.

To the casual observer it may appear that Electronic Systems manufacturing is something that Britain did in the 1950s and 1960s; but since then, has moved inexorably to lower-cost economies leaving a post-industrial UK manufacturing with very little activity. Nothing could be further from the truth! Though it has undergone revolution in scope and shape under the influences of globalisation, the UK's Electronic Systems manufacturers continue to thrive, employing around 200,000 UK people in around 5,000 operations today.

UK Electronic Systems manufacturers are significant exporters, with the sample of companies surveyed in the Manufacturing Workstream aggregating 72% of output exported and many companies exporting above 90% of output.

Whilst off-shoring of UK manufacture has been a feature of recent years, 25% of those who had off-shored some or all of their production have subsequently re-shored manufacturing to the UK. And 85% of companies declared an intention to increase the number of products manufactured here.

**Peter Maxwell**, Managing Director of Cooper MTL says: *"We were large enough to invest early in capital intensive automated board assembly equipment in the UK. This enabled us to keep close control on our quality, save costs by minimising inventory holding and stay flexible by being able to introduce new products quickly, all while staying cost competitive against competitors who manufacture in lower cost economies."*

Electronic Systems manufacturing companies tend to become net exporters early in their development. In the UK we have the skills, innovation, application knowledge and entrepreneurialism that have resulted in a vibrant community, attracted significant inward investment and have made the UK an important geographic node within the global Electronic Systems ecosystem. With a supportive business environment and infrastructure that encourages capital investment we can gain a competitive edge in the formation and sustaining of these companies. However, in the face of competition from other ambitious nations who see the future through the same lens, we need to continually review and reinforce these advantages.

R&D investment is vital to manufacturing operations; 95% of companies interviewed had R&D operations in the UK associated with UK manufacturing. 56% also have associated R&D operations in the UK for products manufactured outside the UK (average of 38% of their UK R&D activity). The physical separation of design and manufacturing has proven particularly problematic in some areas, and has been a key driver of the emerging trend to re-shoring manufacturing to the UK.

Electronic Systems manufacturers have deep roots in the UK:

- 9% have been manufacturing in the UK for more than 20 years.
- 28% have more than one UK manufacturing site.

### Costs of Doing Business in the UK

67% of UK Electronic Systems manufacturers consider that there is a cost penalty for manufacturing in the UK, estimating the premium at about 20% (see Figure 7). Allan Rankin, Managing Director of International Rectifier Newport commented: "Our US sister plant is paying 1/3rd of our energy cost; energy-intensive manufacturing businesses cannot compete in the long-term against this scale of differential in input costs."

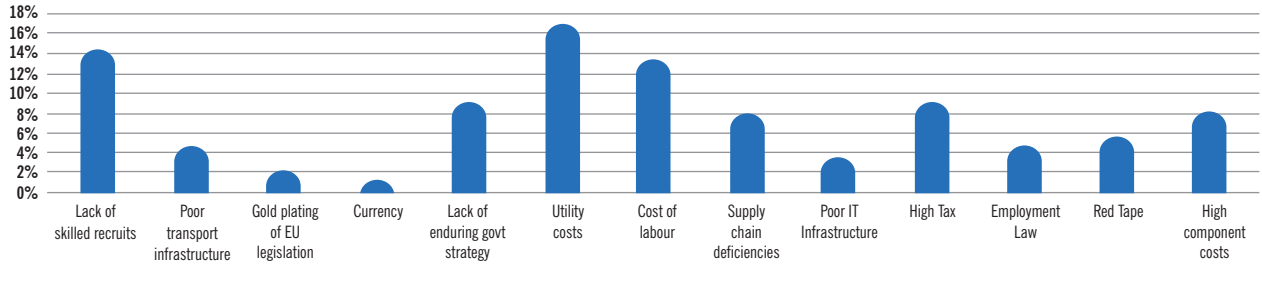



**Figure 8: Drawbacks to Manufacturing Electronic Systems in the UK**

"AUTOMATION, SENSING AND INSTRUMENTATION ARE TRANSFORMING THE UK'S MANUFACTURING CAPABILITY IMPROVING PRODUCTIVITY, ENERGY EFFICIENCY AND QUALITY."

Joe Willson, Emerson Process Management

## KEY FINDINGS

Companies making highly differentiated or high added-value products find locating their manufacturing in the UK of great technical benefit which can offset the increased cost – but only just! However, many manufacturing businesses do not operate in such markets; for them maximising profit potential through lower cost of manufacture is a key factor. The result of a higher cost base is inevitably less manufacturing here, lower levels of investment for the long term and ultimately less employment. The drivers of higher costs in the UK are typically common across multiple industries and have been the subject of much campaigning from a broad range of industrial bodies.

**Joe Willson** of Emerson UK commented: *"We all enjoy a good standard of living in the UK but the Government has a key responsibility to ensure input costs of UK manufacturing enterprises remain at least competitive with other developed nations."*

Whilst businesses already located in the UK have a natural bias towards remaining here, many of the senior management have had the opportunity to work overseas or are part of businesses with overseas manufacturing locations. Their observations are recorded in Figure 8.

### Manufacturing Summary

- Manufacturing is healthy in the UK Electronic Systems sector, where it adds high value to the product, maintains quality, secures brand value, maintains control and improves flexibility.
- Many who have previously off-shored manufacturing have now brought it back to the UK, citing quality and flexibility issues as hidden costs of off-shoring.
- Cost of manufacture in the UK is a critical issue – utility costs are more expensive here, with component costs and labour costs also seen as key drivers.
- UK Supply Chains are weak due to many years of off-shoring and the lack of a strategic approach to procurement by UK companies.

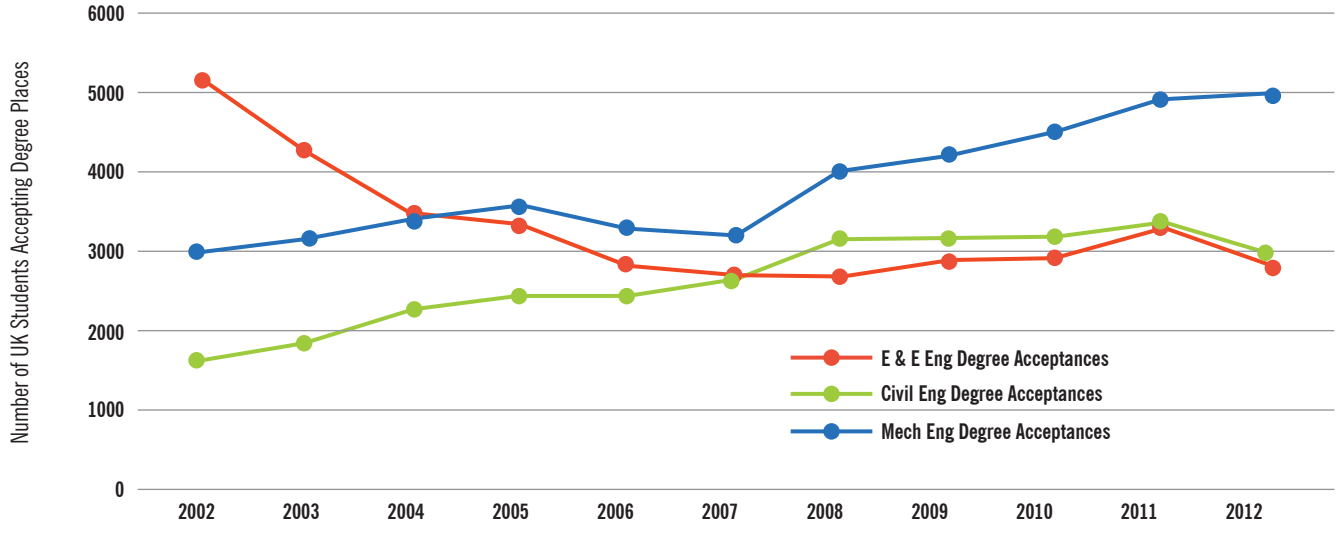
## Workstream 5: Skills[37]

Skills shortages were by far the most common challenge raised during ESCO consultations across all of the workstreams and are a critical enabler to support and achieve our ambition for growth. There are already major shortages in both quality and quantity; ***a situation predicted to get much worse in the near future.*** Through the technical trends highlighted in this

| Future Technologies | Future Skills |
|---|---|
| Connected car | Smartphone Operating Systems, applications, Telecommunications network operating standards |
| Driver information system, including ADAS warnings | Wireless connectivity and understanding of relevant standards such as WiFi, DLNA, WiFi direct, BT, NFC, Mirrolink |
| Connected HD displays and sensing | Protocol stacks, Ethernet and security<br>Image analysis and graphics processing |
| Predictive HMI | Displays and touch technology |
| Seamless CE device integration | Human Machine Interface (HMI) and graphics design |
| Vehicle and driver contextual and situational awareness | Optics and Image projection technology<br>Multiband reception, Software defined radios, smart antenna tech |
| Cloud services | Complex Electronic Systems architectures – systems architect/engineers<br>Linux, HTML5, JavaScript, XML, SOAP and RESTful web APIs |

**Table 3 – Future Skills in Automotive Electronic Systems**

**Figure 9 – UK Students Accepting Degree Places at UK Universities (Source: UCAS)**




report, the required competencies to address the engineering challenges facing modern Electronic Systems businesses are changing significantly and rapidly. Take the example shown in Table 3 from the automotive industry[38]. The cost-effective application of future technologies will be a major determinant of commercial success in the automotive environment. All of these are delivered through Electronic Systems, with the future skills requirements demonstrating the multi-disciplinary nature of our community today.

There are major opportunities in developing excellence at a national level in this domain and yet there are major challenges. The starting point is the failure of the UK to produce high quality STEM graduates in sufficient quantity. The industry has recognised a need and, through the UK Electronics Skills Foundation[39] (UKESF), is working collectively to provide young people with information on the varied and exciting careers the industry has to offer. UKESF is also seeking to address the male-female gender imbalance where close to 90% of Electrical and Electronic Engineering degree applicants are male. We must communicate that:

- These skills will be required and will enable every vertical market sector with high potential in career choice and competitive salaries.
- It is an open competitive landscape – this is a rapidly evolving area, the UK is already significant nationally, globally and has an opportunity to take the lead on a world stage.

In short, this is an exciting and significant area to work in. To quote **Lord Browne of Madingley** *"Engineers will decide the UK's economic future".*

All advanced manufacturing and engineering (AME) industries are fishing in the same talent pool; a pool that is getting smaller due to an increasing average age demographic and falling roll numbers in schools. This is substantiated by Semta who state of the AME sector:

- 82,000 engineers, scientists and technologists need to be recruited and trained by 2017[40]
- There was a 47% decline in the numbers of UK entrants to Electrical and Electronic Engineering degrees at universities between 2002 and 2012 (Figure 9).

In response to these declining numbers, NMI co-ordinated a strategy that engaged key partners from industry and academia, supported by BIS and Semta. This led to the birth of UKESF, whose goals are:

- Connecting employers with students in schools and universities.
- Promoting the electronics industry and its value to society and the economy.
- Raising awareness of the range of stimulating careers in electronics.

Since start-up in 2010, UKESF has partnered with relevant organisations to deliver:

- Industry-sponsored summer work placements, industrial mentoring, an annual bursary and professional development training for 75 students rising to over 100 with agreed placements for 2013.
- Residential Summer Schools for 80 Year 12/S5 students interested in finding out more about degrees and careers in electronic engineering before they make their UCAS applications, with committed funding for a further 60 students at the 2013 Summer School.
- A schools project that reflects the nature of work in today's Electronic Systems industry, has relevance to the school curriculum and engages employers with local schools has been piloted in 2012, engaging teams of six school pupils from 10 different schools with a view to national roll-out from 2013.

Between 2010 and 2012, leading employers have already invested over £500,000 in UKESF.

## KEY FINDINGS

### Apprenticeships

Apprenticeships present a different option to the identification and development of talent with a variety of entry and progression routes, for example:

- Student Apprenticeships – at undergraduate level
- NEW Higher Apprenticeships – at Foundation Degree and Degree level
- Technician Apprenticeships – at levels 3 and 4
- Craft Apprenticeships – at levels 2 and 3

With the recent increase in university tuition fees in England, Wales and Northern Ireland there has been an overall 12% reduction in university applications (UCAS). This is resulting in young people choosing alternative modes of training and education (earning whilst learning). The UK Electronic Systems community need to explore this alternative source and route to talent in order to address the common criticism of poor practical skills.

### Qualification Levels and Continuous Professional Development

Qualifications vary considerably across the spectrum of Electronic Systems enterprises. For most involved in research, development and IP creation, a degree is the entry-level requirement. For example, figures from ARM show that 95% of ARM employees in Cambridge have a degree, and 50% a postgraduate degree.

The 'education system', however, does not produce job-ready engineers. Employers expect that graduates will need at least two years on-the-job and postgraduate training before they are fully productive, with ongoing training programmes for the rest of their professional lives to maintain that level of competence in the face of rapidly changing technology.

**Indro Mukerjee** commented: *"Continuous Professional Development (CPD) is not only a recognised part of the job, but also constitutes a significant part of the engineering education process. Its inclusion in our national strategies is vital, rather than optional."*

**Opportunity:** The critical shortages can be addressed in-part by:

- Re-training in selected disciplines through training courses delivered by the private sector.
- Initiatives such as the Advanced Skills Accreditation Scheme (ASAS)[41], which provides modular training courses leading towards a formal Masters qualification.
- The provision of appropriate Centres for Doctoral Training (CDTs) and Industrial Case Awards.
- The provision of parallel industrial experience/vocational training for undergraduates interspersed into their course either in the long Easter and summer breaks or as a year of industrial experience immediately before their final year.
- Encourage actions to support Continuous Professional Development (CPD), both in the provision of training courses and the training of individuals.

Schemes such as UKESF will take several years to have an impact, so greater short-term flexibility to recruit more graduates from overseas into industry has been submitted and key job titles have been agreed by the Migration Advisory Committee in their review of Shortage Occupations in Feb 2013[42].

### Summary of Key Skills Challenges

To address these skills shortages, the industry, trade associations, sector skills councils, trade unions, government, academia and the education system must work together to:

- Attract new talent of the right quality and quantity to the right disciplines.
- Increase the rate of adoption and range of apprenticeships with an increased emphasis on undergraduate apprenticeships.
- Increase industry participation in undergraduate support, placement and employment.
- Secure sufficient  postgraduate skills and suitable financial models.
- Pay closer attention to the role of CPD in supporting engineering capability in the workplace.

The Electronics Sector Strategy Group (ESSG), co-ordinated by Semta, will act as the owner and driver for the STEM-based skills and knowledge agenda, in partnership with a broad range of UK stakeholders and partners.

# AMBITIONS, STRATEGIC OBJECTIVES & ACTIONS

**Our 2020 targets are:**

- **Employment growth from 856,000 today to 1,000,000.**
- **Economic growth from £78 billion to £120 billion.**

**We believe this will be delivered by:**

- **Building greater recognition of this strategically important key enabling sector.**
- **Accelerating growth in the UK vertical sectors as a result of the use of UK Electronic Systems.**
- **Growing and exploiting UK Electronic Systems capability globally.**

We see today as the perfect time to step-up to meet the challenges the Electronic Systems sector faces and reflect that our direction is well aligned with the industrial policy proposed by the Business Secretary, Dr Vince Cable.

We see a UK Electronic Systems sector that can be world class in its own right. We see it creating UK businesses of global scale, whilst also enabling new companies, products and services in a range of diverse markets such as health, transport, energy, education, security, aerospace, defence and automotive.

The key recommendations arising from this report are highlighted in the Report Infographic and described below:

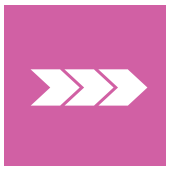
## Smart Leadership and Engaging the Community

***Goals are inward-facing within the community and outward-facing to government and other UK industrial sectors:***

- ***Inward: develop broad recognition of ESCO and support for its aims and objectives.***
- ***Outward: develop a Leadership Forum, ensuring this is well-supported and connected.***

**Establish a new UK Electronic Systems Leadership Forum (ESLF)**, in partnership with government: to agree and lead the implementation of the Action Plan and promote this across the Electronic Systems community.

**Engage the community by working through the Trade Associations and key stakeholders who will create a strategic collaboration agreement committing resources to support the Forum and the ESCO Action Plan.**



## Smart Supply

***Goal to ensure UK verticals can source UK Electronic Systems technologies and attract system integrators to the UK.***

### Leadership Forum Connected to Key Verticals

As indicated by Figure 10, Electronic Systems is an industry sector with its own supply chain and a critical part of almost every other vertical industry. The Electronic Systems Leadership Forum (ESLF) will build strong relationships with key verticals such as aerospace, automotive and defence, ensuring strategic alignment at the most senior level.

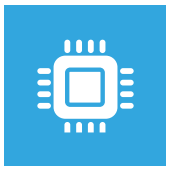
To facilitate these advances, the Electronic Systems Leadership Forum will propose 'sector-focused ambassadors' to establish a dialogue with their counterparts in selected 'Vertical' Leadership Groups and identify strategic supply chain development opportunities that could bring Electronic Systems R&D and manufacturing to the UK.

### Building UK Ecosystems

***Leading companies provide the basis for strong ecosystems. Using PowerElectronicsUK*** [43] ***as a model, the Electronic Systems community will develop ecosystems around strategic supply chain development opportunities.***

The initial priorities identified from this report are:

- Energy – The intelligence in the Smart Grid
- Healthcare – The heart of Smart Healthcare
- Transport – The hub of Smart Transport



# Smart Industries Delivering Smart Jobs

***Goal to improve collaboration across relevant stakeholders from industry sectors, government agencies (funding and procurement) and academia, leading to improved investment that will more effectively position the UK at the forefront of creating new Electronic Systems-based industries.***

Electronic Systems Technology Group (ESTG) to be created and working closely with key vertical sectors, Research Councils and the TSB, develop and maintain a relevant technology roadmap.

The ESTG will:

- Provide a forum for industry and academia to explore potential opportunities together.
- Produce evidence that highlights the most promising opportunities for public sector investment in R&D and postgraduate skills.
- Establish joint working programmes with the Catapult Centres to stimulate collaborative working on joint projects with strategic verticals.
- Comment on the potential of 'disruptive technologies' such as plastic electronics, graphene, 3D printing and others to help inform strategic funding decisions.

## Government Procurement Driving Innovation

ESLF will work with government to develop systems and processes to encourage UK involvement in public procurement opportunities. We would particularly like to utilise UK government spend on healthcare, transport and Smart Grid to develop and position the UK Electronic Systems community as global leader within these markets. We will commit to reviewing current initiatives, such as the '3millionlives'[44] campaign, and work with the relevant agencies to examine how economic benefits can be realised for UK companies.

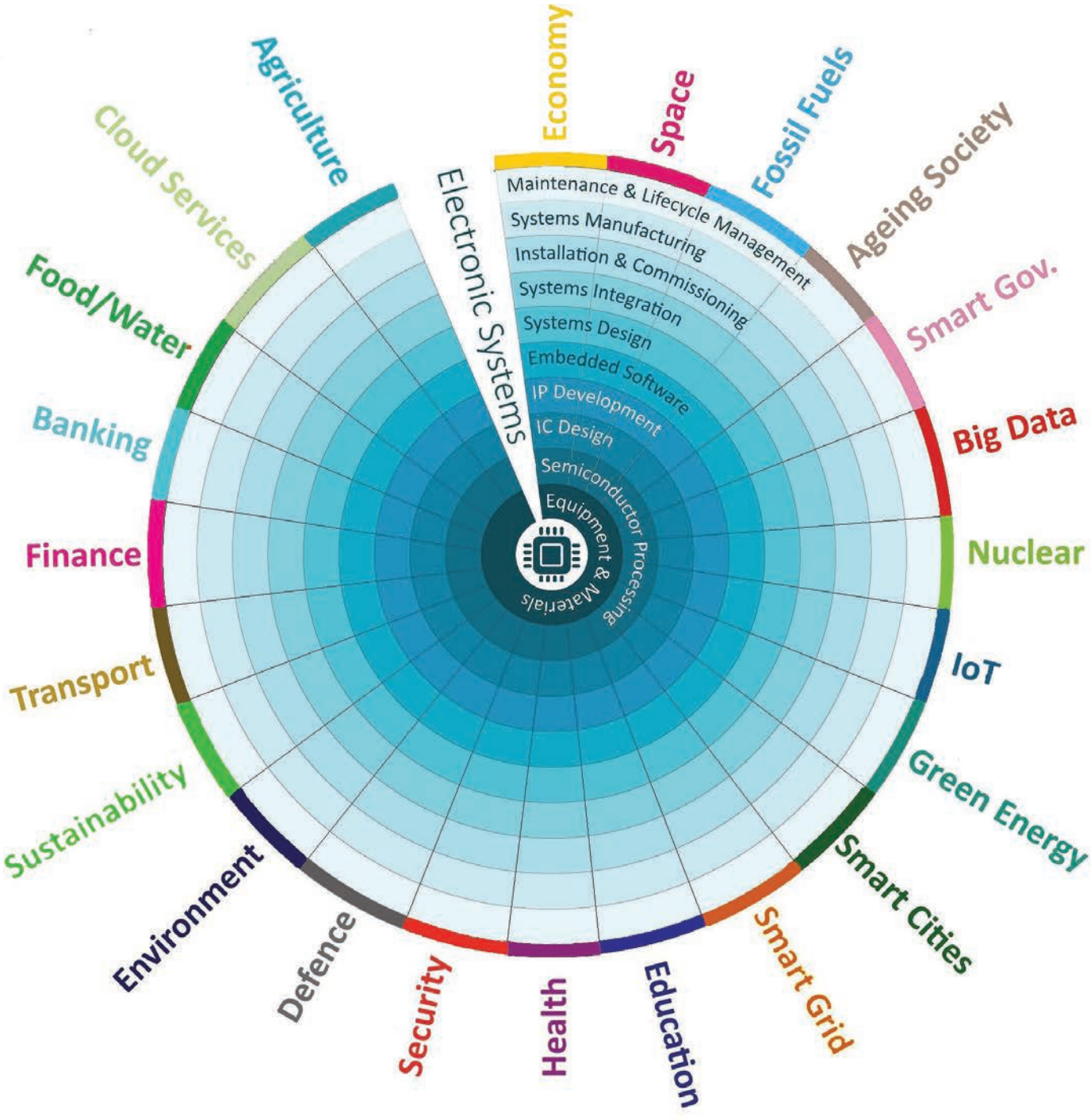



Figure 10: Multiple layers of Electronic Systems technologies under-pinning market needs

## Smart UK to Global UK

***Recognising that the UK punches above its weight in technology creation, the goal is to ensure that UK industry and academia continue to create great new technology whilst striving for greater UK-led exploitation and increasing exports.***

### Promoting UK Electronic Systems Capability on the Global Stage

Work with UKTI to develop a concrete action plan to ensure the UK Electronic Systems community and their capabilities are properly represented given their economic importance.

### Taxation as a Strategic Incentive

The Research, Development and Innovation Workstream consultations recognised the strong support for the use of tax credits to encourage investment by industry. They are seen as easy to understand, un-bureaucratic, resource effective and timely. Other initiatives such as the Seed Enterprise Investment Scheme[45] offer investment incentives and have been a useful investment mechanism for innovative small companies. At the same time, other incentive tools such as Capital Allowances and The Patent Box are less relevant. The Electronic Systems community will work with government to review the use of the taxation system to encourage greater private sector investment and prosperity.

### Intellectual Property – Recognition and Protection

Work with the Intellectual Property Office to develop a consultation seeking to resolve issues on patent trolling, protection and use of Intellectual Property.

### Catapults and Doctoral Training Centres – Recognising the importance of Electronic Systems

Establish joint working programmes with the TSB and EPSRC in order to ensure recognition of the role and scope of Electronic Systems and encourage greater engagement from the industry.

### Helpline – Support through the Funding Maze

Work with the Electronics, Sensors, Photonics Knowledge Transfer Network (ESP KTN) to produce consolidated guidance and online support to encourage greater engagement with and use of available support for R&D.

## Smart Brands, Known Brands

***Goal is to support UK business growth to see more UK companies with globally dominant consumer-facing brands.***

### Growing Companies of Scale Study

While the UK is home to several of the world's leading 'Business-to-business' (B2B) brands, we don't yet have any globally dominant consumer-facing electronic brands headquartered here. Doing so would help to raise the profile of the industry as a whole and overcome many of the challenges raised in this report. We will develop a study that reviews potential inhibitors and barriers to growth with a view to informing industrial strategy and investment.

# Developing Smart Skills

***Goal is to develop a skills base that provides UK industry with the resources required to take advantage of future markets.*** This requires concerted action by industry, academia and government across a broad range of skills challenges.

## Schools & Undergraduates: Develop the UK Student Skills-base

There is a real need to increase the number of bright young people considering careers in the Electronic Systems Community and a particular opportunity to address the gender imbalance. The industry needs to increase co-ordinated activity reviewing ways to 'inform and excite' young people about working in the industry. Engage with relevant initiatives, such as the UK Electronics Skills Foundation, Raspberry-Pi and Code Club[46] , See Inside Manufacturing[47], The Big Bang Science Fair[48] and others. It also needs to engage the public media to increase general awareness of careers and interest in technology.

## Electronic Systems Graduates

UKESF should expand its scope to cover the full breath of relevant skills and technologies; in particular to include computer science courses. It needs greater industrial engagement to expand its scale to influence a substantial percentage of the industry's needs for graduates.

## Increasing Availability and Quality of Apprenticeships

Increase the range of available craft and student apprenticeships and work with stakeholders to raise awareness with potential apprentices and increase industrial engagement. Also consider how to reduce the cost, to SMEs in particular.

## Postgraduate Skills Prioritisation

There is a need to examine available funding and resources for postgraduate skills. There is also a need for industry, funding agencies and academia to align postgraduate skills investment with the stated priorities of the ESTG.

## Migration

Recognising the global scarcity of highly-talented engineers and that bringing international talent to the UK is required to complement our indigenous talent pool, there is a need to continue working with the Migration Advisory Committee (MAC) to ensure key policy and implementation concerns can be raised and addressed.

## Smart Sustainable Government Partnership

**Sir Hossein Yassaie** commented: *"Government is a critical partner across all aspects of sector development. Improving the education system, shaping taxation and incentive packages, setting public investment levels and priorities, promoting capability internationally and other key areas are heavily influenced by government actions. The goal is therefore to develop a strategic partnership with joint objectives; a partnership that spans multiple parliaments."*

# Smart Partnership

## Adopting the Economic Model

We intend to develop the 'income-based' economic model of the Electronic Systems community and use it to quantify the development of the UK Electronic Systems community and its contribution to the UK economy. Whilst this will be industry-led it will require support from government economists.

## Setting Joint Strategic Objectives

The new Leadership Forum will develop an agreed set of joint objectives with key government departments. For example, the government could play an active role in co-sponsoring initiatives aligned with our ambitions and previously highlighted within this report:

- Electronic Systems – The intelligence in The Smart Grid.
- Electronic Systems – The heart of Smart Healthcare.
- Electronic Systems – The hub of Smart Transport.
- Opportunity for smarter use of government procurement.
- Adoption and support of the income-based economic model.
- Promoting UK Electronic Systems capability internationally.
- Better use by our industry of government programmes and initiatives for apprenticeships, supply chain and innovation.

# CONCLUSIONS

The growing dependence on Electronic Systems in all aspects of 21st century living is beyond doubt. So too is the vital economic and societal contribution that our industry is making in the UK today and should continue to do in the future. We are a diverse community, with many highly innovative SMEs.

We are a growth industry, highly geared towards exports and a sector that can bring jobs, investment and economic benefits. Electronic Systems also under-pin almost every market sector that exists today and the required skills are precious in those market sectors also. In this way Electronic Systems can be seen as key to anchoring other vertical industry supply chains in the UK.

***Together with Government, we must shape policies that improve the innovation climate and maximise growth potential.***

We need to build a platform that:

- Ensures recognition for the role of the UK's Key Enabling Technologies (KETs), as happens elsewhere in Europe[49].
- Provides a basis for more investment in research, development and innovation.
- Develops our innovation climate supporting the Prime Minister's stated ambition of "The UK being the best country in Europe to start, finance and grow a company."[50]
- Supports the development of new supply chains for the industries of tomorrow.
- Delivers the improvements in capability and availability of engineering skills we need.

Through the measures identified in this report, we believe we can improve skills and stimulate further growth and exports.

However, there are significant threats from other regions that appear to be ahead of the UK in their realisation that Electronic Systems really will deliver the future, and are already taking investment decisions with this in mind. **To safeguard its future and enable the industry to achieve its full potential, we must tackle the challenges and seize the opportunities outlined in this report together.**

Our starting point is to build the members of this community into a better connected, more visible and influential force – which requires your engagement.

For further information and to add your weight to the ESCO initiative, visit **www.esco.org.uk**

# APPENDIX 1 - DEFINITIONS

ESCO uses various terms which without clarification might be misunderstood.

In logical order...

- **Systems:** are Objects that deliver tangible functionality to satisfy End-User (you or I) needs.
- **Sub-Systems and Components:** are objects deployed within systems whose functionality is important for the behaviour of the System, but whose operation is essentially invisible to the end-user.
- **Manufacturing:** is the process of reproduction of physical objects, which may be Systems, Sub-Systems or Components. For resolution of doubt, it does not implicitly include R&D.
- **R&D:** is a collective term for the pre-production actions of Research and Development.
  - **Research (R):** is literally "finding out". In the academic context, it tends to focus on scientific discovery and the formation of new and novel concepts. In the business context, it is the search for reliable technology and methods to use to create competitive advantage in products. Research is not limited to the technologies embodied in products themselves, but also applies to the processes by which products are made i.e. manufacturing.
  - **Development (D):** is the process of transforming a specific idea or concept into a commercially viable and reproducible Product. Development frequently (but not always) involves the use of new technology or capabilities to provide competitive product differentiation. Development applies to the Product itself, but equally applies to the process by which the product is made.
- **Product:** is a package of a System, Sub-System or Component (including Intellectual Property) along with a business model, which offers commercial value.
- **End-Product:** is a Product that an End-User purchases for its provided utility.
- **Electronic Technology:** is technology which modulates electricity through the use of amplifying devices such as transistors of any genre. It applies primarily to the chemistry, design, assembly and reproduction of devices, sub-systems and systems which incorporate them as well as the passive components which are necessary for circuit functionality.
- **Embedded Software:** is computer software, written to control machines or devices that are not typically thought of as computers. It is typically specialized for the particular hardware that it runs on and has time and memory constraints. This term is sometimes used interchangeably with firmware.
- **Electronic Systems (ES):** [1] are systems or products whose functionality is critically dependent on the deployment of Electronic Technology within them.
- **The UK Electronic Systems Community (UK-ESC):** [2] are the UK based businesses and stakeholders involved in Research, Design, Qualification, Production, Manufacture, Installation and Maintenance of Electronic Systems, their Sub-Systems or Components.

Notes 1 and 2: A complete definition is located in Appendix 1

# APPENDIX 2: THE ESCO TEAM

**This report was created under the guidance of a Steering Group of leading individuals from industry and academia:**

| | |
|---|---|
| Jamie Urquhart | Pond Venture Partners, Chairman |
| Steven Beaumont | University of Glasgow |
| Warren East | ARM |
| Indro Mukerjee | Plastic Logic |
| Keith Williams | Altran |
| Joe Willson | Emerson UK |
| Sir Hossein Yassaie | Imagination Technologies |
| Chris Carr | Department for Business, Innovation and Skills |

**The Steering Group was also supported by a Management Group as follows:**

Workstream 1 – Economic Footprint of the UK Electronic Systems Community – Ian Philips, ARM

Workstream 2 – Research, development and IP Creation - Alastair McGibbon, NMI

Workstream 3 – Innovation Climate – Marco Pisano, Intellect

Workstream 4 – Manufacturing – Graeme Philp, Gambica

Workstream 5 – Skills: Supply, Demand, Provision and Gaps – Darren Race, Semta

Additional support in the development of this report and the supporting Workstream Reports was provided by:

Julien Clausse (Altran), Stephen Pattison (ARM), Peter Brooks (Electronics Yorkshire and UK Electronics Alliance), Nigel Rix (ESP KTN), Tony King-Smith and Woz Ahmed (Imagination Technologies), Roger Rogowski (UK Electronics Alliance), Mark Begbie, Julie Bott, Steve Dempsey, Keith Hodgkinson & Mark Turner (Department for Business, Innovation and Skills).

**The organisations listed below led the development of this report and associated workstream reports. They would be pleased to hear from anyone interested in joining them and supporting these activities.**

## NMI

NMI is the trade association representing the UK Electronic Systems, Microelectronics and Semiconductor Communities. Its objective is to aid the development of a sustainable, world-leading industry by building a strong network and acting as a catalyst and facilitator for commercial and technological development.

Geddes House, Kirkton North, Livingston EH54 6GU
T +44 (0)1506 401210
E info@nmi.org.uk
W www.nmi.org.uk

## GAMBICA

GAMBICA is the national organisation representing the interests of companies in the instrumentation, control, automation and laboratory technology industry in the UK.

Broadwall House, 21 Broadwall, London SE1 9PL
T +44 (0)20 7642 8080
E assoc@gambica.org.uk
W www.gambica.org.uk

## Intellect

Intellect is the voice of the UK's technology industry, helping companies of all sizes compete and innovate in a dynamic global market. It represents the views of industry to Government and regulators and provides opportunities for Government and regulators to interact with industry on key policy and market issues.

Russell Square House, 10-12 Russell Square, London WC1B 5EE
T +44 (0)20 7331 2000
E info@intellectuk.org
W www.intellectuk.org

## Semta - Sector Skills Council for Science, Engineering and Manufacturing Technologies

Semta address the sectors' skills needs, providing expert support to improve performance and growth by working with employers, partners and training providers to shape skills and training solutions that meet employers' needs.

14 Upton Road, Watford, WD18 0JT
T +44 (0)845 643 9001
W www.semta.org.uk

## UK Electronics Alliance

The UKEA comprises the leading trade associations within the Electronic Systems community, enabling a coordinated voice. The UKEA provides a platform for interaction and partnering and undertakes activities in the collective interests of the Trade Association members.

T +44 (0) 1959 561345
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W www.ukelectronicsalliance.org.uk

## Electronics, Sensors, Photonics Knowledge Transfer Network (ESP KTN)

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# APPENDIX 3: CONTRIBUTORS

**We are indebted to all who gave their opinions and experiences freely throughout the production of this report. They represented the following companies and organisations:**

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Aero Engine Controls
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Amino Communications
Apical
Aptina Imaging (UK)
Arcam
ARM
Arrow Technical Services
ASL Vision
Astute Electronics
Avon Magnetics
Axiom Manufacturing
Axis Electronics
BAE Systems
Beka Associates
Biochrom
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Blade Electronics
Brynleigh
BSC Filters
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Calex Electronics
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Electronic Motion Systems
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University of Southampton
University of Warwick
Wolfson Microelectronics
Xaar
Zetex Semiconductors
Zyconix

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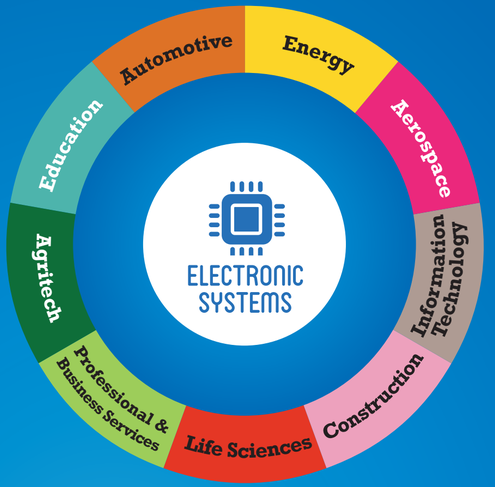
ESCO
Electronic Systems Challenges & Opportunities

THE ESCO REPORT: A BLUEPRINT FOR UK ECONOMIC GROWTH

"IT IS THE AIM OF THE ESCO INITIATIVE TO ENSURE THAT THE UK RECOGNISES THE IMPORTANCE AND ENABLING NATURE OF ELECTRONIC SYSTEMS AND THE HUGE BUSINESS AND ECONOMIC BENEFITS TO THE NATION. A STRATEGIC AND LASTING PARTNERSHIP BETWEEN THE INDUSTRY AND GOVERNMENT IS FUNDAMENTAL TO OUR FUTURE SUCCESS."

**Sir Hossein Yassaie**
Chief Executive, Imagination




## CONTENTS