

CIVITAS

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ERA Foundation

Future Prospects For Civil Aerospace in the UK

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Foreword

This report arose out of a project to find alternative work for employees of BAE Systems at Brough, on Humberside, following an announcement in September 2011 that nearly 900 people were to be made redundant. It looks briefly at how BAE found itself with surplus capacity as a result of falling defence orders and its strategic error in 2006 of selling its 20% stake in Airbus, now among the most successful civil aircraft manufacturing projects in recent times.

Christopher Simpson describes the background and proposes a major project to keep the manufacture of civil aircraft in the UK. The Government says it wants to encourage high-tech sectors but it is an inescapable fact that doing so will require considerable government funding. Every nation with a significant aerospace sector has benefited from substantial investment by taxpayers.

Public funding could be kept to a minimum, perhaps with the aim of cancelling out subsidies from other governments and thereby ensuring that business success rests on productive efficiency rather than the weight of subsidy. But there is no escaping some kind of government investment. Without it, our aerospace sector and its skilled high-tech jobs will gradually move overseas.

David G. Green

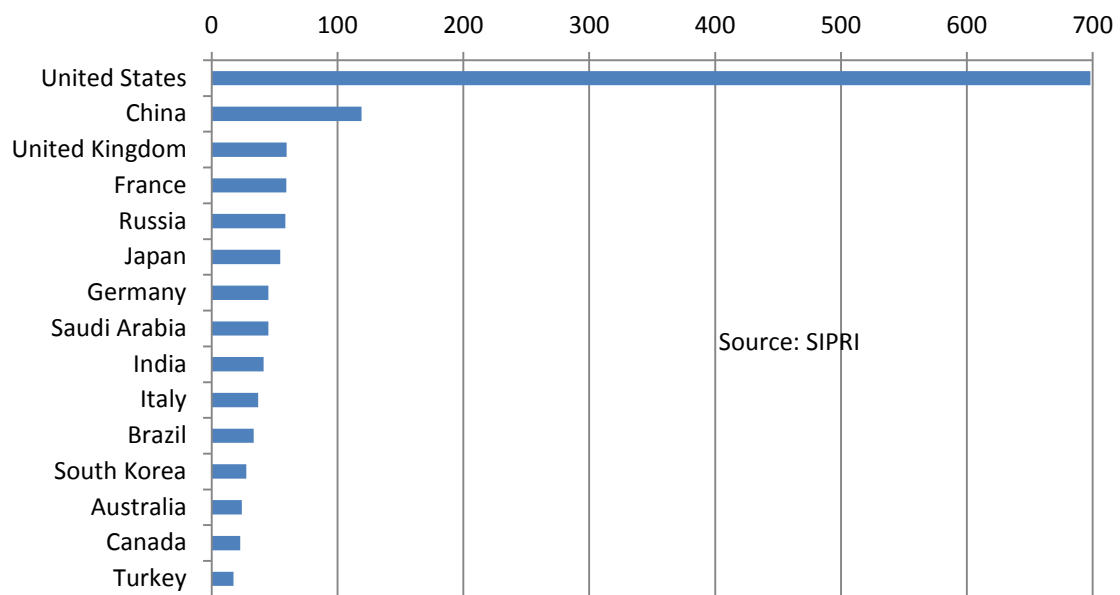
1 BAE Systems and Civil Aircraft Manufacture

Military Expenditure

America's budget crisis is prompting tough discussions about its defence spending, which, at nearly \$700 billion, is bigger than that of the next 17 countries combined. Other western countries, particularly in Europe, are also facing stringent budgetary constraints. Only China's defence spending, which has risen by nearly 200% since 2001 to reach an estimated \$119 billion in 2010 is expected to grow, although so far it has remained fairly constant in terms of its share of GDP.

For any company engaged in the defence industry and with the objective of achieving a global position, a strong presence in the US market is indispensable.

Military Expenditure in \$ bill. 2010



Demand for Military Aircraft

With this background of forecast declining military expenditure and thus demand for military aircraft, particularly from the US where BAE is so dependent (exacerbated by the recent success of unmanned air vehicles (UAV's)), they have been forced to re-evaluate capacity requirements. In order to retain the viability of the business and to protect the employment of the majority of the workers, it appears inevitable that capacity within the Group has to be reduced. It is claimed that the decisions affecting Brough have been

made after a careful comparative evaluation of all the BAE sites to determine where the most productive and cost effective capacity is available. Again it is outside our brief to comment on the validity of this comparative evaluation, other than that it has been undertaken with rigour and the input of considerable resources.

The Market for Civil Aircraft

Any comprehensive appraisal of the current situation has to take into account the sale of the BAE shareholding in Airbus which took place in the autumn of 2006 and the developments that have occurred thereafter. The first indications of the desire of BAE to sell their 20% holding in Airbus were in April 2006. BAE Systems, then a state-owned company, joined Airbus, in 1979, but it may be argued that BAE never really saw itself as a builder of passenger planes. When Airbus was transformed into a corporation in 2000, BAE made clear that its interest in the company was financial and not strategic. The terms at the time included an option for BAE to sell its 20 percent stake back to European Aeronautic Defence and Space EADS, which owned the other 80 percent. By a number of measures, the collaboration was a success, lifting Europe's share of the world commercial aircraft market to about 50 percent from 10 percent in the 1970's, making it a fierce rival to Boeing. Airbus has produced a series of highly successful aircraft like the A320 and A340 followed by the first A380 superjumbo, the world's largest passenger plane.

In June 2006 Rothschild Investment Bank set the valuation of BAE's 20% share at EUR 2.75 billion, significantly less than the EUR 5.0-5.75 billion anticipated by analysts when BAE announced its sale, or even the reported EUR 3.5 billion based on EADS' own accounts at the time. The valuation came shortly after a 26% fall in EADS share price linked with allegations of executive misconduct followed by major turnover among its top executive ranks. EADS offered to pay BAE that value in cash.

BAE determined to carry out an audit of Airbus to find out why the valuation was roughly half of what it expected. There was also concern among EADS investors about why Rothschilds offered such a low assessment of what the business was worth. In September the Board of BAE announced that it has completed the audit, and stated its belief that BAE should sell:

“Airbus is facing a challenging short to medium-term outlook, in particular with respect to certain of its principal programmes.... a significant amount of management focus, time and investment will be required to address the issues currently facing Airbus to improve its operating and financial performance and thereby to increase its value. Inevitably, there are risks involved in such a recovery programme and, having reviewed the Audit, the Board is concerned about the possible cash requirements of the Airbus business in the

medium-term. The Board therefore believes that it is in the best interests of the Company to exit...."

At the Extraordinary General Meeting in October 2006, the shareholders of BAE Systems passed a resolution approving the disposal of BAE Systems' entire interest in Airbus. The voting on the resolution was 99.85% in favour, despite the resistance of some small shareholders to quote:

"I am not happy about the sell-off of the Airbus business.....this was a balanced company, but if it goes ahead it will be an unbalanced company."

"I am very unhappy about the sale of Airbus - it would put all of your eggs in one basket."

"It is quite wrong for the board to make this major departure from commercial aviation..."

Dick Olver, the BAE chairman, was reported as saying the sale "was in line with the company's strategy", pointing out that "BAE was a minority shareholder in Airbus with little say over its direction". "It was a moment in history when it was right to move" There is little doubt this was a sentiment shared by the City investors who clearly had become alarmed by the news of a third delay in 16 months on the A380 aircraft because of problems with the new aircraft's wiring (failure to provide uniform software to aircraft design teams), apart from the other problems.

BAE had ultimately negotiated a £1.9 billion sale of its 20% shareholding, which had generated £360m in profit for BAE over the previous three years, Airbus was in crisis and shares in the parent company EADS fell by as much as 12% in trading in one morning and overall by 25%. The EADS co-chief executive Tom Enders promised to change Airbus" radically". Further announcements included changes in production as part of a €2 billion annual cost-savings programme. It is obvious that neither BAE nor the UK City institutions had confidence that Airbus could bring about recovery.

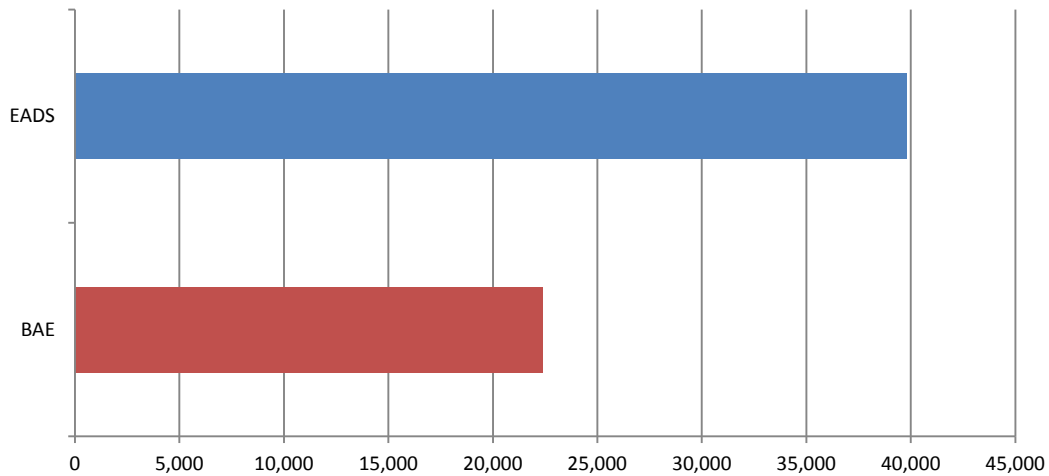
BAE's departure now could now be described as transformational not only for it, but also for Airbus, whose ownership and decision-making structure was to evolve. It is relevant to look briefly at the current position of the respective companies through the published information available from BAE and EADS. Clearly comparisons are not exact because EADS has other activities apart from its Airbus holding, but it is believed some valid conclusions may be drawn.

Market Capitalisation BAE and EADS

BAE Systems plc - £9.55 billion

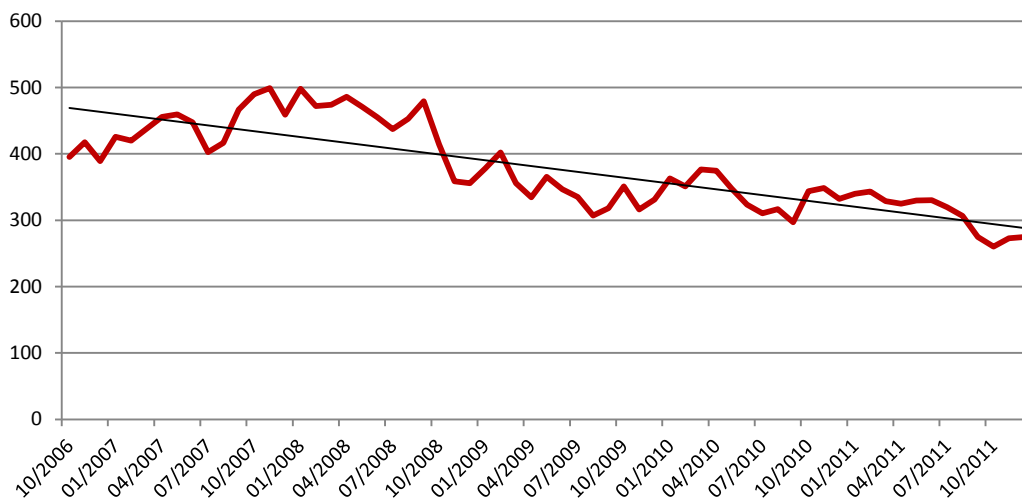
European Aeronautic Defence and Space Company EADS - £18.26 billion

Revenue £ billion in 2010



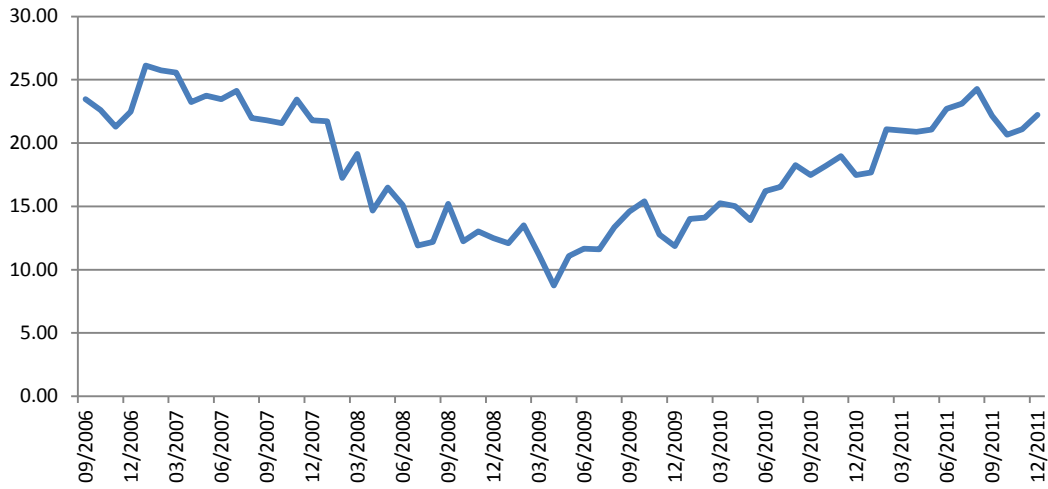
The BAE share price improved in the immediate post disposal period, but has been in continuous decline since then.

BAE Share Price

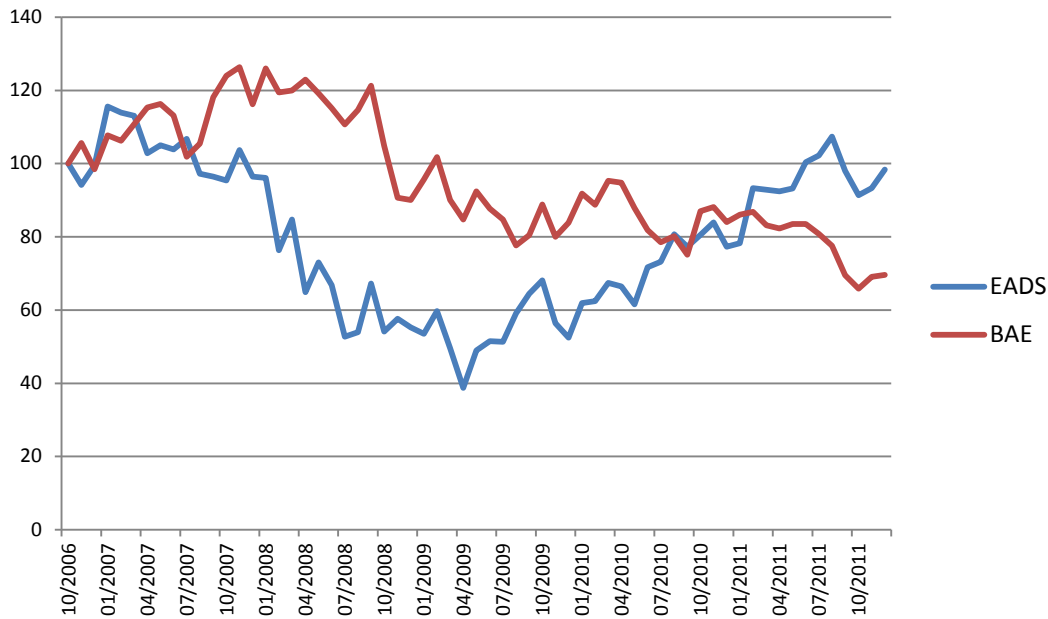


The EADS share price declined for some considerable time before starting to recover as both orders and more importantly production and deliveries improved. At the 2011 Paris Air Show, Airbus received total orders valued at about \$72.2 billion for 730 aircraft, representing a new record in the civil aviation industry.

EADS Share Price

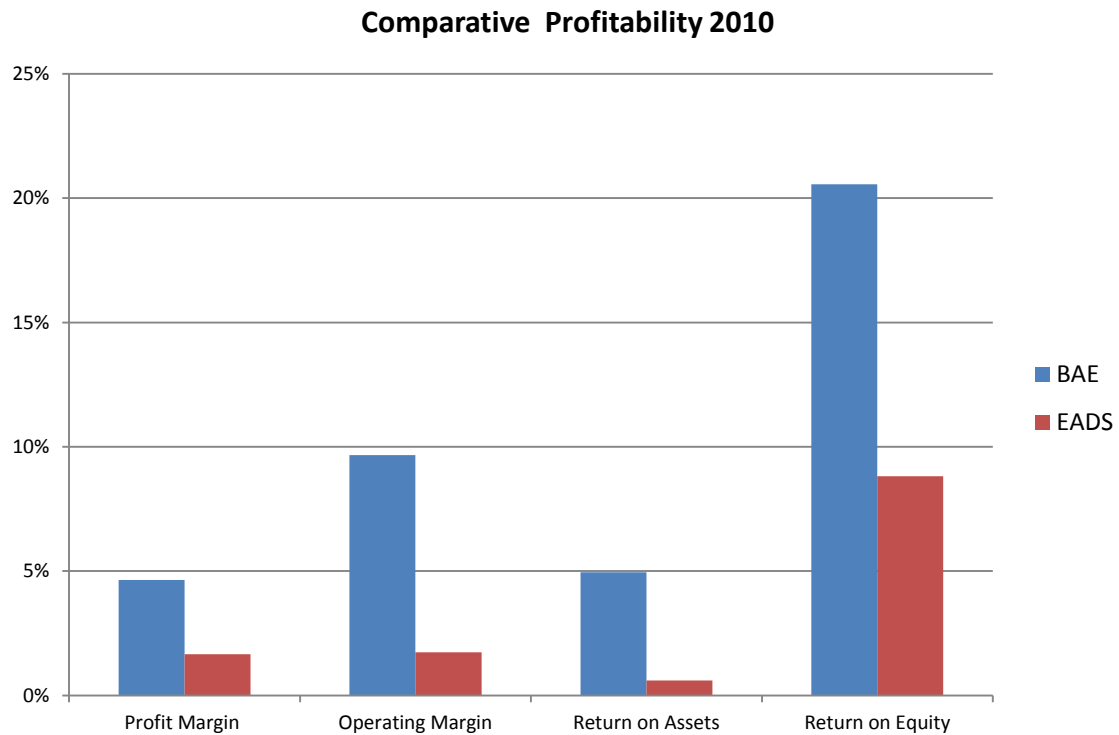


**Comparative BAE SYSTEMS and EADS Share Prices
October 2006 = 100**



As at the end of 2010, Airbus had an order backlog of over 3,550 aircraft, which equates at current delivery rates of ca. 500 per annum, to over seven years of production. It is employing approaching 60,000 people mainly in France, Germany the UK and Spain. The company has shown the ability to overcome its major problems and now appears to have a secure future. As will be seen below, however, the financial performance of the company is well below that of BAE when measured against the standard financial

parameters.



This is a classic example of the current debate about the relative merits of the US and British financially dominated system demanding ever higher financial rates of return, compared with the European approach of a long term strategy that takes into account the interests of all the stakeholders. The latter focuses on the development of products and market positions, in parallel with ensuring reasonable profitability, without which no business is ultimately sustainable. It can be summarised by comparing the benefits of a full order book and full employment with modest profits, against a situation of overcapacity and redundancies yet higher rates of return for the investors.

It is submitted that the overwhelming pressure that the financiers impose on manufacturers in the UK for ever increasing short term profits has to be addressed. This in turn raises the question of corporate governance, which surely has fundamentally to be re-appraised. The view was expressed at the time as to how much influence BAE had with its 20% shareholding in Airbus Industrie; but for certain a zero shareholding equates with zero influence.

The Strategic role of UK Aerospace Manufacturing

The UK is the world's seventh largest manufacturing nation.

Referring to the UK aerospace industry: *'At present, the UK has a 17 per cent share of that global market, way above its share of most other global industrial markets'*.

The UK aerospace sector is a successful, vibrant, high value high technology engineering, manufacturing and service industry that generates good returns to all its stakeholders. With over £20 billion per annum in value added revenue and employing over 100,000 directly, and over 220,000 indirectly, the industry is one of the UK's largest exporters adding around £2.8 billion annually to the UK balance of trade and involves around 2600 companies across all regions of the UK.

The aerospace industry is the UK's largest high value manufacturing industry and is at the pinnacle of advanced manufacturing, which the government has identified as strategically important for rebuilding a balanced economy. The UK must safeguard its enviable reputation as an innovator in the aerospace industry and constantly enhance its ability to exploit efficiently its significant investment in new technologies and strive to maintain its world standing as the second largest aerospace nation to the USA.

There is a real threat from Europe of the UK losing its dominance, with the continual erosion of design capability for the civil market and decisions about the Airbus work share arrangements being made in France. Also, the UK's leading aerospace companies, Rolls Royce and BAE Systems, are facing significant military cutbacks and in parallel experiencing financial incentives to manufacture overseas. The UK also faces increasing competition, in terms of new technologies and lower direct labour costs, from both traditional international competitors and from new entrants aspiring to develop their capabilities in this prestigious industry.

The industry is entering a challenging period of rapid technology developments; with the need to design ecologically acceptable aircraft, the application of new advanced materials and the adoption of cost effective and sustainable manufacturing processes. The UK aerospace sector faces considerable difficulty in matching the advances being achieved by foreign competitors due to their investments in this industry.

The past decade has seen the lowering of economic trade barriers, an overall reduction in transport costs and the enabling effect of information and communications technologies. Manufacturing is a highly competitive business, and work tends to gravitate to those countries with the lowest manufacturing costs.

To sustain manufacturing operations in high-cost economies requires radical thinking in order to remain globally competitive. In the UK this has already resulted in changes to:

- The composition of the manufacturing base away from traditional areas towards the high-value, knowledge-intensive goods sectors

- The focus of activities away from manufacturing and more towards provision of lifetime service, around a portfolio of products
- The business model, in terms of increasing specialisation and outsourcing non-core activities. However, a prerequisite requirement is the retention of core technologies, key components and the necessary skills to meet mandated quality standards.
- The consolidation of companies, leading to the creation of large players who focus new technology developments in global centres of excellence.

It must be acknowledged that the design of sought-after products and their associated cost effective production is the key to future prosperity. It is the sale of these manufactured goods and services that is the principal route to generating wealth. Continued investment in advanced design and manufacturing is therefore strategically important to the UK.

Competition in Aerospace and Defence Industries

Emerging Markets

The UK aerospace industry has gained considerable benefit from being at the forefront of aerospace technology and can legitimately claim to have been a leading innovator across all sections of the industry. This enviable position has been achieved through long-term investments mainly directed at product innovation. Aerospace markets have been dominated by a few airframe and engine builders competing on product technology. However, the growing investments being made by world-renowned companies or government backed institutions in China, India, Japan, Brazil, Canada and Russia, all with ambitions to compete in the growing short haul aircraft and military aircraft markets, will provide customers with much greater choice. Increased competition in this market sector will make it more difficult to establish clear product differentiation and choice will be influenced by the traditional purchasing parameters of cost, quality and delivery. Based on these drivers, manufacturing will be a significant competitive weapon as it is responsible for managing over 70% of sales revenues and ensuring quality products are delivered on time to customers.

Globalisation and the emerging markets present significant threats to the UK aerospace industry, particularly with respect to the ability of small and medium sized UK companies to win business in international markets. These SMEs need to invest in the development of new technology, whilst reducing their cost base, if they are to remain commercially viable. However, one of the most significant threats and challenges is to fully convince the political and financial decision-makers of the importance of manufacturing industry to the UK economy. All other world leading economies are investing in growing their aerospace industry, benefiting from the prestige these high visibility programmes bestow.

USA, UK, and Europe

Historically, military requirements have driven investment in aerospace technologies. The USA, France and UK have championed building sophisticated weapon platforms, sustaining advancement in airframes, engines, systems and subsystems. Involvement in these programmes provided access to emerging technologies and an extensive supplier base evolved to support aerospace and defence industries. This accelerated technology

development which could be transferred and exploited in the larger civil aircraft industry, driven by people's desire to travel and thus sustaining global economic growth. Through the merger of aerospace companies in the USA and Europe, these technologies have been successfully integrated into today's commercial aircraft. The civil aircraft business is dominated by Boeing - USA and Airbus - Europe. Both have invested extensively in new larger aircraft which have an extended range and operate at lower costs per passenger mile. Their unassailable position on large aircraft will be maintained for at least the next two decades due to the long timescales needed to develop large complex passenger airliners and the extremely high entry costs. The world jet engine market is dominated by Rolls Royce in the UK and two American suppliers. A similar dominant position has evolved on major systems; flight controls, undercarriages, avionics, power generation, gearbox manufacture and such. However, the aerospace industry is a global business and companies in emerging markets have access to aerospace technologies through partnering with appropriate airframe, engine and system suppliers.

The civil aircraft market is led by Boeing and Airbus with 43% and 47% shares respectively. The quest for building larger, advanced technology aircraft has been driven by the long haul market as opposed to developing their higher volume 150 - 190 seat, short range single aisle business. Both companies plan to launch replacement aircraft for the aging Boeing 737 and Airbus A320 by around 2020, but these plans have now been superseded by significant upgrade programmes. Sales for these aircraft represent 40% of the market by value, and this delay has provided a window of opportunity for ambitious countries in emerging markets to enter this prestigious civil aerospace business, possibly creating several formidable competitors. Over the next twenty years the estimated demand for single aisle aircraft is 20,000 planes with a predicted market value of \$1.6 trillion. This represents a significant growth in global demand. The UK aerospace industry must take every opportunity to develop competitive strategies and win a significant share of this business.

China

It has recognised that significant growth in airline passenger numbers is needed to sustain current levels of economic growth. Asian airlines are expected to purchase 10,000 new planes by 2025, with over 2,200 sold to Chinese airlines. In March 2008, the Chinese government officially approved the launch of China Commercial Aircraft Corporation to manufacture a range of civil aircraft. Through negotiating necessary off-set agreements, a final assembly line for the Airbus A320 was installed and the first aircraft left the Chinese factory on 23rd June 2009. Over the past 10, years by cooperating with Boeing and Airbus, the Chinese have acquired the necessary technical and engineering knowledge to produce commercial aircraft components. Now a consortium, China Aviation Industries Corporation, has expressed a strategic objective to design and build a Chinese-developed short haul aircraft. The first aircraft will have 156 seats with a 2,200 mile range. First flight is scheduled for 2014 with delivery from their assembly lines by 2016. They have also established a military aircraft capability, the J-20, an advanced stealth fighter, which first flew in January 2011.

India

The government-owned Hindustan Aeronautics (HAL) is aiming to become a top-tier supplier for Airbus and Boeing, following the Chinese and Japanese example, and have acquired orders for \$1 billion of components to be manufactured in India over the next 10 years. Traditionally, HAL has focused on an indigenous military Advanced Light Helicopter, Light Combat Helicopter and Intermediate Jet Trainer programmes and licence build of Russian, French and British military aircraft. However, it now plans to invest in research and development activities for an Indian Regional Jet and work with Russia on joint programmes to develop a medium transport aircraft and fifth-generation fighter. Tata Group, which owns Jaguar Land Rover and Corus in the UK, has a history in aviation and helped launch Air India. In 2009, Tata TASL set up an aerospace manufacturing facility based in an Aerospace Special Economic Zone near Hyderabad and a high technology, world class composite manufacturing capability in Bangalore. Joint venture agreements have been negotiated with Sikorsky to assemble S-92 helicopter cabins and with Boeing to handle \$500 million of defence-related aerospace component work for export to the USA.

Japan

Mitsubishi Heavy Industries (MHI) announced its regional jet (MRJ) programme in March 2008 with first deliveries expected in 2014 and Toyota has teamed with them on this programme. It will carry 70 to 90 passengers with development costs expected to be 150bn yen (\$1.5bn). The Japanese Ministry of Economy will provide one third of the costs under an initiative to nurture the aviation industry. The airframe and control surfaces will be Japanese but the flight systems and controls are being developed in collaboration with US suppliers. Other Japanese companies are involved in significant aerospace programmes. Kawasaki is prime contractor for the Ministry of Defence T-4 intermediate jet trainer, the P-3C antisubmarine warfare patrol airplane, and is developing the larger P-X maritime patrol airplane and the C-X transport aircraft. They also manufacture a variety of helicopters jointly developed and manufactured with Eurocopter. Fuji Heavy Industries Aerospace Division is a prime contractor for the Japan Defence Agency and manufactures commercial and defence-related aircraft and helicopters, supplying key components for the Airbus A380, Boeing 777, Boeing 787 and Hawker 4000. The Honda Aircraft Company is building a five-seat HA-420 Honda Jet in Greensboro, North Carolina based on proprietary Honda designs and technologies. They have developed their own jet engines and are partnering with leading aerospace industry suppliers for manufacturing major subassemblies. First customer deliveries are projected for the first quarter of 2012.

Brazil

In 1969, the Ministry of Aeronautics created Embraer to build military aircraft which has provided the knowledge base needed to build an extensive range of short haul aircraft. In 1994, Embraer was privatised and formed partnerships with American companies Parker Hannifin, Allison Engine Company and Honeywell to secure the necessary investment to develop the ERJ 145, seating 50 passengers. Sales of these aircraft have allowed Embraer

to become one of the world's main regional jet aircraft manufacturers. More than 1,000 aircraft based on the ERJ platform have been delivered to many international airlines. In 2002, they released a complementary range of commercial jet aircraft, the Embraer 170 and in 2004 an extended 195 version, seating 122 passengers.

Canada

In 1986, Bombardier Aerospace Division was launched by acquiring Canadair from the Canadian Government. In 1989, the near-bankrupt Short Brothers based in Northern Ireland, was acquired, followed closely by the bankrupt Learjet Company and finally in 1992 the Canadian Boeing subsidiary de Havilland Aircraft. Aerospace now accounts for 50% of Bombardier's revenues. Its current most popular aircraft include the Dash 8 and CRJ range of regional airliners. In 2008, it built a \$375 million assembly plant near Montreal for its new CS series aircraft seating 130 people with a range of 2,200 miles. First flight is scheduled for 2012 with deliveries planned to start in 2013. It is marketing these aircraft to compete with the Boeing 737 - 600, Airbus A318 and Embraer 195.

Others

There are several other countries that currently have no aspirations to produce the whole aircraft, but are making significant investment in companies with the capability to manufacture Tier 2 or Tier 3 aerospace components. If successful, these countries have the potential to become serious competitors.

Key Drivers for Aerospace and Defence Manufacturing

The Challenge

The UK aerospace civil and defence industries have the opportunity to lead the industry in implementing the significant changes being demanded by airline and military customers around the world. This can only be realised by understanding the potential for investing in existing and new technologies that reduce the overall cost of ownership and make aircraft environmentally acceptable. This will be accomplished by meeting the following challenges:

- Reducing the non-recurring airframe and equipment design and qualification costs
- Introducing new materials that provide longer, service-free life
- Reducing manufacturing costs, whilst maintaining the highest quality standards
- Reducing the weight of airframes, engines and components
- Making aircraft more sustainable, environmentally acceptable and reducing all forms of pollution
- Reducing CO₂ and other harmful engine emissions
- Making aircraft more reliable with considerably lower servicing costs
- Making equipment easier and safer to dispose of at end of life

Technology Drivers for Manufacturing

Affordability

The airline industry has been under increasing financial pressure since the events of 9/11 and Icelandic volcanic eruptions. Cost of fuel is increasing, carbon tax looks a possibility, flight traffic is depressed by the ongoing possibility of recession and the threat of international terrorism continues. Also, national governments have suffered major financial deficits and are making significant savings on the purchase of military air systems.

As a consequence, cost reduction and lowering the overall cost of ownership has become a primary driver for the industry. Future success is dependent on the UK's aerospace industry's ability to deliver cost effective products and services throughout the product's lifecycle. Costs must be addressed in a number of ways, including adopting automotive industry techniques for delivering quality products on time, while continually reducing the cost base.

The aim must be to develop unique design and manufacturing technologies and support tools that reduce the cost of airframe, engine and system manufacture by a minimum of 20%. These savings are needed to remain internationally competitive and ensure high value manufacturing capabilities and associated skills are retained for the benefit of the UK and sustain the financial revenues provided for the economy.

The level of manufacturing research and development expenditure on new technologies and the infrastructure needed to support 'change the game' manufacturing strategies for aircraft has been impacted by the relentless move towards a service orientated economy. The majority of advances have been incremental continuous improvements using conventional equipment and methods. A significant transformation is now required to reduce the high cost base to significantly improve financial performance. There must be increased management and monetary investment in product and process technologies and their successful exploitation in manufacturing high quality, cost effective, desirable products. This requires the introduction of more productive equipment, verifying the capability of key processes, introducing effective organisational structures, collaborating with customers and suppliers to create responsive supply chains with total commitment to the highest quality standards.

Environmental Impact

Environmental concerns that are being voiced by world leaders must be urgently addressed. Consequently, low emissions, low noise, 'green' manufacturing processes and recycling at end of service life are now regarded as fundamental requirements for the aerospace industry. This will require a realignment of emphasis at the programme's conceptual design phase to embed eco-friendly design philosophies, new manufacturing technologies and related modelling capabilities to support effective through-life trade-off decisions. These will be based on the complete product lifecycle from concept to end of life disposal, with decisions focusing on consuming the smallest amount of the world's

natural resources and ensuring a minimal impact on the environment. The optimum balance between economy and ecology are now key success factors for the industry.

Performance

The quantity of fossil fuels needed to power aircraft, taking account of the world's finite resources, must be reduced. Therefore, it is paramount for the industry to design and build more economical, cleaner, quieter aircraft. This will be achieved by developing more fuel efficient engines and improved aerodynamics. However, weight remains the critical factor. Aircraft have traditionally been designed to satisfy particular markets. In future more aircraft variants will be needed to efficiently service different market sectors, routes, duty cycles, operational modes and specific customer requirements.

Sustainable Manufacture

An integrated approach to product development must be established, considering the implications on the consumption of natural resources and the impact products will have on the use of materials and resources. A balance must be achieved for the airframe, engine, and primary systems at the specification and design stages, between affordability, the use of materials that are energy intensive to produce, the environmental requirements and socio-economic implications. Consideration must also be given to the impact associated manufacture and conversion processes have on these factors throughout the aircraft's complete lifecycle.

Particular concerns include:

- Titanium alloys, these are in short supply and the conversion of raw materials is very energy intensive.
- Composite structures are cured using pressurised autoclaves and ways of reusing this energy must found. Alternative composite materials and processing technologies are required.
- Composite materials are expensive to recycle and dispose of at the end of life.

Reliability

The reliability and extended service life of aircraft, engines, systems and components is paramount for the industry. It cannot accept unplanned events due to the possible catastrophic consequences of many failure modes. Engineers must improve the predictable life of systems and components through the application of design for manufacturing techniques, by ensuring all manufacturing processes are fully capable and by adopting novel monitoring techniques embedded within the product to detect the onset of failure.

Design Manufacturing Integration

An integrated approach to product introduction must be adopted to ensure aircraft development programmes vigorously embrace product innovation and manufacturing effectiveness with customer requirements and commercial viability being considered throughout the product introduction process. This multidisciplinary team approach

must focus on meeting all reasonable customer expectations, exploiting the benefits of design for manufacture and improving the in-service life and reliability of products. The challenge for manufacturing managers is to fully integrate experts into the design teams to ensure final designs embody key features that allow the benefits of new manufacturing paradigms to be fully exploited.

Particular issues to be addressed include:

- The need for cost effective simulation and modelling tools that can assess the capability of processes and the consequential effects on assembly and product performance, due to components manufactured at the extremes of their tolerance bands.
- The shortage of skilled design and manufacturing engineers; this is partially due to revised secondary school curriculums and a perception that engineering no longer provides rewarding careers.
- New tools and techniques must be identified and introduced to support design optimisation for assembly, sustainability and end of life recycling or disposal.

For a new aircraft, the non-recurring product design and development stages account for approximately 10% of the aircraft's total cost. The recurring costs which are attributable to manufacturing account for a further 75%. However, 80% of these manufacturing costs are determined at the programme design stage. It has also been identified that 80% of defects found in-service are a result of inadequate design.

Responsive Manufacturing System

Advanced manufacturing concepts and acknowledged best practice principles, including lean, six sigma and value stream mapping techniques, must be applied to the whole value system in order to create genuine improvements. Manufacturing facilities and supply chains must be regarded as an asset to the industry and an example of manufacturing excellence. Companies should design customer focussed modular production facilities and install appropriate fully process capable equipment. Depending on the business requirements this could entail; assemble and test finished products, build systems or sub-systems and/or manufacture core components and quality assure all items ready for use. Supply chains must deliver on time and ensure a phased flow of items through the process to ensure stocks and work in progress are consistently at minimum levels, but without significant risk of shortages to production.

Funding Requirements

Traditionally 25% of the UK's aerospace industrial workforce is associated with research, product development and the design of new production systems. Each year the industry commits around £2.5bn to these essential activities, equivalent to 12.5% of total expenditure. Maintaining this level of expenditure is critical for the success of the UK aerospace industry and for retaining the commitment of overseas companies that currently fund product innovation in the UK.

A cause for concern is the threat posed from the growing knowledge-base owned by overseas competitors. UK industry, supported by government, must take radical action to retain our capability to design, manufacture and certify aircraft; currently, only the UK, USA and France have this expertise, for both military and civil aircraft. This capability will be difficult to retain without international partners, therefore alliances need to be established with overseas companies interested in building a viable presence in international aerospace markets.

The aerospace industry is crucial for the present and future prosperity of the UK. The sector directly employs over 320,000 people across 2600 companies with a 17% share of global aerospace markets.

The UK must safeguard its enviable reputation for being an innovator across all sectors of the industry and strive to maintain its world standing as the second largest aerospace nation. It has products, capabilities, facilities and a skilled workforce other nations are willing to invest £billions to acquire these enviable attributes.

Over many years governments, key decision makers and financial institutions have not fully recognised the wealth and social benefits provided by our manufacturing industry and many have passed into foreign ownership or closed. The larger civil aerospace businesses are now predominantly in overseas ownership, apart from Rolls Royce and GKN. The UK industry and government must act in unison to sustain the UK's involvement in this important industry. It is estimated 20,000 new short haul aircraft will be required over the next 20 years with a market value of over a \$1.6 trillion. The UK is one of only three nations with the capability to design, manufacture and flight certify a new civil aircraft carrying more than 150 passengers and replacements are urgently needed for the aging 43 year old Boeing 737 and 23 year old Airbus A320.

In the past twenty years the automotive industry's approach to product design, development, quality, manufacturing operations and supply chains has been transformed by introducing integrated teams and adopting new ways of working across the business. These lessons must be exploited by integrating our superior aerospace product design and manufacturing expertise to create world class products, and manufacturing facilities that sustain long term technical capabilities and tacit knowledge in the UK. Foreign owned companies with aerospace facilities in the UK make investments that meet their corporate objectives, not necessarily to meet the aspirations or ambitions of the UK. The UK aerospace industry is facing unprecedented worldwide competition as emerging industrial countries seek to enter this prestigious and desirable industry. It is known that countries with existing capability are seeking to expand their involvement and Japan, China, India and Russia have declared strategic ambitions to take a significant share of the market. Some industry watchers are predicting that Boeing and Airbus's short haul aircraft market share could drop to 20% each, with Embraer, Bombardier and others expected to take around 10% respectively. However, with currently predicted market growth in commercial aerospace, despite the emerging economies challenge to the dominance of

Europe and USA, there are still tremendous opportunities due to the scale of growth expected in international markets. Therefore, it is essential to continue investing in UK aerospace manufacturing, capitalising on this predicted increase in global demand and the lack of capacity around the world.

The UK Aerospace industry must strive to maintain its strong product innovation and design capability for airframes and systems on civil aircraft to complement the strong international competitive position secured by Rolls Royce on aircraft engines and BAE Systems in military air systems. Several former leading UK aerospace companies such as Lucas Aerospace, Dowty and Smiths Aerospace are now totally owned by foreign competitors. Consequently, there is risk of future programmes being located abroad. It is therefore paramount that industrial leaders and government provide sustained investments in this industry. These investments must be aligned to markets and products that customers want to buy. The design of a new single aisle aircraft, maybe in partnership with an emerging nation, would be a viable way to secure the future of aircraft manufacturing in this country, thus stimulating investment from national and international suppliers and maintaining the UK as a global aerospace industry leader. Without such an ambitious plan, aircraft manufacture will undoubtedly follow other industries in moving out of the UK.

The justification for a new British Single Aisle Aircraft

Background

The UK aerospace industry is the second largest in the world with only that of the USA larger. It provides great economic benefit and prestige to the whole country. Three of the largest UK companies, Rolls Royce, BAE Systems and GKN have international reputations with industry leading technologies at the pinnacle of advanced manufacturing. The aerospace industry is the remaining manufacturing industry where UK has technical leadership, critical mass, and access to large growing international markets

Long term stability is now in question. Once launched, products remain in production for many years; previous investment decisions taken in the late 80's on major programmes (Airbus A320, Eurofighter and JSF) that provided significant volumes of work are no longer secure. Airbus is launching a re-engined version, the A320 NEO in 2015, with a replacement aircraft planned for 2025. The redevelopment programme for the engine and wings will provide opportunities for work traditionally undertaken in the UK to be offered overseas. (This year, South Korea is reported to have secured contracts to supply composite components - not GKN)

The UK military spending review and cutbacks in Europe have led to significant reduction in the number of Eurofighters required, and a corresponding reduction in work for UK factories. The US Joint Striker Aircraft (JSF) is more expensive than originally budgeted and is under constant review, with deliveries being postponed and numbers considerably reduced (UK companies secured substantial work programmes and made significant investments in the JSF project).

The global aerospace industry is unique in that it is totally dominated by two airframe manufacturers (Airbus and Boeing) and three engine manufacturers (Rolls Royce, GE and Pratt and Whitney). The system manufacturers, component suppliers and support organisations all depend on winning business with one or more of these five companies.

The aerospace industry in the UK must address some major issues concerning its future, if it is to maintain the \$20 billion per annum in value added revenue and direct employment of ca. 100,000 people.

The government has announced that Eurofighter will be the last manned weapons platform.

With BAE Systems having sold its 20% share in Airbus Industrie and consequently the UK has lost its influence on future investments. It can be questioned if EADS controlled by the French and Germans, can be relied on to continue supporting aircraft wing design, development and manufacturing in the UK. Also, emerging nations are offering extremely attractive manufacturing options as they desire to enter this industry – China is building the Airbus A320.

Augusta Westland, an Anglo-Italian helicopter company, is owned by Finmeccanica in Italy, so again the UK is dependent on a European company to invest here.

The major Tier 1 supplier base that supported the industry when previous investment decisions were taken is now in foreign ownership: (including Lucas Aerospace, Dowty and Smiths Aerospace). These companies are now part of international groups which operate on a global basis and are prepared to invest in facilities close to their customers. Costs are also a significant factor; they have started to relocate overseas some aspects of their design, development and manufacturing facilities in order to secure competitive advantage. BAE Systems has closed or is in the process of closing manufacturing facilities at Woodford, Chadderton and Brough due to excess capacity following the cutbacks in military spending and the cancellation of programmes.

The aerospace industry in the UK is under severe threat and will gradually migrate overseas, as have many other industries unless government and industry work together to secure its long term future viability.

An Opportunity for the UK

The world market for civil aircraft is growing, particularly for single aisle aircraft carrying around 200 passengers. These account for around 50% of all aircraft sold. Demand for single aisle aircraft over the next 20 years is forecast to be 20,000 units, worth \$1.6 trillion. Apart from the UK, only two other nations, USA and France, have the capability to design, manufacture and flight certify a passenger aircraft with more than 150 seats. Several countries are attempting to introduce new single aisle aircraft (China, Japan, Brazil, and Canada) to compete in this market which will increase competition. The market is dominated by aging aircraft; the Boeing 737 was designed 43 years ago and the Airbus A320 is 23 years old, with replacements not expected until 2025

Existing aircraft:

- Were developed before the advent of the low cost airlines, so their requirements have not been fundamentally addressed
- Were not designed for manufacture
- Have not benefited fully from the manufacturing methods so effectively introduced into the car industry

Cost of ownership has become a major driver for the industry, which means aircraft must be:

- Cheaper to purchase or lease
- More fuel efficient (airframes and engines)
- Lighter in weight to reduce fuel burn
- Operable with extended maintenance intervals
- More reliable in service, to prevent costly unplanned disruptions to schedules and passengers
- Cheaper to recycle at end of life

Environment concerns are also a major issue:

- Aircraft must be ‘greener’ causing less environmental pollution
- They must be quieter both for passengers and people living near airports
- Materials used to manufacture the airframe, engines and systems must be sustainable without the need for harmful treatments

Implementing a plan to design and build a new UK led single aisle aircraft (possibly in collaboration with an emerging nation), carrying around 200 passengers is the best of very few options available, if the UK is to sustain its largest advanced manufacturing industry. Like other industries considered too important to let fail, money must be found to invest in the design of a new aircraft whilst our aerospace engineers still have the tacit knowledge needed to conceive and develop such a world-beating single aisle aircraft.

Without this ambitious initiative:

- The number of people employed in the industry will continually decline
- The engineering knowledge base will move overseas and, once lost, would be extremely difficult to re-establish
- The global component industry will exit the UK and launch design / manufacturing facilities closer to its new customer base
- Export earnings will reduce as programmes move abroad, negatively impacting our balance of trade
- Advanced Manufacturing Research Centres which are mainly dependent on the aerospace industry will become heavily reliant on Rolls Royce and engine developments (apart from servicing their overseas customers)
- Acclaimed university aerospace research programmes will lack focus, without access to UK companies capable of supporting and commercially exploiting their advanced technological ideas

The risks associated with building a new single aisle aircraft

- Airbus Industrie take exception to any initiative and accelerate moving future wing manufacture overseas
- Failure to establish an appropriate industry and government consortium committed to fund adequately the programme
- Not finding the right industrial leader with all the attributes needed to manage such a complex project
- Politicians not backing the project due to timescales, which will span more than one parliament
- The new technologies being developed by industry, in universities and research establishments, not delivering expected competitive advantage
- Lack of experienced personnel in new flight certification requirements

The Consequences of such a Plan

- Unite the industry and confirm that the UK intends to remain the second largest aerospace nation
- Ensure jobs and expertise essential to be a major aerospace player are retained for the benefit of the UK
- Provide the opportunity for innovation based on requirements and demand created by a strong home market
- Offer SMEs clear routes to markets with opportunities to develop overseas customers
- Create a secure future for people working in the industry
- Provide a flagship for the government's commitment to advanced manufacturing and rebalancing the economy
- Create opportunities for individuals, families and the community to obtain gainful employment either directly or through the provision of wider services needed to support the company
- Offer the opportunity to consider a new model for industrial and government commercial partnerships to provide benefits for the country, the local community and employees

Conclusions

The UK has the skills, experience and capacity and Brough could make a significant contribution. Other countries have already shown the initiative without any comparable set of skills and resources, other than recognition of the opportunity and a determination to succeed. Surely this is where the venture capitalists in the City have a chance to prove that their horizons extend beyond next quarter's earnings and next quarter's bonus.

- The Government must find new ways of forming long term partnerships involving government agencies, manufacturers, trade associations, and the workforce, following the German model that has proved so successful. Companies need strategic protection from the vagaries of the stock market, which causes so much damage with its obsession with short term results. The whole question of corporate governance needs urgently to be addressed. With the Main Boards of most British public companies consisting of a Chief Executive and a Finance Director acting in "gate keeper roles" and surrounded by a large number of non-executive directors representing the City interests, the knowledge and experience of other directors at divisional or functional levels are suppressed and rarely have an impact on key decision making.
- Trading companies for the benefit of city bankers, their advisors and senior directors seeking short term returns on their investment, without considering the long term implications for the company, the effect on its employees or the impact on the

economic interests of the nation, must be intensely questioned. The sale of around £700 billion of UK industrial assets to overseas buyers over a period of 10 years and used to offset the huge balance of trade deficit in goods has had a devastating effect on the long term viability of much of UK industry. In most cases the businesses were undervalued as the stock market takes little account of the value of the in-built intellectual property, knowledge and experience of a company: not just relating to patents, but even more importantly to the huge investment involved in the design and manufacture of products the world wants to buy and the marketing structures required to ensure they can be effectively sold. Very often a position as product market leader takes a generation to achieve and establishing effective overseas marketing operations even longer.

- As Sir Alan Rudge frequently comments in public and in the ERA Reports, good government has a duty to create a “greenhouse” effect in which well managed companies with competitive products and processes can thrive.
- Inevitably such views will generate the response that interventionism “backing winners”, has proved disastrous in the UK in the past, as indeed it did. A strategy, however, of supporting defined industrial sectors and encouraging the growth of companies independent of the stock market for funding is very different. The German Mittelstand, which largely comprises private and often family owned companies, demonstrates the value of such a strategy. With British banks currently securing funds at ½ % and lending on to SMEs at over 10%, there surely have to be better alternatives modelled on the German Sparkassen with their local knowledge and commitment to long term investment.
- Levels of investment in the UK in productive capital equipment and in R& D are way below that of competing nations. In Germany in 2010 the level of investment in automated and flexible plant and machinery was over eight times that of the UK. Machine tool investment the UK now ranks in absolute levels of investment below Turkey and Mexico. Many good investment proposals never gain approval to proceed in the UK because of unrealistically short time horizons. Successful companies entering the Manufacturing Excellence Awards in the UK and Germany spend over 6% of operating revenue on research and product innovation, compared with a general level including BAE of around 3%. Bosch in Germany invested 8.1 % of revenues, amounting to €3.8 billion per year on research and new product development last year and Siemens also is reported to invest around €4.0 billion per year on research and products.
- Government contracting agencies must endeavour to place contracts for design, development, manufacture and in-service support with British based companies following the clear precepts adopted particularly by other European countries. It must instigate and implement an industrial strategy, identifying key industries considered to be important for the economic benefit of the nation and in which it is prepared to invest. Without such a strategy, Airbus would never have achieved its success against Boeing and would not now enjoy the security of a full order book extending over the next seven years.