

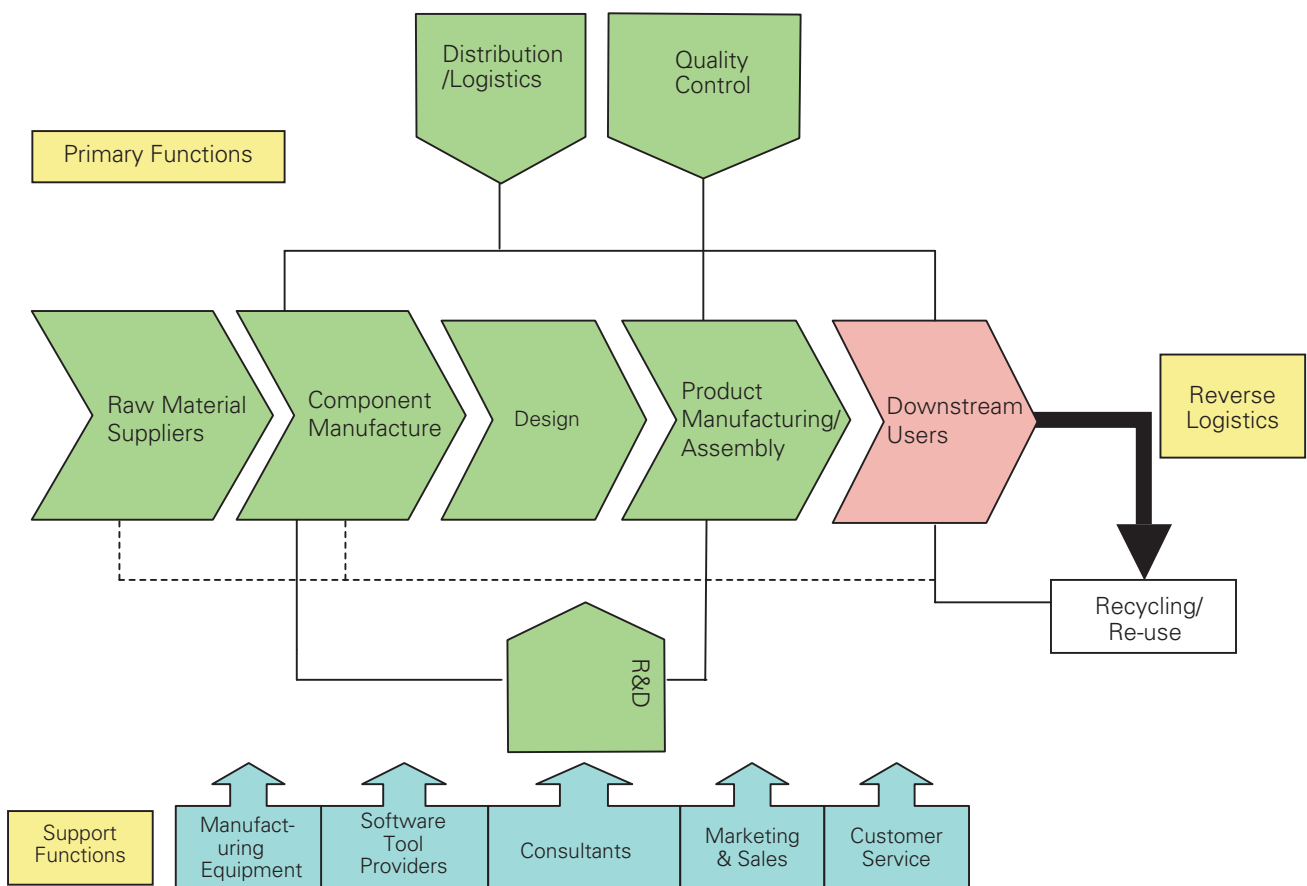


The electronics supply chain

The electronics supply chain is highly complex and continually changing in response to new technologies, new markets, investment constraints, competition and margins, plus external factors. The industry is characterised by high specialisation of firms along the value chain, depending on the product. Often it is not appropriate to talk of 'an electronics supply chain' but individual supply chains, depending on which product or market is concerned, and at what time.

The diagram below (*Fig A.1*) illustrates the complexity of the interactions and the relationships that need to be managed in order to deliver a product to a particular quality level and price point.

Fig A.1: UK electronics value chain



A product is generally designed in response to a market opportunity or demand. Typically, the product will be assembled into a prototype/pilot that is manufactured in relatively small quantities and tested in the marketplace. The product will then be manufactured in low volumes in response to demand and then manufactured in high volume as demand increases. Both quality control and R&D features throughout the value chain.

A number of supporting activities are involved in taking a product to market, such as consultancy services, software provision, marketing, sales and customer services.

Reverse logistics is becoming an increasingly important part of the chain for environmental sustainability, where products are returned by the end-user once they have reached the end of their useful product life. Recent EU regulation requires the companies who produced the products to dispose of them in an environmentally sound manner, by recycling the materials used or refurbishment for re-selling the product.

The highly modular nature of electronics products allows OEMs to outsource production steps and to purchase parts and modules from specialised manufacturers. More and more processes are being outsourced to specialist partners and EMS providers in order to achieve cost reductions, increase asset management efficiency and reduce time to market. As a consequence, the value chain has become more complex and involves more players and stages in a global business.

To illustrate the complexity, here is an analysis of each stage of the process and what type of organisation conducts an activity, e.g. global multinational or SME; and where this process is likely to be undertaken.

PRIMARY SUPPLY CHAIN FUNCTIONS IN CLOSE-UP

Design

Who does it: Product design (including semiconductors, PCBs and other bespoke components) is conducted in-house by an OEM or outsourced in whole or in part to EMS providers or to a range of specialist design houses.

Location: For convenience, design is often co-located with the manufacture of the product. Therefore, the UK's strength is under threat from Far Eastern countries where the manufacture of high volume products has already migrated. The UK has significant design strength but this is under threat.

Quality control

Who does it: All players in the supply chain carry out quality control, including specialist organisations such as test houses.

Location: Global.

Raw materials and process supply

Who does it: Generally, multi-national organisations or specialist niche providers. A significant level of innovation enters the industry via these organisations, as they undertake R&D in order to improve competitive position.

Location: The majority of raw materials and process suppliers have moved out of the UK, as most of their high volume customers are in Eastern Europe and Far Eastern countries.

Component manufacture

Who does it: Typically conducted by specialist manufacturers, e.g. semiconductor wafer foundries, integrated device manufacturers (IDMs), OEMs, packaging companies, etc. They range in size from SMEs to large multinational component manufacturers.

Location: Typically Located in low cost countries for components that are manufactured in high volumes. Component manufacture remains in the UK for low/medium volume specialised products.

Customers: Global OEMs, EMS providers, distributors, fabless semiconductor companies, and PCB brokers.

Fabless semiconductor supply chain

By way an example, the supply chain for the fabless semiconductor industry is shown at (*Fig A.2*). These companies undertake the design function only and contract the manufacturing to so-called ‘foundries’, which provide a contract manufacturing service and do not own any IPR. The industry is important, being part of UK’s independent semiconductor design industry, and representing some 40% of Europe’s design houses and 40% of the design revenue.

The supply chain is complex. There are management issues associated with the many different players in the chain. In addition there are technology issues associated with the complexity of the activity. As chip design has increased in complexity so has the number of issues associated with the all the elements comprising the supply chain. This includes compliance with the design rules of the chosen semiconductor process, wafer fabrication, assembly and test. Cost has risen too, such that the up-front tooling charge of the latest processes is approaching £555,000 (\$1 million), and is in the £100,000’s for more mature processes.

Distribution/logistics

Who does it: These tend to be global organisations & local organisations. Distributors typically source a number of components for a range of customers (SMEs, large multinational OEMs and EMSs). Distributors have a key role to play as they increasingly provide first line customer support, as more and more component manufacturers move to low cost geographies, and downsize their own customer service organisations. Manufacturers (OEMs, EMSs and component suppliers) also often optimise their supply chains by outsourcing the transportation of inventory and finished goods to distributors and specialist logistics firms.

Location: Global but good representation in the UK.

Customers: Large component suppliers may have direct relationships with major OEMs and EMS providers. However, if a component supplier or a customer conducts low to medium volume business, they may choose to source/supply their product via a distributor. Franchised distributors have 31% of the component market (by value) but trade with 95% of the sector¹.

Electronic product manufacturing/assembly

Who does it: Typically OEMs outsource production to global EMS providers.

Location: Increasingly manufacturer/assembly is located in low cost geographies, such as the Far East or Eastern Europe, except for low/medium volume higher value added products and prototypes.

Customers: OEMs are customers for EMSs, but EMSs may be required to interact directly with end-users under the OEM brand.

Reverse logistics

Who does it: Product repair is typically outsourced to large specialist organisations who may interact directly with customers under the OEM brand. Alternatively, repairs are undertaken in-house by the OEM. Significant numbers of SMEs are involved with repair on a local level. Recycling and resale is undertaken by specialist environmental companies, and this market is expected to increase significantly as a result of new EU environmental legislation. Re-use of components is sometimes feasible but repair for most components is unusual.

Location: Repair and reverse logistics is a global business, but repair is usually undertaken within the UK for the UK branch of the business.

Customers: Global OEM's, EMS and distributors generally contract out this aspect of the business to specialist organisations, including significant use of courier/logistic services for retrieval and re-distribution of products. Markets exist in the Far East, Africa and Eastern Europe for product resale.

¹ 2002 figs, Europartners Consultants Report 2003

SUPPORT FUNCTIONS

Manufacturing equipment providers

Who does it: Generally multinational organisations or specialist niche providers provide manufacturing equipment. Equipment manufacturers introduce innovation into the overall supply chain, using their own R&D to improve competitive position.

Location: The majority of equipment manufacturers have moved out of the UK as the demand has decreased.

R&D: Equipment manufacturers are typically multinational companies who conduct their R&D in-house or use university research facilities on a global basis.

Customer service: Increasingly the equipment suppliers are moving their customer services organisations out of the UK, thus reducing the levels of customer service provided to the UK.

Software tool providers

Who does it: For design software tools (e.g. computer-aided design (CAD) software and electronic design automation (EDA) tools) the suppliers tend to be (but not entirely) US-based organisations with global operations. For enterprise software (e.g. supply chain management (SCM), enterprise resource planning (ERP) systems, etc), the suppliers are global organisations headquartered in a range of countries, including increasingly the Far East.

Location: the majority of software tool providers have UK operations and global support organisations.

Consultants

Who does it: There are a range of global consultancies, from supply chain specialists to local design consultants.

Location: UK & globally.

Marketing & sales

Who does it: Marketing and sales is typically handled OEMs themselves & retail organisations that the OEMs use as a channel.

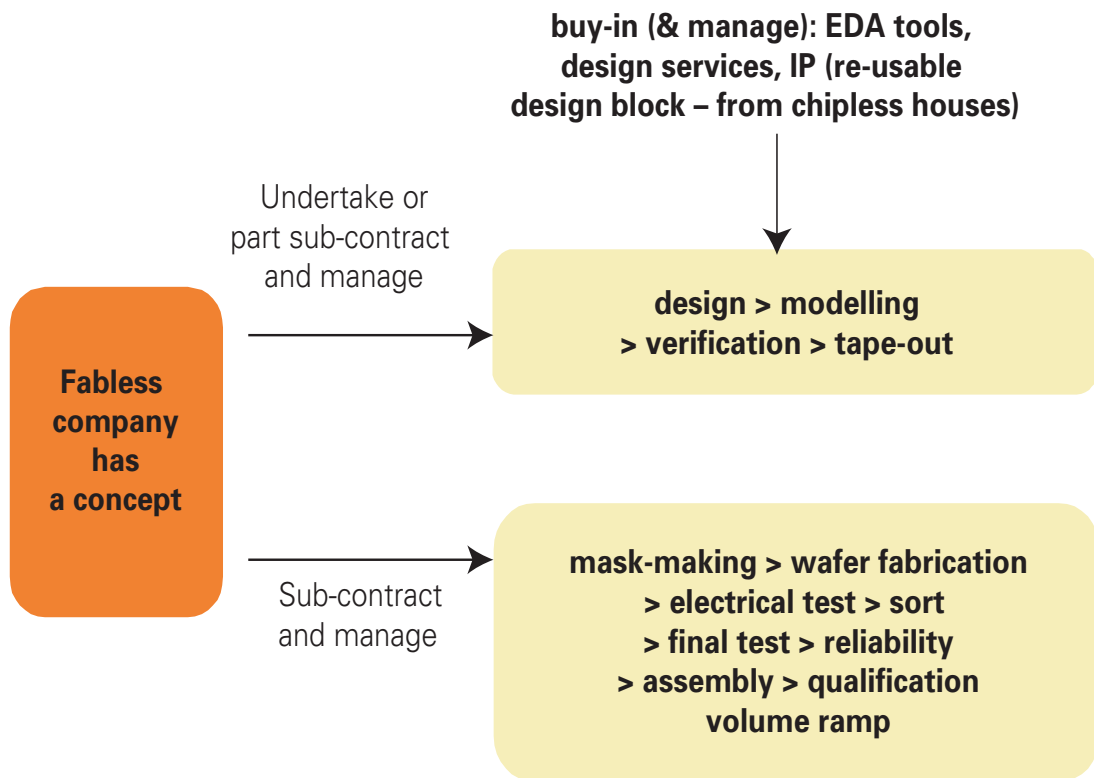
Location: Local to whatever geography the OEM is trying to address.

Customer service

Who does it: For end-products, OEMs may do it themselves or may outsource customer service to specialist organisations.

Location: Local to the country of sale.

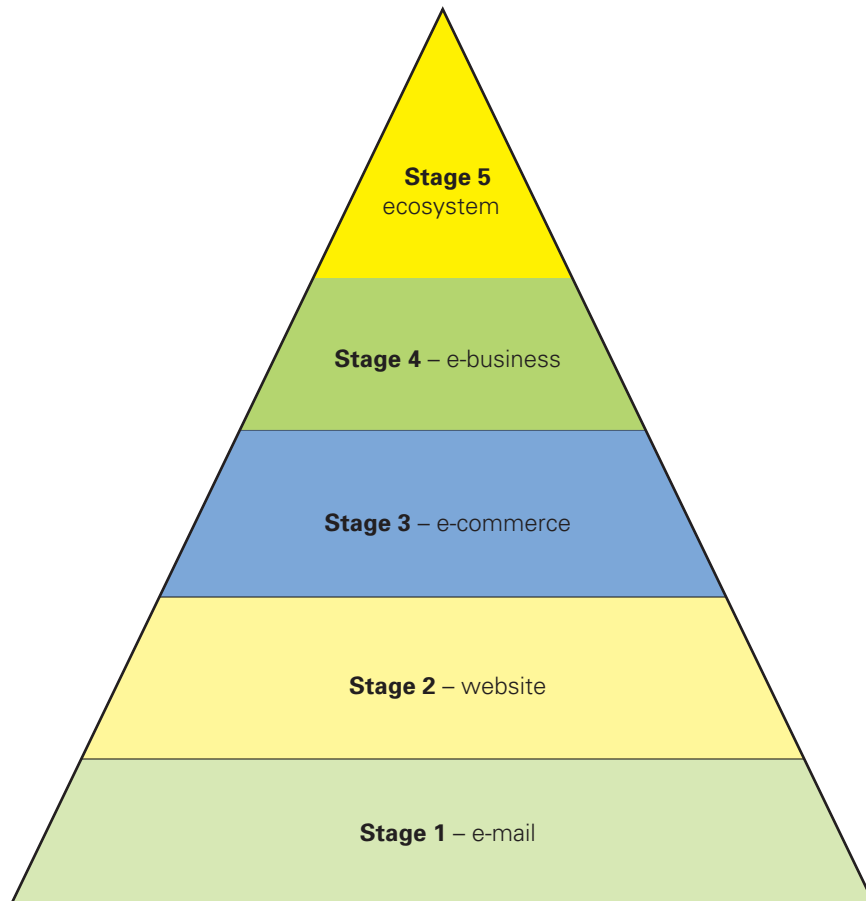
Fig A.2: Fabless semiconductor supply chain



- Fabless companies possess their own integrated design IP – strong focus on core competencies – other activities outsourced.
- **Utopia** = Success in one ramp with seamless and trouble-free manufacturing;
- **Reality** = Multiple iterations & debugging + manufacturability/yield problems in volume production

The 5 stages of the Internet

Fig A.3: The five stages in the process of becoming fully e-enabled



Source: Cisco

Stage 5 – ecosystem comprises highly integrated infrastructures linking customers, suppliers and other key partners. Processes and logistics are largely automated using Internet technology, creating a seamless chain of communication management.

Stage 4 – e-business in which processes are increasingly driven by Internet technology. Through secure intranets and extranets, remote workers, customers and suppliers can access the business at selected points.

Stage 3 – e-commerce enables orders to be placed via the website 24 hours a day, 365 days a year. Together with online service and support, sales opportunities can increase, and sales costs fall.

Stage 2 – a website serves as a shop window to the world and gives even the smallest local business a global presence.

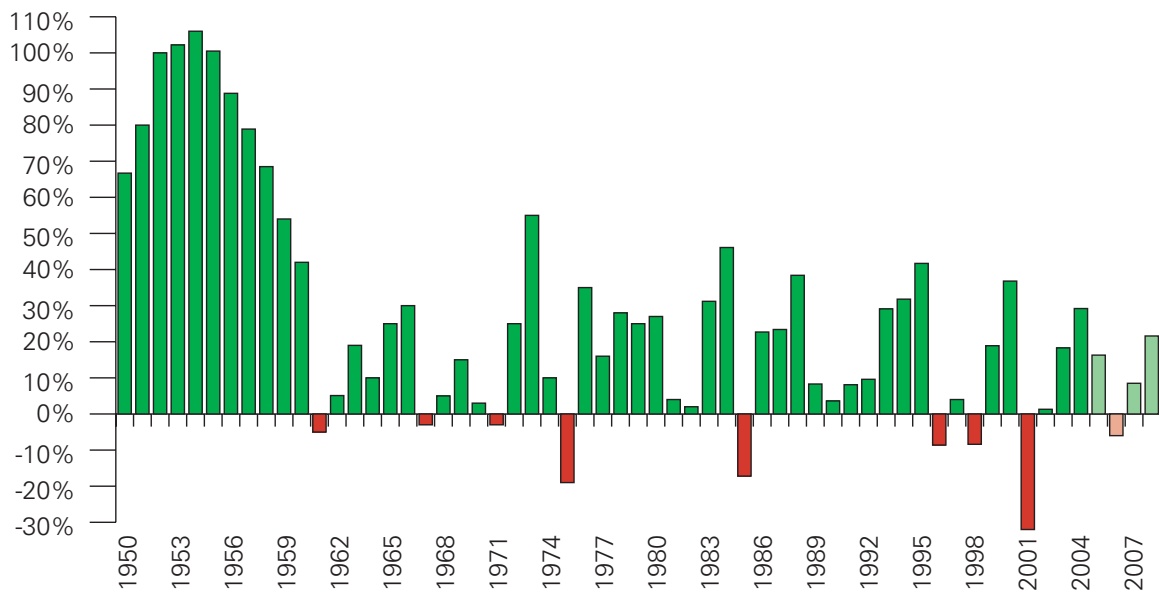
Stage 1 – e-mail makes global communication as easy as exchanging data with a computer on the next desk.

Semiconductor market cycles

The electronics industry, and some sub-sectors in particular, e.g. electronic components and semiconductors, are characterised by complex markets and extended supply chains, high and spiralling capital costs but dramatically falling product prices driven by shortening product cycles and extremely rapid commoditisation.

The chart below (*Fig A.4*) shows the dramatic impact on the market for semiconductors and integrated circuits (chips) since their invention.

Fig A.4: Semiconductor market cycles

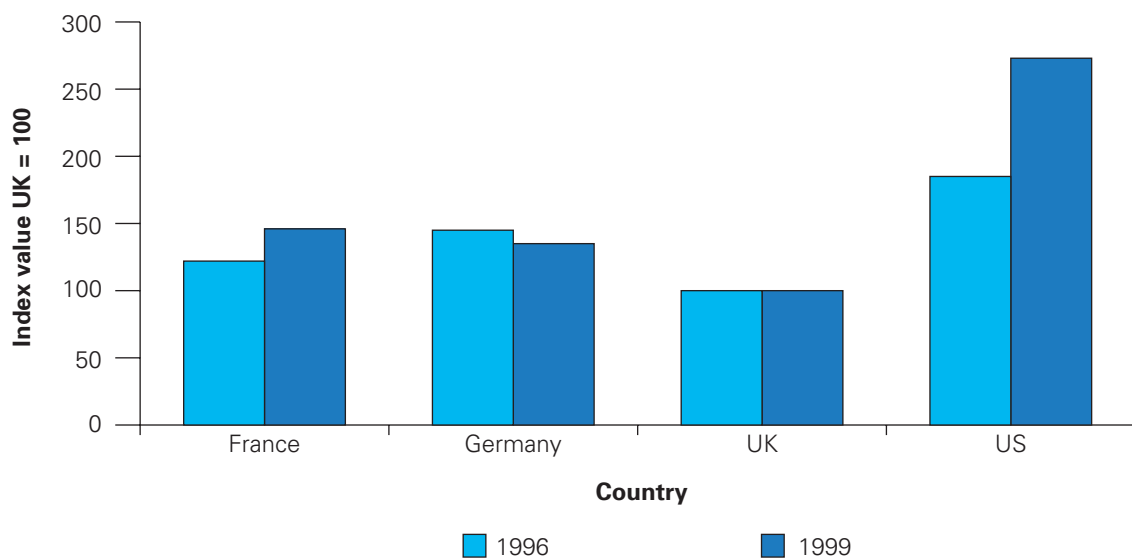


Source: Future Horizons 2004

A question of productivity

There is strong evidence that UK electronics industry is not as economically productive as equivalent firms in Europe, and other sectors both in the UK and Europe, which in turn lag behind the USA, as highlighted by *Figure A.5*.

Fig A.5: Electrical and electronics equipment, labour productivity levels 1996 and 1999



Source: NIESR

While 1999 is the latest date for which reliable comparable data is available, DTI's 2004 Value Added Score Board¹ and other sources suggest that while there have been some improvements by UK electronics firms broadly, the UK is still lagging well behind its main competitors.

Nevertheless, many UK electronics companies, both home-grown and those from overseas, are leading the way in harnessing productivity. The UK plants of most, if not all, global companies are the best or equal to the best in the world. Evidence from the DTI Small Business Service's Benchmark Index² finds that electronics SMEs achieve the highest pre-tax profits both in terms of turnover and per employee among all other manufacturing sectors. However, the evidence is compelling that the electronics sector has an issue with productivity.

Why is productivity important when what businesses is interested in is profitability and getting the best yield from manufacturing processes?

Productivity is broadly a measure of wealth creation or added value divided by the cost of making the product. Gross Value Added (GVA) is obtained by subtracting the cost of bought-in services and materials from the value of the sales of the product.

¹ Source: DTI 2004 Value Added Score Board

² Sources: DTI – SBS Benchmark index – Closing the Gap; www.benchmarkindex.com

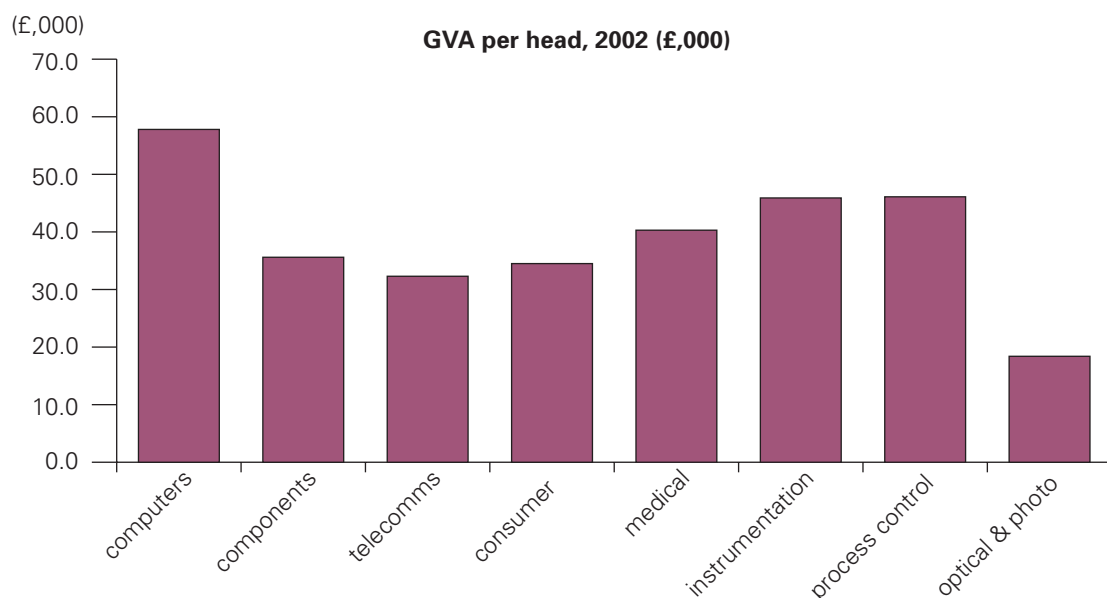
Essentially GVA is a measure of what you have at the end of the day to pay taxes, shareholders, employees, and to reinvest in the future of the business.

The most commonly used measure of productivity is average labour productivity (ALP) and is equal to the GVA per worker or worker-hour.

While profitability is essentially a function of costs, productivity enables business to think more strategically. In economist's speak *Ceteris paribus*, i.e. with all factors being equal in a given market, a company that has higher productivity will enjoy greater profitability. A more productive company can therefore produce the same output with less input, and enjoy a cost advantage or produce more or better output with the same inputs, and command a price premium.

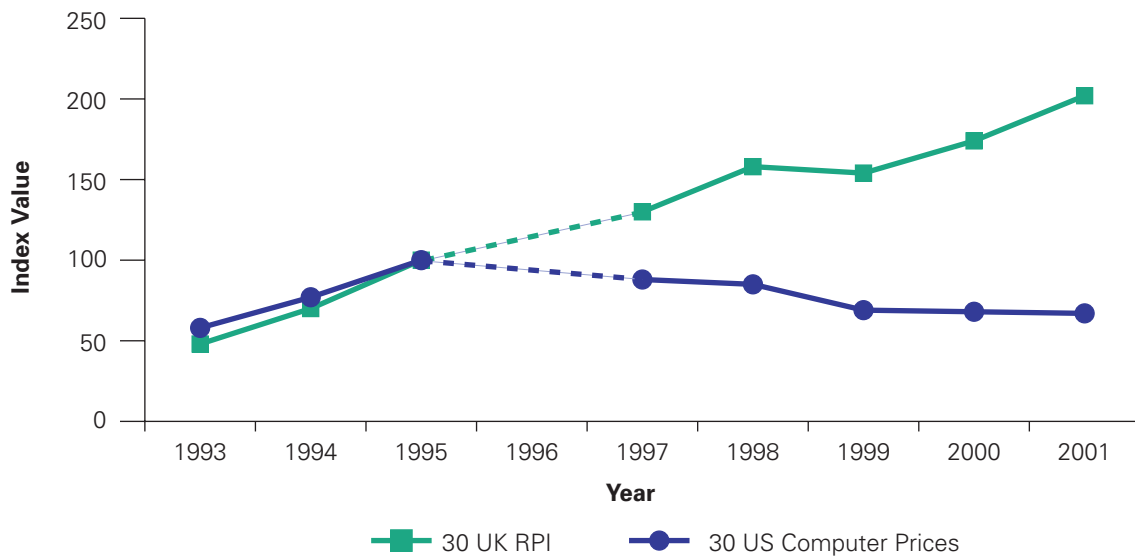
Unfortunately the productivity picture for the UK electronics sector is complex. Analysis is hampered by the problems mentioned with national statistics referred to in *chapter 3*. There are also significant variations between electronics sub-sectors, as highlighted in *Figure A.6*.

Fig A.6: Productivity of electronics sub-sector in GVA per head in 2002



Source: ONS Annual Business Inquiry (Aug 2004)

Comparisons with other countries are further complicated by the variable use of specific price indices. *Figure A.7* shows the impact on the UK computers sectors' productivity data of using the UK retail price index (RPI) and the US computer prices index. These so called hedonic indices are used in some electronics sub-sectors when the quality of the product has been increasing over time and the price per unit of quality has been falling e.g. computers and PCs.

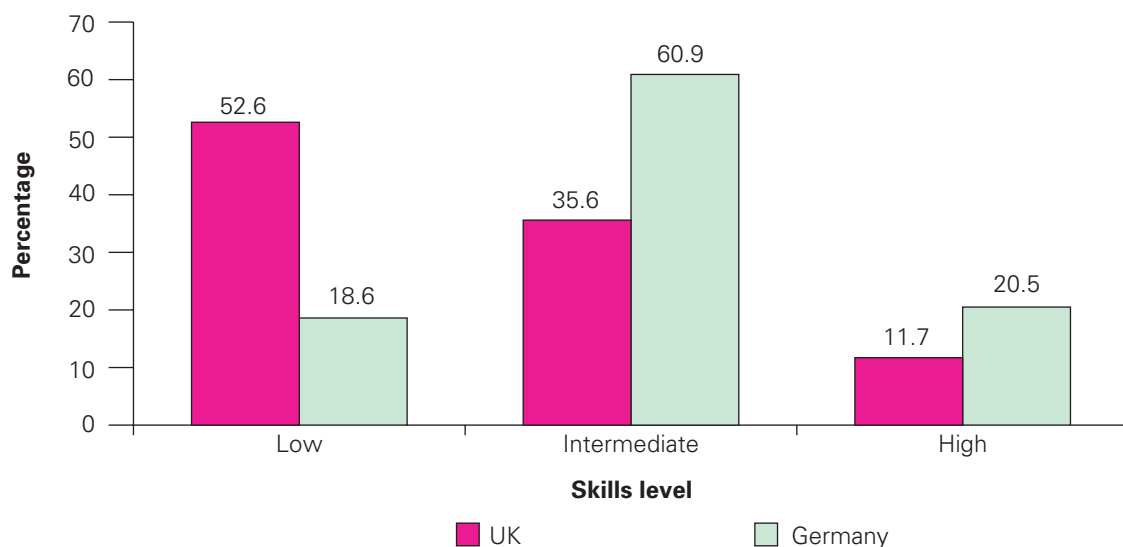
Fig A.7: Average labour productivity*

Source: NERA (*No data available 1996)

UK computer sector sensitivity to price index

To underpin the work of the EIGT, the DTI Electronics Unit commissioned a significant body of analysis on the competitiveness and productivity of the UK electronics sector, to supplement its own analysis activities. To understand productivity and its main drivers the EIGT and its working groups drew on the findings of NERA, DTZ, and the DTI Small Business Service's Benchmark Index.

From this body of work and its own analysis the EIGT has identified, markets and technology (*chapter 4*); innovation (*chapter 5*); supply chains (*chapter 6*); and skills (*chapter 7*) as the key drivers that need to be addressed to raise the productivity of the sector and harvest its global competitiveness.

Fig A.8: Electrical and electronics equipment, skill composition (1998)

Source: NIESR productivity data

Take for example the impact of skills. *Figure A.8* compares the quality mix of skills between Germany and the UK – the disparity is obvious. The picture is similar across all the electronics sub-sectors. NERA identified in its report to the DTI that there is no correlation in the UK electronics sector between productivity and the capital that is employed per worker. In other words, *it appears that it's not what you do but how you do it that's important.*

Glossary of acronyms

| | |
|-----------------------|--|
| AIDC | Automatic Identification and Data Capture |
| AIM | Alternative Investment market |
| ALP | Average Labour Productivity |
| ASEM | Asia Europe Meeting |
| ASIC | Application Specific Integrated Circuit |
| CAD | Computer Aided Design |
| CAGR | Compound Annual Growth Rate |
| CCD | Charge Coupled Device |
| CCTV | Close Circuit Television |
| CDT | Craft Design and Technology |
| CEM | Contract Electronic Manufacturer |
| CGT | Capital Gains Tax |
| C³I | Command, Control and Communication |
| CMOS | Complementary Metal Oxide Semiconductor |
| CRT | Cathode Ray Tube |
| DTV | Digital Television |
| DTZ | DTZ Piedad Consulting |
| DVD | Digital Versatile Disk |
| EDA | Electronic Design Automation |
| EDI | Electronic Data Interchange |
| EDP | Electronics Data Processing |
| EMC | Electromagnetic Compatibility |
| EMS | Electronic Manufacturing Service |
| FDI | Foreign Direct Investment |
| FPD | Flat Panel Displays |
| FTSE | Financial Times Stock Exchange |
| GDP | Gross Domestic Product |
| GVA | Gross Value Added |
| HEI | Higher Educational Institutes |
| HNC | Higher National Certificate |
| HND | Higher National Diploma |
| I&P | Interconnect and Packaging |
| IMRC | Innovative Manufacturing Research Centre |
| INTERSECT | Intelligent sensors for control technologies |
| IP | Intellectual Property |
| IPO | Initial Public Offering |
| IPR | Intellectual Property Rights |
| IT | Information Technology |
| ITEC | Information Technology Electronics and Communication |
| ITRI | Industrial Technology Research Institute |
| JCGQ | Joint Council for Qualifications |
| LCD | Liquid Crystal Display |

| | |
|----------------|--|
| LEP | Light Emitting Polymer |
| LFS | Labour Force Survey |
| MBO | Management Buy-Out |
| MEMS | Micro-Electro Mechanical Systems |
| MRO | Maintenance, Repair and Operations |
| MSP | Member of the Scottish Parliament |
| NASA | National Aeronautics Space Administration |
| NASDAQ | National Association of Securities Dealers Automated Quotation |
| NDI | Northern Defence Industries |
| NERA | National Economic Research Associates |
| NIESR | National Institute of Economic and Social Research |
| NOP | National Opinion Poll |
| OECD | Organisation for Economic Cooperation and Development |
| OEM | Original Equipment Manufacturer |
| OLED | Organic Light Emitting Diodes |
| PCB | Printed Circuit Board |
| PRIME | Products with Interdependent Mechanical and Electronic parts |
| R&D | Research and Development |
| RAPID | Reconfigurable Pipelined Data Paths |
| REACH | Registration Evaluation & Authorisation of Chemical Hazards |
| REPIC | Recycling Electrical Producers Industry Consortium |
| RFID | Radio Frequency Identification |
| RoHS | Restriction of Hazardous Substances |
| ROI | Return On Investment |
| RPI | Retail Price Index |
| SBRI | Small Business Research Initiative |
| SCM | Supply Chain Management |
| SEA | Science and Engineering Ambassador |
| SEEDA | South East England Development Agency |
| SIC | Standard International Classification |
| SLD | Super Luminescent Diodes |
| SME | Small & Medium sized Enterprise |
| SMS | Short Messaging Service |
| SoC | System-on-a-chip |
| STB | Set-Top Box |
| STEM | Science Technology Engineering and Mathematics |
| TAC | Technical Adaptation Committee |
| UKEA | UK Electronics Alliance |
| VC | Venture Capitalist |
| WEEE | Waste Electrical and Electronic Equipment |
| WTO | World Trade Organisation |

Electronics Innovation & Growth Team (EIGT)

MEMBERS OF VARIOUS GROUPS AND CONTRIBUTORS

STEERING GROUP MEMBERSHIP

| | |
|---------------------------|--|
| David Kynaston (Chairman) | Former Snr Corporate VP and President of Europe Solectron (retired March 2004) and Vice-President Manufacturing, Intellect |
| Ollie Althorpe | MD, ST Microelectronics Limited |
| Dr Gerald Avison | MD, TTP Group plc |
| Mike Bannard | MD, Kelan Circuits Ltd |
| Sheridan Comonte | Former Chief Executive, TT Electronics plc (retired March 2004) |
| Martin Goosey | Chief Scientist & Technical Fellow, Rohm & Haas Electronic Materials Ltd |
| Phil Healy | VP Strategy, Marconi Corporation Ltd |
| John Higgins | Director General, Intellect |
| Bruce Huber | MD, Broadview International – Europe |
| David Jordan CBE | Former Chairman & MD, Philips Electronics UK Ltd (retired December 2003) |
| Gary Kibblewhite | Chairman, afdec |
| Prof John V McCanny CBE | Director, Institute of Electronics Communications and Information Technology, Queen's University Belfast |
| Susan Morrell | EPSRC (until December 2003) |
| Bill Nixon | Formerly General Manager, Solectron Scotland (retired December 2003) |
| Vince Osgood | EPSRC (from January 2004) |
| Mike Richardson | Mgr, Jaguar & Land Rover Technical Research Group |
| Ken Sanders | Independent Director |
| Sir Robin Saxby | Chairman, ARM |
| Jim Stewart | UK & Ireland HR Dir, Agilent Technologies UK Ltd |
| Daniel Storey | HM Treasury |
| Paul Talbot | Assistant General Secretary, Amicus |
| Mike Wilson | Former VP Europe, Celestica Ltd |
| Geraldine Alliston | Director Electronics, DTI |
| Martin Simmonds | DTI |

SECRETARIAT

| | |
|-------------------|-------------------------------|
| Silu Ali | Oracle (on secondment to DTI) |
| Peter Maguire | Intellect |
| Dr Tim Reynoldson | DTI |
| Dr Tim Scragg | DTI |

WORKING GROUPS

Innovation Working Group

| | |
|------------------------|--|
| Ken Sanders (Co-Chair) | Independent Director |
| Bruce Huber (Co-Chair) | MD, Broadview International – Europe |
| Dr Gerald Avison | MD, TTP Group plc |
| Prof John McCanny CBE | Director, Institute of Electronics Communications and Information Technology, Queen's University Belfast |
| Susan Morrell | EPSRC (until December 2003) |
| Vince Osgood | EPSRC (from January 2004) |
| Daniel Storey | HM Treasury |
| Jim Stewart | UK & Ireland HR Director, Agilent Technologies UK Ltd |
| Dr Peter Batchelor | DTI |
| Ian Williams | DTI |
| Richard Waterhouse | Intellect |

Sectors & Regions Working Group

| | |
|--------------------------|---|
| David Jordan CBE (Chair) | Former Chairman & MD, Philips Electronics UK Ltd (retired Dec 2003) |
| Ollie Althorpe | MD, ST Microelectronics Limited |
| Sheridan Comonte | Former Chief Executive, TT Electronics plc (retired March 2004) |
| Howard Farmer | Philips Consumer Electronics Ltd |
| Philip Hargrave | Nortel Networks |
| John Higgins | Director General, Intellect |
| John Howe | Thales (UK) plc |
| Paul Hurst | Europartner Consultants |
| Richard Foggie | DTI |
| Mark Begbie | DTI |
| Graham Gara | UK Trade & Investment |

Supply Chain Working Group

| | |
|----------------------------------|--|
| Bill Nixon (Chair from May 2004) | Formerly General Manager, Solectron Scotland (retired Dec 2003) |
| Mike Bannard | MD, Kelan Circuits Ltd |
| Marianne Culver | Premier Farnell plc |
| Martin Goosey | Chief Scientist & Technical Fellow, Rohm & Haas Electronic Materials Ltd |
| Andrew Gowen | Exel Business Development |
| Gary Kibblewhite | Chairman, afdec |
| David Lea | A-Novo Ltd |
| Chris McArdle | Innotec |
| Gary Mitchell | Change Management Consultant |
| Simon Phillips | Celestica Ltd |
| Mike Richardson | Manager, Jaguar & Land Rover Technical Research Group |
| Kathryn Walsh | Loughborough University |
| Steve Whigham | Supply Chain Consultant |
| Mike Wilson | (Chair until April 2004) Former VP Europe, Celestica Ltd |
| Dr Tim Reynoldson | DTI |
| Jeff Asser | DTI |
| Andrew Frankton | DTI |

Cross-cutting Government and industry issues

| | |
|--------------------|---------------------------|
| Geraldine Alliston | Director Electronics, DTI |
| Dr Tim Scragg | DTI |
| Peter Maguire | Intellect |

Skills

| | |
|------------------|---|
| Nigel Akam | High Technology Talent Strategy Board for Scotland/Scottish Optoelectronics Association |
| Pauline Jack | Director, t3 Plus Ltd |
| David Tait | Atmel Corporation |
| Allan Russell | SEMTA |
| Jim Stewart | Agilent Technologies UK Ltd |
| Darren Race | Filtronics plc |
| Grace Mitchell | National Semiconductors |
| Neil Fraser | National Semiconductors |
| Derek Boyd | NMI |
| David Law | NMI |
| Andrew Watson | DTI |
| Pauline Zielonka | DTI |

INDUSTRY CONSULTATION PROGRAMME INTERVIEWERS

| | |
|---------------------------|--|
| David Kynaston (Chairman) | Former Snr Corporate VP Solectron and President of Europe (retired March 2004) and Vice President Manufacturing, Intellect |
| Ollie Althorpe | MD, ST Microelectronics Limited |
| Dr Gerald Avison | MD, TTP Group plc |
| Mike Bannard | MD, Kelan Circuits Ltd |
| Marianne Culver | Premier Farnell plc |
| John Higgins | Director General, Intellect |
| Bruce Huber | MD, Broadview International – Europe |
| Paul Hurst | Europartner Consultants |
| Pauline Jack | Director, t3 Plus Ltd |
| David Jordan CBE | Former Chairman & MD, Philips Electronics UK Ltd (retired December 2003) |
| Bill Nixon | Formerly General Manager, Solectron Scotland (retired December 2003) |
| Vince Osgood | EPSRC |
| Simon Phillips | Celestica Ltd |
| Ken Sanders | Independent Director |
| Geraldine Alliston | DTI |
| Silu Ali | Oracle (on secondment to DTI) |
| Dr Peter Batchelor | DTI |
| Richard Foggie | DTI |
| Dr Tim Reynoldson | DTI |

Other contributors

| | |
|----------------------------------|------------------------|
| Brian Davis (EIGT Report Editor) | Creative Dream Company |
| Christopher Moir | DTI |
| Rick Donnegan | DTI |
| Carol Rice | DTI |

INDUSTRY CONSULTATION LIST

3i Group plc
A&R Electronics Development Ltd
Abacus Group plc
Acal plc
Alps Electric (UK) Ltd
Amadeus Capital Partners Ltd
Anglia Circuits Ltd
Anglia Components Ltd
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TTP Group
Tunstall Group Ltd
Whitehead Mann
X-Fab UK Ltd
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Stakeholder Groups

AIM UK
Electronics Yorkshire
e-Skills (UK)
GAMBICA
Institution of Electrical Engineers (IEE)
Intellect
JEMI (Joint Equipment & Materials Initiative)
Microsystems Manufacturing Association (MMA)
National Microelectronics Institute (NMI)
SEMTA
TUC (Trades Union Congress)

Academia & others

Advantage West Midlands
Cavendish Laboratory, University of Cambridge
Centre for Business Research
Communications Innovation Institute, University of Cambridge
EEDA
EMDA
GO-East
GO-EM
National Competitiveness Network
National Physical Laboratory
Prime Faraday Partnership
Scottish Executive
Surrey Ion Beam Centre
SWRDA
The Cambridge-MIT Institute
University College Northampton
University of Cambridge
Yorkshire Forward

Sources of information

Trade Bodies

Association of British Certification Bodies (ABCB)
www.abcb.demon.co.uk

Association of British Healthcare Industries (ABHI)
www.abhi.org.uk

Association of Franchised Distributors of Electronic Components (AFDEC)
www.afdec.org.uk

Association for Automatic Identification & Mobility (AIM)
www.aimglobal.org

Association of Manufacturers of Domestic Appliances (AMDEA)
www.amdea.org.uk

Association of Police and Public Security Suppliers (APPSS)
www.appss.org.uk

British Electrical and Allied Manufacturers Association (BEAMA)
www.beama.org.uk

Bio Industry Association (BIA)
www.bioindustry.org

British Measurement and Testing Association (BMTA)
www.bmta.co.uk

British Naval Equipment Association (BNEA)
www.maritimeindustries.org

British Plastics Federation (BPF)
www.bpf.co.uk

British Standards Institute (BSI)
www.bsi-global.com

British Security Industries Association (BSIA)
www.bsia.co.uk

Confederation of British Industry (CBI)
www.cbi.org.uk

Chemical Industries Association (CIA)
www.cia.org.uk

Defence Manufacturers Association (DME)
www.the-dma.org.uk

Engineering Employers Federation (EEF)
www.eef.org.uk/UK

Fibreoptic Industry Association (FIA)
www.fibreoptic.org.uk

Fire Industry Confederation (FIC)
www.the-fic.org.uk

Freight Transport Association (FTA)
<http://www.fta.co.uk>

Institution of Electrical Engineers (IEE)
www.iee.org.uk

Instrumentation & Control Industry Trade Association (GAMBICA)
www.gambica.org.uk

Chartered Institute of Logistics and Transport
www.ciltuk.org.uk

Information Technology Telecommunications and Electronics Association (INTELLECT)
www.intellectuk.org

Institute of Directors (IOD)
www.iod.com

Joint Equipment & Materials Initiative (JEMI)
www.jemiuk.com

Joint Security Industry Council (JSIC)
www.jsic.co.uk

Microsystems Manufacturing Association (MMA)
www.mma.org.uk/

National Consumer Council (NCC)
www.ncc.org.uk

National Microelectronics Institute (NMI)
www.nmi.org.uk

Personal Computer Association (PCA)
www.pcassoc.org

Photonics Cluster UK (PCUK)
www.photonicscluster-uk.org

Recycling Electrical Producers Industry Consortium (REPIC)
www.recyclingtoday.com

Society of British Aerospace Companies (SBAC)
www.sbac.co.uk

Semiconductor Industry Association (SIA)
www.sia-online.org

Society of Motor Manufacturers and Traders (SMMT)
www.smmt.co.uk

Scottish Optoelectronics Association (SOA)
www.optoelectronics.org.uk

Telecommunications Industry Association (TIA)
www.tia.org.uk

UK Consortium for Photonics and Optics (UKCPO)
www.ukcpo.org

UK e-Health Association (UKEHA)
www.ukeha.org.uk

UK Microelectronics Environmental Advisory Committee (UKMEAC) (now part of NMI)
www.nmi.org.uk

Virtual Socket Interface Alliance (VSIA)
www.vsi.org

Government departments

Better Regulation Task Force (BRTF)
www.brta.gov.uk

Department for Education and Skills (DfES)
www.dfes.gov.uk

Department of Health (DoH)
www.dh.gov.uk/Home/fs

Department for Transport (DfT)
www.dft.gov.uk

Department of Transport (US) (DoT)
www.dot.gov

Department of Trade and Industry (DTI)
www.dti.gov.uk

DTI – Electronics Unit (DTI)
www.dti.gov.uk/industries/electronics

Foreign and Commonwealth Office (FCO)
www.fco.gov.uk

Home Office (HO)
www.homeoffice.gov.uk

Health and Safety Executive (HSE)
www.hse.gov.uk

Government programme supporting business & research collaborations (LINK)
www.ost.gov.uk/link

Learning and Skills Council (LSC)
www.lsc.gov.uk

Manufacturing Advisory Service (MAS)
www.mas.dti.gov.uk/home.jsp

Management Leadership and Skills Unit (MLSU)
www.dti.gov.uk/bestpractice/management

Ministry of Defence (MoD)
www.mod.uk

Office of Government Commerce (OGC)
www.ogc.gov.uk

Office of National Statistics (ONS)
www.statistics.gov.uk

Office of Science and Technology (OST)
www.ost.gov.uk

Registration Evaluation & Authorisation of Chemical Hazards (REACH)
www.dti.gov.uk/sectors_chemicals

Restriction of Hazardous Substances (RoHS)
www.dti.gov.uk/sustainability/weee/

Small Business Service (SBS)
www.sbs.gov.uk/

Small firms Merit Award for Research in Technology (SMART) renamed Grant for R&D
www.dti.gov.uk

UK Trade & Investment (UKTI)
www.uktradeinvest.gov.uk

Skills and research

Engineering and Physical Sciences Research Council (EPSRC)
www.epsrc.ac.uk

Higher Education Funding Council (HEFC)
www.hefce.ac.uk

Sector Skills Council for Science, Engineering and Manufacturing Technologies (SEMTE)
www.semta.org.uk

Science Engineering and Technology Network (SETNET)
www.setnet.org.uk

Science Engineering and Technology regional delivery POINT (SETPOINT)
www.setnet.org.uk

Regional development

Business Links (BL)
www.businesslink.gov.uk

Department of Enterprise Trade and Investment (Northern Ireland) (DETI)
www.detini.gov.uk

Regional Development Agency (RDA)
www.consumer.gov.uk/rda

Scottish Enterprise (SE)
www.scottishexecutive.gov.uk

Welsh Development Agency (WDA)
www.wda.co.uk

Electronics-related initiatives

Continuing Education in Electronics Systems Integration (CEESI)
www.ceesi.ac.uk

Electronics Design Network (EDN)
www.e-design.org.uk

Electronics Innovation Growth Team (EIGT)
www.dti.gov.uk/industries/electronics/eigt

Electronics in Schools (EiS)
www.electronicsinschools.com

Electronics and Photonics Packaging and Interconnections (EPPIC)
www.eppic-faraday.com

Electronics Scotland (ES)
www.electronics-scotland.com

Energy using Products (EuP)
www.dti.gov.uk/sustainability/EUP

Pan-European Cooperative R&D (EUREKA)
www.eureka.be

Intelligent Sensors for Control Technologies (INTERSECT)
www.intersect.org.uk

Information Technology for European Advancement (ITEA)
www.itea-office.org

Micro-electronics Developments for European Applications (MEDEA)
www.medeas.org

Packaging and Interconnection Development for European Applications (PIDEA)
www.pidea.com.fr

Shell Technology Enterprise Programme (STEP)
www.step.org.uk

Welsh Electronics (WE)
www.welsh-electronics.com

Other useful contacts

British Venture Capital Association (BVCA)
www.bvca.co.uk

China Britain Business Council (CBBC)
www.cbcc.org

Defense Advanced Research Projects Agency (US) (DARPA)
www.darpa.gov

DTZ Pidea Consulting (DTZ)
www.dtzpideaconsulting.co.uk

Institution of Electrical Engineers (IEE)
www.iee.org

Institute of Nanotechnology (ION)
www.nano.org.uk

The Institute of Physics (IOP)
www.iop.org

Industrial Technology Research Institute (ITRI)
www.itri.org.tw/eng

National Economic Research Associates (NERA)
www.nera.com

National Institute of Economic and Social Research (NIESR)
www.niesr.ac.uk

Small Business Research Initiative (SBRI)
www.sbri.org.uk

Picture credits

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www.dti.gov.uk/

