IKINET Intermediate Report

INNOVATION AND KNOWLEDGE CREATION PROCESSES IN TWO AEROSPACE CLUSTERS IN WALES

Professor Philip Cooke
Dr Oliver Ehret

CookePN@cardiff.ac.uk
EhretOM@cardiff.ac.uk

Centre for Advanced Studies
Cardiff University

44-45 Park Place
Cardiff CF10 3BB
United Kingdom

7 March 2006

CONTENTS

1. INTRODUCTION TO AEROSPACE SECTOR AND REPORT

1.1. THE AEROSPACE SECTOR IN WALES

The Welsh aerospace industry has emerged over the last 20 years and is now worth around £ 2 billion to the Welsh economy. Over the past 15 years, companies in Wales have invested over £ 17 billion. The Welsh Development Agency (WDA) estimates that the aerospace industry in Wales currently incorporates over 150 companies. This tally rises to over £ 100 billion if companies providing support services are included. Wales is home to plants of 6 of the world's top 20 aerospace companies, including: 'Airbus SAS,' 'BAE Systems,' 'General Dynamics,' 'General Electric,' 'Raytheon' and 'Thales.' The aerospace industry in Wales employs over 20,000 people. The industry accounts for 10 % of Welsh export trade and 30 % of exports to the USA (Aerospace Wales Panorama 2005).

The Welsh aerospace sector is characterised by a north-south divide. There are two and largely separate aerospace areas in Wales. The sector in North Wales is dominated by a relatively clearly structured aircraft manufacture supply chain to Airbus at Broughton. The sector in South Wales, however, is much more loosely organised; and more involved in aerospace Maintenance, Repair and Overhaul (MRO), R&D, and training, than in aircraft production. There are hardly any companies and other organisations engaging in aerospace activities in the sparsely populated and barely industrialised mid-Wales.

The north-south divide is a major finding of the research undertaken by the Centre for Advanced Studies (CASS) of Cardiff University in the context of IKINET. It can be seen on the figure or 'cluster map' portraying the Welsh aerospace sector in sub-section 3.1.1., 'The structure of the aerospace sector in Wales,' of this report. The division has also been confirmed by interviewees representing various organisations, most notably the 'Barry College International Centre for Aerospace Training,' 'Aerospace Engineering at the University of Wales, Swansea,' and 'Aerospace Wales St Athan;' discussed in detail in the next chapter.

North Wales is clearly dominated by the Airbus plant at Broughton, which mainly produces wings for the Airbus fleet. Also branches of other large companies, including 'Raytheon' and Magellan,' are located in the region primarily involved aerospace manufacturing. 'Magellan Aerospace UK Limited' is part of the supply chain to Airbus, and examined by the present report. There are a range of branches of other larger groups of companies, or independent SMEs, settled in North Wales. 6 have been investigated by the CASS research as well, all of which belong to the Airbus supply chain. There are also some non-industrial organisations involved in aerospace in North Wales, such as the 'Hawarden Business Park' financed by the WDA, which CASS will examine at a later stage.

South Wales is home to major Maintenance, Repair and Overhaul firms such as 'GE Aircraft Engine Services' and 'Nordam Europe.' There are also leading aerospace research and training institutions including the 'Barry College International Centre for Aerospace Training' and 'Aerospace Engineering at the University of Wales, Swan-

sea.' The Centre for Advanced Studies has examined all of the above and other firms and organisations in South Wales. CASS has also identified 'British Airways Maintenance Cardiff' and the 'Defence Aviation Repair Agency' as major players, and seeks to investigate these and further actors in the future.

The aerospace industry in Wales and worldwide has largely been on an upward cycle for the last two years. This continued and strengthened the continuous growth of aerospace in Wales and around the globe materialising during the last few decades, which was only temporarily stopped by the terrorist attacks in New York of 11 September 2001 and the SARS crisis in Asia. However, the worldwide including the Welsh aerospace industry have meanwhile been recovering from the severe downturn that materialised in the aftermath of the above events and are now booming; and expect still further substantial increases in growth for the future (Aerospace Innovation and Growth Team 2003).

Airbus SAS, i.e. the international Airbus group, is one of the companies benefiting from the current worldwide aerospace boom. Production volumes for most Airbus planes have increased dramatically; and new aircraft types such as the 'super-jumbo' A380 are being developed and market-introduced. Also the Airbus plant in North Wales has been benefiting from this trend, and experiences a dramatic upsurge in production volumes for wing components of many aircraft types and especially the A380. Airbus Broughton has recently extended its production facilities substantially. Most of the Airbus suppliers are experiencing a boom period as a result, with many having full order books for the next two years.

In the absence of strong connections between Airbus and South Wales, this part of the country could not benefit substantially from the Airbus Broughton growth. Out of all companies investigated by CASS, only the 'Prematec Corporation' and 'GE Aircraft Engine Services' (GEAES) recorded substantially growing sales due to the Airbus boom. It seems that South Wales is recovering more slowly from the post-2001 downturns than the north, with interviewees being less enthusiastic about business prospects than their northern counterparts. One problem is that the 'Defence Aviation Repair Agency' as a major MRO firm has drastically reduced jobs, with the Welsh Assembly Government still struggling to make up for job losses with the development of the 'Aerospace Wales St Athan' business park. There are also positive signs, however, with GEAES, for instance, recently also gaining long-term maintenance contracts for the servicing of the substantial 'Ryanair' fleet.

The Welsh Assembly is the key player on the governmental side for both North and South Wales. It funds and directs several organisations promoting aerospace. The most important are the Welsh Development Agency, generally in charge for fostering economic development, the export-support agency 'Wales Trade International' (WTI), and the networking body 'Aerospace Wales Forum' (AWF). These bodies are keen to develop the aerospace industry as a key cluster, and this is a key focus of their business support activities. The aerospace industry is not only seen as a valuable employer. To the Welsh Assembly Government, the industry is also at the forefront of technological development, and plays a key role in improving the skills of the Welsh workforce. The focus of the development activity is on the SME sector, since the larger companies are generally regarded to have the resources and expertise available to operate and grow successfully without the need for public sector assistance. Key pro-

jects promoting SMEs are the 'Hawarden Business Park' and the 'Aerospace Wales St Athan' business parks. To date the CASS team has investigated the AWF and the St Athan business park; and through this achieved a good overview over the relevant developments. The Welsh Assembly Government also offers large financial incentives for bigger companies to convince them to locate in Wales. The grant aid that is available, such as 'Regional Selective Assistance,' is to support business expansion or the purchase of large capital equipment.

Finally, there are a number of aerospace training and academic research institutions in Wales, resident mainly in the southern part of the country. These include the 'Barry College International Centre for Aerospace Training,' and 'Aerospace Engineering at the University of Wales, Swansea,' mentioned above. In conjunction with developing capacities in MRO, the Welsh Assembly Government also seeks to encourage the expansion and upgrading of aerospace training and academic R&D.

It is important to note that the aerospace sector in Wales has not yet been 'mapped' either by industry or governance actors. While there are reports covering the whole of the United Kingdom, they can at best convey a very rough picture of the Welsh situation (House of Commons 2005). The main sources informing this report are the comprehensive interviews conducted, supplemented by electronic and printed documents, published or informally provided by the firms and organisations concerned.

1.2. THE STRUCTURE OF THE REPORT

In the next chapter, the aerospace firms and organisations of Wales are examined. The discussion of each body focuses on six issues of central importance to IKINET. These are: Investment and Innovation, Internal Organisation and Knowledge Exchange, and Local Environment and International Economy. The first section of chapter 2 discusses the 15 firms that have been examined by the Centre for Advanced Studies. The second section reviews the 3 research institutions, and the third section the 2 public institutions, which the CASS research has covered so far. The selection of firms and organisations has followed the IKINET methodology.

The third chapter of the report cross-analyses the findings for the individual firms and institutions previously presented, and synthesises the results towards a wider picture of the aerospace sector across Wales. In the first section, the industry structure of the sector is mapped. Also, features common between the firms of North and South Wales are established, in line with the six central concerns of IKINET recalled above. In the second section, the institutions examined by CASS so far are analysed in a different, more selective and policy-focussed way. While this highlights some key aspects of the relationship between institutions and firms in aerospace, no full picture of the role of institutions in Welsh aerospace can be established at this stage.

2.THE AEROSPACE FIRMS AND ORGANISATIONS OF WALES

2.1. INDUSTRIAL FIRMS

Senior managers of 15 aerospace companies were interviewed by the Centre for Advanced Studies in November 2004 and January 2005. The interviews were conducted by Robert Wilson, then a Senior Researcher at CASS, who was mostly accompanied by Paul Lindsay, Deputy Director of the 'Aerospace Wales Forum.' As the below table indicates, as suggested by the IKINET methodology, the firms include Original Equipment Manufacturers (OEMs) and other key players in the Welsh aerospace sector. In addition, lower ranking companies including System Suppliers and Subcontractors at the Tier 1 and Tier 2 level were interviewed.

However, as already noted above, it emerged that no one and united aerospace sector exists in Wales. Rather, there are two and largely separate aerospace areas in Wales. The sector in North Wales is dominated by a relatively clearly structured manufacture supply chain to Airbus at Broughton. The sector in South Wales, however, is much more loosely organised; and more engaged in aerospace MRO, R&D, and training than in aircraft production.

Thus, the southern sector could only be mapped to a less conclusive degree than desired by the IKINET methodology, assuming a relatively simply structured and easily discernable organisation. As a result, a few important MRO actors in the south, such as the 'British Airways Maintenance Cardiff' and the 'Defence Aviation Repair Agency,' could only be identified late, and have not as yet been interviewed. To gain a fuller picture especially of the South Wales sector, it is therefore advisable to interview some additional central MRO actors in the future, exceeding the number of firm interviews required by IKINET.

Industrial Firms Investigated	
NAME & LOCATION IN NORTH OR SOUTH WALES	MAIN AEROSPACE PRODUCT OR SERVICE
Airbus, Broughton, NW	Manufactures aircraft wings
Contour Premium Aircraft Seating, Cwmbran, SW	Produces aircraft seats for airlines & does some MRO
Cottam & Brookes Engineering, Caerphilly, SW	Manufactures tooling for aircraft MRO industry
Cytec Engineered Materials, Wrexham, NW	Produces composite materials for aerospace
Doncasters Blaenavon, Pontypool, SW	Manufactures forged & ring rolled components
Ellison Sensors International, Wrexham, NW	Makes pressure transducers and transmitters
Gardner Aerospace Wales Ltd, Maesteg, SW	Manufactures wing components for aerospace
GE Aircraft Engine Services, Caerphilly, SW	MRO of plane engines & engine components
Magellan Aerospace UK, Wrexham, NW	Precision engineering, metal treatments & parts
Metal Improvement Company, Broughton, NW	Provides shot peening for aerospace industry
Nordam Europe, Blackwood, SW	MRO of jet engine systems & engine parts
Prematec, Llantrisant, SW	Manufactures large airframe components
RD Precision, Queensferry, NW	Manufactures precision engineering components
Thales Optics, St Asaph, NW	Modules & components for aerospace industry
Tritech Precision Products, Wrexham, NW	Metal casting for aircraft industry

2.1.1. Airbus

'Airbus' at Broughton in North Wales is one out of two major production plants operated by 'Airbus UK' in the United Kingdom. The Airbus Broughton site is by far the largest aerospace operation in Wales and mainly manufactures wings for the Airbus aircraft family. Airbus UK is a subsidiary of the European 'Airbus SAS,' which competes with the American 'Boeing Company' for global market leadership in civil aircraft. 'Airbus Industrie GIE,' the forerunner of Airbus SAS, was established in 1970 by a French-German consortium between the aerospace companies 'Aerospatiale' and 'Deutsche Airbus.' The consortium was joined by 'CASA' of Spain shortly afterwards, and by 'British Aerospace,' which is 'BAE Systems' today, in 1979. Each of the partners, known as 'Airbus France,' 'Airbus Deutschland,' 'Airbus UK' and 'Airbus España,' operated as a national firm with special responsibilities for producing particular sections of aircraft, to be transported to Toulouse in France for final assembly. In 2001 Airbus became a single integrated company incorporated under French law as a simplified joint stock company or 'SAS,' with headquarters in Toulouse. The four national entities which had previously formed the Airbus consortium transferred their Airbus-related assets to the new company Airbus SAS and became shareholders. The French, German and Spanish sections merged into the 'European Aeronautic Defence and Space Company' (EADS) with 80 % shares in Airbus SAS. BAE Systems came to operate Airbus UK as a wholly-owned subsidiary of Airbus SAS, and owns the remaining 20 % of the overall shares.

Starting with only one model on offer when Airbus made its first plane deliveries in 1974, the firm has expanded its range of aircraft to 12 types today. Seating capacity and operating range stretch from 100 seats provided by the short-range A318, to 555 seats to be soon offered by the ultra-long range A380, with various aircraft types of intermediate seating and range-capacities in between, such as the popular A320 and most of the large medium or long-range A330 and A340 versions. Electronically-managed 'fly-by-wire' flight control systems and the use of composites on primary structures represent examples for major technological innovations Airbus introduced over the years. The company has long been enjoying market success. The Airbus share of the global market for large civil aircraft has grown from 8 % in 1980 to 52 % in 2003, exceeding Boeing in delivery volume and making Airbus SAS the largest supplier of civil aircraft. While the terrorist attacks of 11 September 2001 and SARS affected the Airbus' sales badly for some time, today order books are full and the company is growing faster than ever before. In 2004 Airbus SAS achieved a turnover € 20 billion and employed 53,000 people in Europe and worldwide.

The next milestone will be market introduction of the A380 'super jumbo' in late 2006, for which 159 orders for passenger and fright versions have been placed so far. Five planes were built by late 2005 and are now in the process of being tested. Airbus has also responded to Boeing's new 250-seater 7E7 'dreamliner' aircraft, and launched the A350 as a rival model. Airbus is also set to enter the military market with its A400M 'Strategic Transport Aircraft' and its A330-based 'Future Strategic Tanker Aircraft.' Manufacturing is structured around 16 key production sites in Europe, each of which is responsible for producing a complete aircraft section for delivery to the final assembly lines in Toulouse and in Hamburg, Germany. There are 6 'Centres of Excellence' headquartered in Europe as well, which relate to R&D and unite technological expertise across different production sites. Airbus also runs many support operations in North America, Japan, China, and Russia; and sources from more than 1,500 suppliers in over 30 countries around the globe.

Airbus UK is responsible for the design and manufacture of the wings for all Airbus models, as well as the overall design and supply of fuel systems. For most Airbus models the company is also in charge of the overall development and delivery of the landing gear. Apart from the Broughton site, Airbus UK operates a large plant in Filton near Bristol in England, as well as several smaller support facilities in England. Airbus UK has a workforce of over 12,000 employees in Britain and claims to support "80,000 UK jobs from direct, indirect and induced employment. This will rise to around 100,000 UK jobs when the A380 and A400M projects reach full production" (quoted in House of Commons 2005: 15). Broughton together with Filton makes up the 'Centre of Excellence Wing.' Broughton is mainly responsible for the manufacture of large wing components, such as the aluminium alloy panels forming the external surfaces or 'skins' of aircraft. The site is also in charge for the sub and final assembly of wings, as well as for wing equipping, for the whole Airbus fleet. Production activities include wing skin milling, stringer manufacture, full wing equipping and wing box assembly. Moreover, Broughton deals with composite materials for aircraft fuselages to a limited degree. While Broughton is essentially a wing manufacturing and assembly site, Airbus Filton carries out engineering and design activities along with some production work for wings, fuel systems, and landing gears.

The Broughton plant has always been very large and employed more than 5,000 people in 2003. The start of the A380 production and an increase in the manufacturing volumes of other aircraft types, however, required a massive extension to the site. In January 2003, three new facilities for producing large components for A380 wings were opened. The developments had been constructed within the original 'East Factory' site at Broughton and represented a £ 73 million investment. Moreover, to house the wing assembly facilities for the A380 and new production equipment for other planes, an outstandingly large 'West Factory' was opened in July 2003. The investment was worth £ 350 million, and designed to be operated by up to 1,200 additional staff, to be hired once the A380 manufacture comes into full swing. In the absence of the projects qualifying for Regional Selective Assistance, the WDA supported the expansion with £ 20 million. In early 2005 employment figures at Airbus had gone up to over 6,000. According to a personal WDA communication, some 10,000 people are employed in Welsh-based companies supporting the airbus operations in the UK.

The Welsh Development Agency recently established a 'Hawarden Business Park' next to the Airbus plant, to accommodate aerospace firms expected to settle, to take advantage of the growing Airbus supply demand. According to senior staff of the Agency, it is mainly due to the presence of Airbus that 'a strong and vibrant cluster of aerospace suppliers' has emerged in Broughton and its vicinity (Aerospace Wales Panorama 2005: 10). As the below discussion of other aerospace firms operating in Wales shows, for a number of firms Airbus indeed represents a major customer, and geographical proximity sometimes plays an important role in fostering the business relationships. These companies are 'Cytec Engineered Materials,' 'Ellison Sensors International,' 'Magellan Aerospace UK,' 'Metal Improvement Company,' 'RD Precision,' 'Thales Optics,' and 'Tritech Precision Products.' What is striking about the CASS interview with senior Airbus staff, however, is the contrast between the largely positive attitude of suppliers towards Airbus praising the locally embedded, longstanding and trustful business relationships; and the low commitment of Airbus to its local suppliers the interviewee portrays. While referring to local suppliers in occasionally slightly cynical terms, the interviewee stresses the European rather than national or regional nature of Airbus, and emphasises the international structure of the supply chains, driven by the imperative to reduce costs, and little perceptive to the notion of trust. The interviewee discusses Airbus SAS policies in relation to the whole company rather than from the perspective of the Broughton plant, and talks mostly about Airbus supply chains in general, rather than from a regional point of view.

Reflecting the integration of its corporate units of 2001, Airbus increasingly centralises its procurement internationally, and aggregates its worldwide supply chains. Airbus hopes to create leverage and volume discounts by sourcing centrally, and to thus substantially reduce its supply costs. Airbus seeks is to minimise the complexity of its supply chains as far as possible, also to lessen the burden of supply chain management currently placed on the firm. The idea is to have contact only with a small number of Tier 1 suppliers, which are able to develop and manufacture larger aircraft components for Airbus, and subcontract work out to lower-tier suppliers. Airbus has had to be very aggressive on product development over the last five years to gain market share from Boeing, and introduced a significant amount of new products. Yet, some of the Airbus market assumptions regarding the A380, in particular, turned out to be overly optimistic. Moreover, the in comparison to the € weak US $ created problems for the company, as its aircraft sales were paid for in $, while much of the

production costs were invoiced in €. Thus, Airbus SAS had to save € billions, with a large part of the savings concerning supplies. The total supply costs had to be cut by 10 % annually in recent years; with € 85 million having to be saved by Airbus UK year by year alone. So, Airbus put extra pressure on its suppliers, threatening to source elsewhere if the demanded low prices could not be guaranteed.

Also, Airbus started to pursue an existing strategy to recruit more risk-sharing suppliers more consequently, when the costs for developing the A380 on its own became prohibitive. Airbus usually asks only Tier 1 suppliers to cooperate as a risk-sharing partner, as only these have the required R&D capacities and production size. Risk-sharing suppliers develop and produce more complex aircraft components at greater own risk, but enjoy the chance of higher profits and capturing a part of the Airbus market share. Especially for the development of the very procurement-led A380, Airbus enrolled several risk-sharing partners. While the plane could only be developed and brought to the market in this way, the downside for Airbus is that it loses market share to its suppliers. However, the Airbus supply chains do not run as smoothly as the company wishes. This is because the drive for centralisation conflicts with the existence of many separate production sites and Centres of Excellence. So, traditionally local souring requirements continue to play a role next to central procurement, and many local and central access points for suppliers exist in parallel. This mixture hampers efforts of efficient procurement planning. Also, in the opinion of the interviewee, Airbus does not assign sufficient resources to its procurement units to allow them to work efficient. In general, decision making in Airbus seems to be poorly organised and difficult. The company would like to see itself more as an architect or integrator of aircraft, placed at the top of the supply chain and without much interest in making detailed components. In reality, however, Airbus does not achieve this aim, and continues to produce a great number of parts itself.

The interviewee feels that Airbus is ‘arrogant about its position in the supply chain,’ and does not strongly enough take the situations of its suppliers into account. Firms such as RD Precision pay a price for this, in that they are largely restricted to delivering those supplies on a last-minute base that central procurement has failed to purchase in time, without receiving much of the regular work they needed to plan ahead and keep all of their workforce permanently. As a result, the likes of RD tend to reside ‘more in the back of order territory,’ and to rank as tactical suppliers rather than long-term Airbus partners. The interviewee recommends suppliers to think ahead and invest in technologies, related for example to composites, that will be in growing and long-term demand. ‘GKN’ represents an example of a supplier who recognised chances early on and undertook the required investments in composites, and benefits from this now in receiving much Airbus work. Firms such as Metal Improvement Company that specialise on producing components that will soon be replaced by composites, however, are bound to eventually run out of business. European supplies face a strong threat from the Far East at any rate, since Airbus increasingly ‘develops trade’ with this region experiencing the largest growth in aircraft demand worldwide. By sourcing from suppliers in the Far East, Airbus expects to gain the support of the relevant governments, where preferences regarding plane purchases are concerned. Given its global focus, the central Airbus procurement has no particular interest in sourcing from Wales. A problem of the UK and Wales that the interviewee repeatedly mentions is a lack of skilled personnel. Airbus struggles to find good aerospace engineers and supply chain managers, for instance, and has observed such problems in

some of its supplier firms as well. If the situation does not improve, some knowledge-intense aerospace work is bound to migrate overseas.

2.1.2. Contour Premium Aircraft Seating

'Contour Premium Aircraft Seating Ltd.' is based in Cwmbran in South Wales. The company looks back at 60 years of history, during which it has experienced a number of changes in terms of ownership and site locations. Important is the relocation in 2001 from Camberley in England to Cwmbran, which was helped by a grant incentive by the WDA. Today Contour is one out of four firms forming the 'Britax Premium Aircraft Interior Group' (Britax PAIG). The headquarters of Britax PAIG are situated in Cwmbran as well; and next to the UK the firm operates manufacturing plants in the USA and Germany. Britax PAIG itself is part of the larger and British-owned 'Britax International' group, which produces also non-aerospace goods. As the name suggests, Contour Premium Aircraft Seating specialises in the manufacture of first class, business, and premium economy seating.

The Cwmbran site is designed to achieve an annual turnover of £ 100 million. Contour operates at the top end of the market and does not supply the economy end at all. The strategy is to be first to the market with new types of products, such as the recently launched 'flying beds.' While 'British Airways' and 'Virgin' are the main customers, Contour also produces for a wide range of other airlines, including 'Air France' and 'Cathay Pacific.' So, rather than being a part of aircraft supply chains to Original Equipment Manufacturers such as 'Airbus' or 'Boeing,' Contour produces for the end users of aircraft directly. Contour also undertakes seating refurbishments for whole planes, and is thus involved in MRO next to production.

Contour has its own machine shop for making structural parts such as the main frames, pads and headrests of seats. The firm buys all non-structural parts, such as cocktail tables and in-flight entertainment equipment, from its numerous suppliers, or receives them without charge for assembly from the customer airlines. Some components are delivered by different branches of Britax PAIG. In spite of its own machining, Contour is essentially an assembly site; well equipped and largely self-contained where assemblies are concerned. Most design and R&D is done at another branch of Britax PAIG, and by staff more highly educated and trained than the largely semi-skilled workforce of Contour. Contour relies on a worldwide network of 180 suppliers, but seeks to reduce the number to 100. The strategy is to source from a group of 25 'premium suppliers' wherever possible, which increasingly take over more demanding system integration tasks. The USA stand out as the region where most supplies originate from, and deliver about a quarter of all supplies. France is also an important supply country. Deliveries from low-cost countries such as South Africa and Poland are becoming increasingly important, with firms supplying components at highly competitive prices and often to fully satisfactory standards.

Contour has supply links with firms located just across the English border, in Bristol and Gloucester, for instance, and in the Camberley area, where Contour had moved from. Contour only uses a few Welsh suppliers, and does not have a policy to develop

an indigenous supplier base. The firm uses 'United Aerospace' in Pembroke as a composite supplier, 'Excel Assemblies' in Port Talbot as a harness supplier, and the firm 'Gwent Cables' of Cwmbran that only supplies very small quantities. Contour experienced problems with Welsh suppliers in the past and found that potential new suppliers mostly lack the equipment and skills required. While Contour sees a potential for low-volume and high-standard supply production in Wales, potential suppliers are often not willing or able to afford the necessary investments. Contour received a visit from the WDA aiming at the development of a Welsh supplier base. Yet, given the problems with Welsh suppliers and the fact that Contour wants to shrink its supplier base anyway, the company seems unwilling to buy into the vision of the WDA.

2.1.3. Cottam & Brookes Engineering

'Cottam & Brookes Engineering' is a single site and privately owned small company based in Caerphilly in South Wales. The firm provides precision machined components, fabrications and tooling to the aerospace industry. Cottam & Brookes was established in 1989 and initially supplied the automotive industry. Due to the downturn in the motor sector the company later turned into an aerospace supplier, and moved to its current site in 2001. Turnover rose to £ 750.000 in 2003 and the firm employs a 'fairly large workforce.'

Cottam & Brookes' main business is to supply tooling for all aspects of Maintenance, Repair and Overhaul work on aero engines including strip tooling, engine handling, balancing fixtures and test equipment. The company provides the tooling that the MRO industry requires to maintain, repair and overhaul aircraft on the ground. Amongst the jet engine producers Cottam & Brookes sells tooling for are 'GE Transportation Aircraft Engines,' 'Rolls Royce,' and 'Pratt & Whitney.' Most of the sales are domestic and indeed regional, with the local company 'GE Engine Aircraft Engine Services Ltd.' (GEAES) and the Blackwood-based 'Nordam Europe Ltd.,' partly owned by GEAES, accounting for 70 % of the Cottam & Brookes business. Cottam & Brookes traditionally only sold its products in South Wales. Yet, in recent years clients have been gained in the USA, Canada, Scandinavia, the Middle East, France, Belgium, Portugal, and China.

Cottam & Brookes has a clear focus on quality and trains its workforce to a high level of competencies to achieve high standards of production. The company believes it is the quality of its products that ultimately allows Cottam & Brookes to beat its competitors that are often able to sell at a cheaper price. Cottam & Brookes regards the skills of its workforce as a core asset that is to be continuously developed, and is very reluctant to lay off staff even at times of crisis, such as in the aftermath of the events of 11 September 2001. The company has long been approved by GEAES, Nordam, and several other larger firms as a quality supplier; and has introduced a quality management system in recent years. Cottam & Brookes have also invested approximately £ 300.000 in new machinery over the last five years and try and introduce LEAN manufacturing. The management structure is flat and knowledge is easily shared in the small company by word of mouth with news travelling fast from management to

shop floor. Cottam & Brookes also has a networked computer platform with a structured system for orders, specifications and drawing that is available to all staff.

Interesting is the relationship between Cottam & Brookes, GEAES, and Nordam. Though Cottam & Brookes is supposed to supply tooling according to the specifications provided by its customers, in practice it often shows that modifications to the original design are needed to make it work. Then joint work between the three parties is required, during which product specification and design are improved. According to the interviewee, such collaboration is clearly made easier by the close proximity of the operations, and the long-standing and close working relationships developed.

Cottam & Brookes experienced problems where own suppliers in Wales are concerned, mainly related to the old machinery of firms that is unable to meet demanding aerospace standards. As a consequence, Cottam & Brookes has turned to manufacturing over 95 % of its products in-house. The company has used the export-support services of 'Welsh Trade International' to market its products overseas and is very happy with the help received. After entering the export markets also thanks to WTI financial support, Cottam & Brookes had substantial business success. While the firm also received help from the WDA, it benefited less from this. Moreover, Cottam & Brookes found that the WDA representatives it dealt with had little knowledge of the aerospace industry. The involvement in the networking activities of the 'Wales Aerospace Forum,' however, proved to be useful.

2.1.4. Cytec Engineered Materials

'Cytec Engineered Materials' (CEM) at Wrexham in North Wales is a branch of a US group of companies trading under the same name, with a range of operations in the USA, Canada, Europe and Japan. CEM is one of the world's largest suppliers of composite and adhesive materials to the aircraft market. The group is represented with a plant in England apart from the Wrexham operation in the UK, and forms a division of the major US 'Cytec Industries Inc.,' trading in chemicals next to materials technology. The CEM branch in Wrexham is mainly a raw materials supplier of carbon and glass reinforced plastic materials for aerospace. Yet, it also sells materials to producers of Formula One racing cars. The Wrexham site was established in 1982 by a firm later taken over by CEM, when operations formerly based in England were moved to Wales.

CEM Wrexham is currently experiencing a boom with some 40 % growth in 2004, and an expected 20 to 30 % in 2005. The business with the nearby 'Airbus' Broughton plant accounts for much of the growth. Employment has risen from 125 employees in 2003 to 160 in early 2005. Some 30 % of the CEM Wrexham business in Europe was done with Airbus in 2004, a figure expected to rise to 40 % in late 2005, so that Airbus is set to account for 35 % of the total turnover. With absorbing 20 % of the CEM Wrexham European sales, 'Bombardier' in Northern Ireland is another major customer. 'BAE Systems,' 'Boeing,' and 'Ferrari' provide examples for other clients. CEM Wrexham sells its products also outside of Europe, in the USA and

Australia, for example. After completion of an ongoing company purchase by CEM, turnover at Wrexham is expected to rise to US $150 million a year.

The Airbus A380 has been a major driver for CEM Wrexham's growth, since a section of the plane is made from a material called 'GLARE.' This is a hybrid between composite materials and aluminium, which offers significant advantages, such as lower weight. CEM developed GLARE and represents the only supplier; and Wrexham got involved in production and contributed substantially to forging the Airbus deal. Important to these developments were the availability of required manufacturing skills at CEM Wrexham, the good existing relationship between the firm and Airbus arising from previous cooperation, and the transport-related advantages of geographical proximity. As a result, CEM has taken over a significant share of their main competitor's Airbus business, and supplies a large proportion of the carbon fibre materials on the A380 today.

While CEM Wrexham is essentially a production plant, also some R&D mainly related to improving GLARE is carried out. Investment in recent years went towards raising the skill levels of the workforce, and upgrading the manufacturing facilities of the site. A process innovation called 'Priform' has been introduced, for instance, and used for producing materials for the Airbus aircraft A330 and A340. CEM Wrexham is planning a major expansion taking place in a couple of years, to establish a technology centre in an adjoining unit. The management structure used to be very hierarchical, but was changed with the arrival of a new Managing Director a few years ago, and is now relatively flat. The Director regards good internal communication as very important and has introduced various new schemes fostering knowledge exchange. There is an employee forum, for example, where day-to-day issues such as problems and concerns can be discussed, and there are regular lunchtime meetings, where information about the corporate situation and policies is exchanged between all levels of staff. Major investments in IT have been made over the past five years. All communication systems regarding routine business activities are now globally networked between all CEM operations. As a result, the Wrexham plant can access the production plans and order books of all CEM plants worldwide, and vice versa.

Airbus is likely to become a still more important customer in the future. Airbus depends on the deliveries of CEM to some degree, since CEM represents one out of worldwide only two qualified suppliers of certain composite materials. Airbus also accepts some quality assurance procedures of CEM Wrexham as their own. While Airbus usually sets the targets and specifications CEM has to produce towards, the companies also engage in some limited joint R&D, concerning Priform, for instance. European subsidiaries of the Japanese companies 'Toray' and 'Toho,' together with the multinationals 'Dow' and 'Shell,' are the main suppliers of carbon fibre, the main materials input CEM requires.

The Wrexham plant has one Welsh supplier weaving fibres, and subcontracts some engineering work to local firms. Since there are no suppliers producing carbon fibre in the UK, procurement is necessarily international. CEM Wrexham has started establishing links with 'Bangor University,' but finds that the university currently offers no technologies of interest. CEM Wrexham has also connections with the 'Queen Mary College' in London, as well as with the universities of Cranfield and York. So, while

the Airbus business adds a strong regional touch to the activities of CEM Wrexham, the main connections operate on the national, European and global level.

2.1.5. Doncasters Blaenavon

The 'Doncasters Blaenavon Ltd,' based in Pontypool in South Wales, belongs to the 'Doncasters Group,' a medium-size international engineering company that operates from 25 sites across the UK, continental Europe and North America. Doncasters Blaenavon manufactures forged rings, casings, blades and discs for the aerospace, industrial gas turbine and specialized engineering industries. The firm also offers machining and project management services for 'engine ready' parts further up the value chain. Doncasters looks back at 35 year experience in the manufacture of critical components to high standards. Main customers are the companies 'Rolls Royce,' 'ABB' and 'Solar,' the latter based in the USA.

Recent years saw Doncasters' relocation from Leeds in England to Pontypool, helped by incentives provided by the Welsh Assembly Government. According to Doncasters' CEO, a major reason for the move was "the availability of a locally trained and skilled workforce," next to the 'technical and operations capabilities' of the existing production site taken over from another firm. Doncasters places great emphasis on innovation and has invested substantially in the upgrading of its production facilities since its arrival in Pontypool, thereby aided by the Assembly again. Since 2004 both have jointly invested some £ 6.5 million in upgrading production facilities to expand the capacity and be able to supply customers with more sophisticated products.

In late 2005 Doncasters announced to invest at least another £ 3.5 million towards improving production machinery, helped by another Assembly grant covering close to £ 1 million of the £ 3.5 million total investment. The investment is expected to create 100 additional jobs and to strengthen the Welsh aerospace sector as a whole. Another effect is that the Pontypool site is now able to manufacture components higher up the value chain, and thus receives parts to finish for 'engine-use' from other plants of the Doncasters Group.

2.1.6. Ellison Sensors International

'Ellison Sensors International' is a small and privately owned company located in Wrexham in North Wales. The company history goes back to the firm foundation in England by the then and current owner Mr. Ellison in 1985, who decided to relocate to Wales in the context of enhancing his business activities. Next to the firm today known as Ellison Sensors International, Mr. Ellison founded two other and smaller companies, which jointly with Ellison Sensors International make up the group 'ESI Technology.'

The group employs 25 people in North Wales and has a turnover of about £ 1.5 million. Ellison designs and manufactures pressure sensors, transducers and transmitters, differential pressure transducers, strain gauges, and panel meters. The firm also offers strain gauge on-site bonding services for aircraft manufacturers such as Airbus. Ellison tries to differentiate itself from competitors by offering especially accurate and reliable products. To achieve this the skill levels of staff had to be improved, whereby the local NEWI institute, but also Southampton University, provided the necessary aerospace training and higher education.

Ellison regards innovation as crucial to its business success and has introduced a range of new products, such as a 'silicon on sapphire' sensor, over the years. Investment has been substantial, and mainly concerned manufacturing equipment on the shop floor. The management holds regular meetings and exchanges information via intranet, which is also accessible to lower-level staff.

Major domestic and European customers include Airbus Industries, EADS, BAE Systems and Shorts Bombardier; while Boeing and the US Armed Forces represent examples for important customers further afield. Airbus at nearby Broughton has been a key customer for the last couple of years, with Ellison frequently sending in substantial teams fitting strain gauges required for development and testing to the A380 wings. Both the skills of the Ellison workforce and the geographical proximity to Airbus played an important role for the success of the joint work.

However, Ellison also has regular visits from US customers undertaking quality audits, while Mr. Ellison and his staff often travel overseas in turn for marketing purposes. Welsh Trade International has helped Ellison by financing some of the travel.

2.1.7. Gardner Aerospace Wales Ltd

'Gardner Aerospace Wales Ltd', located in Maesteg in South Wales, is an aerospace division of the UK-owned 'Gardner Group Ltd.' The Maesteg site was set up in 1969 by the then 'Gardner Group Plc.,' but came under the ownership of the newly established Gardner Group Ltd. in 2003. Gardner Aerospace Wales manufactures components for the aerospace industry and employs some 90 people at its Maesteg base, and achieved a turnover of £ 4.5 million in 2004.

Gardner recently won long-term contracts with 'BAE Systems' to manufacture Boeing 767 and 777 aircraft wings. Gardners is a second tier supplier to 'Boeing:' while Gardners' main customer is Boeing's first tier supplier BAE Systems, Boeing is the final customer. Important in terms of the exchange of knowledge is the cooperation between Gardner and Boeing. Boeing's design authority supports Gardner in achieving design changes and improvements on fixed leading edge work for 767 and 777 planes. Gardner is also a second tier supplier to a big US first tier supplier to Boeing.

Recent investment by Gardner has mainly concerned the upgrading of its production machinery, since this was required to allow competitive manufacture of the 767 and 777 wings. The Welsh Assembly Government supported Gardner in the upgrading of

the machinery with a Regional Selective Assistance grant worth about £ 0.5 million. Next to machinery, Gardner has also invested in knowledge-intensive innovations such as a 'Total Manufacturing Service' that helps customers to meet supply needs more efficiently. The different aerospace division of Gardner Group are keen to share information and are developing common standards and systems for issues such as performance measurement, aided by the extensive introduction and use of IT.

Gardner is looking to outsource some of its activities while seeking to limit the number of suppliers. The company is also establishing supply chains in low cost countries. Overall, however, Gardner has very few suppliers, since the firm prefers to rely on in-house resources that are seen more suitable to match the requirements of Gardner's very specialised business field.

Gardner only sources one key product from a Welsh company called 'Timet UK.' This is because usually there are no Boeing approved suppliers for the products Gardner requires. Gardner also uses 'RMD' in West Wales who has no Boeing approval, but supplies some tooling requirements under Gardner's own approval. While Gardner see advantages of sourcing in Wales, such as shorter lead times, most potential suppliers lack the approvals required to qualify them as suppliers. Another problem is that the major aerospace firms are shrinking their supply base. Hence, Gardner has no policy to develop supply chains in Wales.

2.1.8. GE Aircraft Engine Services

'GE Engine Aircraft Engine Services Ltd.' (GEAES), based in Caerphilly in South Wales, is a branch of 'GE Transportation Aircraft Engines' (GEAE), the world's leading producer of aircraft engines. The US-American GEAE ranks amongst the world's 'top ten' aerospace companies, and is itself a part of the multinational 'General Electric Corporation,' operating in a range of business fields. GEAES services, repairs and overhauls a wide range of jet engines produced by GEAE, 'Rolls Royce' and other manufacturers including 'Pratt & Whitney.'

The site in Caerphilly was bought by GEAE from 'British Aerospace' in 1992, and was used for servicing all of the jet engines of the 'British Airways' (BA) fleet then. While the work commissioned by BA has declined since, the plant's overall client base has been widened to about 80 firms. GEAES today operates on a one million square foot site, and is one of the largest aircraft engine MRO centres in the world.

After the crash of a Concorde in Paris in July 2000 and events of 11 September 2001, GEAES lost much of its previous work, and had to reduce its workforce from 1800 to 800. In November 2004, however, GEAES secured a major 10-year contract with 'Ryanair' for servicing the airlines' several hundred strong Boeing 737 fleet. At the same time, GEAES was selected as the worldwide first service facility for the GP7200 engines, powering many of the Airbus A380 to be build, and jointly produced by GEAE and Pratt & Whitney. To secure the latter contract worth several £ million against tough international competition, GEAES received a Regional Selective Assistance grant from the Welsh Assembly Government. When announcing the contract,

however, the GEAES CEO also stressed the significance of the 'experience and skills' of the resident aerospace workforce for securing the work.

GEAES has undertaken major process innovations in recent years, which removed divisions between MRO teams previously only in charge for one engine type each, and got all staff involved in servicing any incoming engine. This required a comprehensive retraining of the workforce amongst other things, and an overall upgrading of staff skills. Much of the retraining has been done in-house. Product and process innovations related to quality improvement and LEAN manufacturing have also taken place, the introduction of which was helped by GEAES 'very flat' management style. There is a steady flow of information between different company departments and levels of staff, relying on Intranet, Internet and Email amongst other things.

GEAES sources most of its material supplies from the companies producing the engines that are being serviced, including its parent company GEAE, as well as Rolls Royce and Pratt & Whitney. However, GEAES receives supplies also from a much wider range of around 900 firms around the globe, based, for instance, in the USA and Singapore. GEAES also subcontracts specific MRO work to the approved suppliers to the firms producing the engines GEAES services. While GEAES has several major suppliers in the UK, only one is based in Wales. This is the 'Nordam Europe Ltd.,' partly owned by GEAES and partly by the 'Nordam Group,' which undertakes MRO work on nacelles and thrust reversers for GEAES.

There are a few more and smaller supplier in Wales, most notably the local firm 'Cottam & Brookes Engineering' that provides tooling both for Nordam and GEAES, and collaborates in product specification and design with the two. Although Cottam & Brookes and other small suppliers enjoy certain advantages related to geographical proximity, however, the overall amount of GEAES' regional procurement remains small. Building strong relationships with any supplier, wherever located, is very important to GEAES; and a high level of personal interaction and trust is regarded key to maintaining these relationships.

In Wales, GEAES has received grant support from the Assembly and the WDA in several cases aside the A380 MRO deal. The grants did not encourage the development of an indigenous supplier base, however, and GEAES has put no policies in place to this effect. The company runs its own apprenticeship programme and works together with local colleges in this respect. Overall, however, GEAES perceives and regrets a lack of networking in the Welsh aerospace sector, but welcomes the establishment of the Aerospace Wales Forum as a positive step towards overcoming the current and insufficient exchange of knowledge between different players.

2.1.9. Magellan Aerospace UK

'Magellan Aerospace UK Limited' is a part of the medium-size Canadian 'Magellan Aerospace Corporation,' which also runs operations in the USA. Magellan UK has plants at three English locations, as well as in Wrexham in North Wales. While the Wrexham activities are run by three separate Magellan branches, due to their com-

plementarity this report treats them jointly as Magellan UK in North Wales. The firms offer services in precision engineering and metal treatment, and supply precision components to the aerospace and high tech industries. 'Airbus' absorbs 60 % of their UK output; other major customers include 'Bombardier,' and 'Aero Structures Corporation' in the USA. Magellan UK bought its Wrexham sites in 2000 and employs about 400 staff there today. The turnover forecast for 2005 amounts to £ 22 million.

Magellan was able to get into business with Airbus due to its ability to invest in the development of the A380 and to share some of the risk. Magellan has mostly had a good relationship with Airbus, and enjoyed reasonably good contracts as well as continuity of work. Still, there were also problems according to the interviewee: While "the benefit of being close to your biggest customer is that you can get work on the basis of the close proximity; the downside is that when he's recruiting he's got no qualms about pinching your labour and it's causing us problems." Also, the interviewee felt disappointed about the unwillingness of Airbus to share financial aid that had been granted by the government also due to the lobbying of suppliers, and after Airbus had asked for the suppliers' support with reference to expected joint benefits.

Magellan has invested several £ million in its production facilities in recent years, and was aided by the WDA with a grant of approximately £ 34,000. While the grant was conditional on creating 30 jobs within three years, Magellan created 60 in the first year. The firm talks to Regional Development Agencies such as the WDA, but has not found much benefit in such contacts. This is because Magellan typically knows its customers better than the Agencies that try and connect different parties. The interviewee does acknowledge, however, that the networking assistance of the Agencies might be of value to less established firms. Magellan has used governmental export services in the past, and participated, for instance, in funded outward missions. With the Wrexham sites now being part of an international corporation, however, the need for export support is disappearing.

Magellan rates itself as a Tier 1.5 supplier; and sources from suppliers in England and Wales. The small Welsh firms, however, mainly supply low-tech machining and consumables, but nothing of great sophistication or commercial value. While Magellan uses colleges and universities for supervisory training, and offers work experience for the local schools, it does not have any product development or R&D links with academic institutions. Internally, knowledge is exchanged in regular management meetings, and IT plays an important role.

2.1.10. Metal Improvement Company

The 'Metal Improvement Company' (MIC) in Broughton in North Wales is a branch of a US group of companies trading under the same name. Although MIC at Broughton is formally referred to as the MIC 'Chester Division' and thus associated with England rather than Wales, the actual location of the site is in Wales. The MIC group provides metal treatment services for critical components operating in aerospace, automotive, and other applications. It runs over 50 facilities in North America and Europe; and apart from the Broughton plant owns several other sites outside of

Wales in the UK. The group itself is a subsidiary of the 'Curtiss-Wright Corporation' based in the USA, a major player in aircraft component supplies.

The MIC Chester Division was established in the early 1980s mainly to provide metal treatment for 'Airbus' aircraft wings, initially operating on a site in Deeside in NW, which was expanded in 1990. During the following decade, however, the volume of treatment work for the wings of various Airbus plane types dramatically grew, outgrowing the capacity even of the expanded Deeside plant. The wing size of the ever larger aircraft constantly increased, moreover, which made it indispensable to move closer to Airbus and the Hawarden Airport that Airbus uses for shipping aircraft parts. Thus, in 1999 MIC relocated to its current, much larger and newly built site in Broughton, close to Airbus and airfield. MIC Broughton has increased its workforce recently and employs over 100 staff today; and achieves an annual turnover of about £ 10 million. The main service MIC provides is shot peening largely for the aerospace industry, but also for automobile and other producers. Close to 90 % of all MIC work is now done for Airbus.

Shot peening is a process that enhances the performance and extends the life of critical components, such as aircraft wing skins, spars, ribs, and stringers. The process involves throwing steel ball bearings at the surface of the treated parts; and helps preventing premature metal fatigue and corrosion failures, thus improving reliability and saving weight. MIC receives components that are part completed from its customers, treats them against metal fatigue, and sends them out again to the firms they came from. MIC has not altered its shot peening technology substantially in recent years, since the treatment process has remained essentially the same across the industry.

However, MIC has massively upgraded and expanded its peening capacity. Between 1982 and 1999 the firm treated some 10,000 Airbus panels and other wing parts for the medium size A319, A320 and A321 aircraft, but also the large A310, A330 and A340 planes. From 2000 to 2004 the firm shot peened the much larger number of 12,000 parts mainly for the more modern of the above aircraft, but with the total also including some exceptionally large components for the A380 treated from 2003. While the events of 11 September 2001 triggered a temporary drop in demand for the MIC services, today the company looks optimistically in the future and expects further substantial increases in the Airbus business.

The MIC management structure is described as lean and very hands-on. Whereas the peening process machinery does not heavily rely on computer technology, MIC runs a networked IT system for administrative purposes. Knowledge is mainly exchanged by word of mouth in the company, with the management frequently chatting with production staff. The management also regularly meets with Airbus to discuss and coordinate the business relationship, but the meetings typically conclude that everything runs smoothly and that there is no need for change. Trust is quite important in the long-standing relationship, since the flow of parts is somewhat erratic and out of immediate Airbus control, but with Airbus trusting due to previous experience that wing components are treated to full satisfaction.

MIC also participates in supplier fora that Airbus occasionally holds and meets other, including regional, aerospace suppliers there. MIC sources the shot peening balls it mainly requires overseas rather than in the UK, but buys consumables and some

smaller items such as masking tape locally. While the local connection with Airbus is central to the business activities, the interviewee stresses that most of the standards that regulate the globally operating aerospace industry and MIC are of an international nature. The main sources of knowledge MIC draws on in shot peening process technology and quality assurance reside at the global level, and are shared between all divisions of the MIC group.

2.1.11. Nordam Europe

'Nordam Europe Ltd.,' located in Blackwood in South Wales, is a major force in the aerospace industry in Wales. It is specialist aircraft overhaul and repair centre that services commercial airline bonded airframe and flight control surfaces, thrust reversers, nacelles and engine components. The company is a joint venture between the internationally operating 'Nordam Group,' whose headquarter is located in Tulsa in the USA, and the 'GE Aircraft Engine Services Ltd,' a world leader in engine repairs, based in Caerphilly in South Wales. Nordam Europe was persuaded by the Welsh government to locate in Wales in 1995; and assistance from the WDA played a decisive role in attracting the £ 11 million investment. In 2003 the firm received a £ 3.3 million RSA grant for expansion of the operation, and today employs 400 staff.

A major innovation for Nordam Europe was to recently gain the prestigious Joint Airworthiness Regulations (JAR) 21 accreditation as the first independent MRO business in Europe. This allows the company to design and approve repair schemes, and represents a huge marketing advantage that offers significant cost savings to airlines. Nordam Europe services a global market for MRO services. In Wales, GE Aircraft Engine Services that partly owns Nordam is an important customer, for which Nordam repairs nacelles and thrust reversers. Nordam relies on the tooling products of the Caerphilly firm 'Cottam & Brookes Engineering,' where its own regional supplies are concerned. Nordam, GEAES, and Cottam & Brookes even occasionally collaborate in the product specification and design of tooling.

Overall, however, Nordam lacks a Welsh supplier base. Nordam Europe would like to use more Welsh suppliers, to strengthen its position within the Nordam Group by pointing to its strong and locally embedded supplier base. As the interviewee points out, however, potential Welsh suppliers are mostly unable to offer the fast turnaround times that many of the Nordam contracts demand, and also struggle to compete with companies in other parts of the UK and abroad in other respects such as price. While many Welsh firms have the potential to become suppliers, they seem to often fail to grasp existing opportunities, with many citing a lack of machinery and of accreditation as reasons for not getting involved in the aerospace sector. As the interviewee suggests, however, investments in machinery should pay off and product approval is covered by Nordam Europe's accreditation. Thus, often it appears to be a lack of entrepreneurial spirit, a failure to perceive existing market opportunities, and a lack of knowledge of the aerospace sector and its supply requirements, which mainly explains the continuous absence of a Welsh aerospace supply industry.

2.1.12. Prematec

At the time of the interview informing this report, 'Prematec Corporation Limited' operated as an independent contract machining company mainly to the aerospace industry. In March 2005, however, Prematec joined forces with two other aerospace firms and today forms a part of the 'CAV Aerospace Limited.' All three firms as well as CAV are owned by the Japanese machine tool manufacturer 'Shin Nippon Koki & Co. Limited.' The Prematec site in Llantrisant in South Wales was bought from a company called 'NC Industries' in 1997, and employed 75 staff prior to the merger.

Today the main business continues to be the manufacture of large airframe components, such as aluminium wing spars and wing ribs for 'Airbus' and 'Boeing.' The range of aircraft Prematec supplies parts for includes the Airbus A320, A330 and A340, as well as the Boeing 777 and C17. Starting from occasional deliveries about four years ago, Airbus has turned into Prematec's most important customer today, entering into long-term strategic contracts, and boosting order books from £ 0.5 to some £ 18 million.

Prematec had started as a commercial machine shop back in 1997, but, following a strategic decision to switch to aerospace manufacture, gradually changed into an aerospace machine shop. The reorientation has involved investments of £ 7 to £ 8 million in new machine tools. Prematec has a state of the art and comprehensive machine shop today, and describes itself as 'a centre of excellence for advanced manufacturing' in Wales. The firm has received grant funding from the Welsh Assembly Government and the WDA to assist in equipment purchases. Backed by Regional Selective Assistance granted by the Assembly, Prematec is currently increasing its capacity to manufacture aerospace components with an investment worth over £ 5 million.

Prematec's relationship with Airbus and Boeing is hierarchical, with the product specification set by the customer and Prematec building to print without any design authority. The customer also typically specifies a small selection of approved suppliers that Prematec has to exclusively use. The fact that Airbus and Boeing seek to reduce their supplier base and are thus reluctant to approve additional suppliers, is regarded as a major obstacles to building up a Welsh supply industry by the interviewee. Since Prematec has to use approved suppliers and not many of these exist in Wales, most supplies are purchased elsewhere, and mainly in England, America and Switzerland. Prematec has several small suppliers of minor equipment in Wales, but has not developed network relationships with them.

Internally, however, knowledge is exchanged effectively within an extremely flat management structure, and also passed on to lower-ranking staff. Prematec holds production meetings for all the production staff and supervisors three times a week, for example, and regular business reviews, where the management tells the workforce what is happening in the company. All common IT facilities, such as Internet and E-mail, are used to process information. Prematec has received training assistance from ELWa, and maintains links with HE institutions such as Glamorgan University through student work placements.

2.1.13. RD Precision

'RD Precision Limited' was founded in 1987 and is a single site private company owned by two British individuals. The firm specialises in manufacturing smaller precision-engineered components and spares for the aerospace industry. Since 1993 it occupies modern and purpose-built factory units situated in Queensferry in North Wales, located near the Broughton Airbus plant. RD Precision had previously operated at other and smaller production sites, but moved to Queensferry to accommodate its growing production facilities and to get closer to its primary customer. This was 'British Aerospace Airbus Chester,' the predecessor of 'Airbus UK,' which remains the main client today. In 1999 RD Precision bought another and similar engineering company and merged the two businesses.

Starting from a small speed shop mainly producing concessionary bushes for British Aerospace (BA) and other aircraft firms, RD has established itself as a supplier of smaller precision-engineered parts, gained steady contractual work from BA and other customers, and grew substantially as a result. Apart from the regular production facilities for the contractually guaranteed work, RD Precision runs its speed shop still today. While the terror attacks of 11 September 2001 affected the firm badly for some time and forced it to make redundancies, as much of the rest of the aerospace industry RD currently experiences a boom. Turnover for the year ended 2004 stood at £ 5.1 million and was forecasted to rise to £ 7.2 million in 2005. The growth is closely related to the Airbus business and the A380 aircraft in particular.

As early as 1989 RD Precision became an approved supplier to BA, and has expanded its role as a supplier since. Today RD produces for Airbus mainly as a Tier 1 supplier, and delivers, for instance, parts for the A380 wings for a large number of aeroplanes. Moreover, RD Precision acts as a Tier 2 supplier to around six Tier 1 firms on a smaller scale. RD sells components to the corporate jet manufacturer 'Fokker' in the Netherlands, for example, which integrates the parts into larger pieces of kit and sells the whole to Airbus for use on the A380. Firms such as Fokker and 'BAE Systems' take on a lot of the assembly work as Tier 1 suppliers for projects such as the A380 today, and then sub-contract for items that they do not have the capability to produce themselves. This is where companies like RD are able to get into large-scale projects as Tier 2 suppliers. Around 75 % of the RD sales go directly to Airbus production across a range of aircraft models. BAE Systems and Fokker represent other major customers of RD Precision, and some of their purchases go to Airbus as well.

In the light of the current growth of RD and the increasing importance that supply chains play in the strategies of Airbus and other clients, RD works closely together with its customers to increase its size. To cater for an expected growth of supply demands, RD aims to reach a turnover of between £ 10 and £ 14 million in coming years. Airbus and the other key RD customers are keen to see the company achieve its goal, and support the RD growth by offering more steady contractual work. RD Precision has received much support of this kind in the past, and reports that long-standing relationships and trust are of prime importance in the aerospace industry.

Most of the investments during the company history have gone towards the expansion and upgrading of the production facilities. RD seeks to introduce LEAN manufacturing in the future, thereby advised by experts of the 'University of Liverpool.' The firm

has already completed a range of knowledge management and IT innovations, such as the introduction of a 'Manufacturing Planning and Control System,' helping to better organise production. The management structure is very flat, and knowledge is easily shared in the close-knit company environment with an open-plan office. RD is connecting to a new Airbus electronic orders system, which allows Airbus to access the production schedules of suppliers, to address any problems threatening the continuity of supplies.

The key supply demands of RD Precision concern raw materials, for which the firm does not have any suppliers in Wales. The scope for choosing suppliers is limited, since Airbus and other key customers only allow RD to source from an often small range of approved lower-tier suppliers. The interviewee regards the requirement to have approvals from Original Equipment Manufacturers as a major barrier to entry into the supply sector. Whereas many Welsh companies have the capability required to supply aerospace parts, he believes, they are barred from trading since they cannot get an approval from Airbus or other large companies. While approvals are provided for free by Airbus and similar firms in principle, the large companies seek to reduce the complexity of their supply chains. Since the strategy is to strengthen key suppliers, but simultaneously reduce the number of granted approvals, potential suppliers find it increasingly hard to become accepted. Also, the management of the in-house quality assurance systems approved supplies must have is very expensive, and indeed prohibitive for some SMEs.

RD Precision has received help from the WDA in various ways, and obtained, for instance, loans at preferential rates for purchasing equipment. 'Wales Trade International' supported RD as well, mainly by part-financing some trade missions. However, RD does currently do little on the export side, since most sales are domestic, and the firm lacks spare capacity to serve additional international markets.

2.1.14. Thales Optics

'Thales Optics Ltd' is part of 'Thales UK,' which in turn belongs to the French-owned and internationally operating 'Thales Group,' one of the world's ten leading aerospace companies. Thales Optics is based in St Asaph in North Wales, near to Airbus at Broughton. The site owned by Thales Optics today had previously been run by 'Pilkington Electronics,' until it was taken over by Thales in 2000. Thales Optics specialises in the design, development and manufacture of modules and components for the military, aerospace, civil and industrial markets. The company is split into three subdivisions, including 'Thales Avionics,' and employs over 450 people in total.

Since a new and customer-focused managing director took over in 2002, Thales succeeded to break into new product areas and further satisfy existing customers. Internally, Thales is undertaking substantial work to introduce LEAN manufacturing and design. In particular, the firm is introducing process innovations in its glass shop and assembly facilities. Though the company is vertically integrated to a substantial extent, it also subcontracts much work. Thales UK and Thales Optics have different

panels meeting on a regular basis, where knowledge is exchanged and synergies between the different operations as well as supply issues are discussed.

Thales Optics has strong ties to the nearby Airbus site, in that Thales Avionics supplies the whole cockpit and Head Up Display (HUD) for the Airbus A380. Thales Avionics is the biggest producer of optical components for HUD worldwide and serves both domestic and international markets. 'Pilkington Glass' of North Wales is amongst Thales' key suppliers; and the Wrexham-based company 'Tritech' is one of Thales' casting suppliers. Thales' largest purchases are raw materials, which mostly originate either from Pilkington Glass, or suppliers in Germany, Japan or America.

While Thales have tried to use Welsh companies wherever possible, there were often problems with potential suppliers concerning skills and product approvals. Thus, Thales has, by and large, not sourced a lot in Wales. While the firm has occasionally been involved in WDA activities, it did not find them particularly useful. As part of a global corporation, Thales Optics to a large extent relies on group-wide internal contacts, knowledge and other resources, and depends less on local inputs for innovation.

2.1.15. Tritech Precision Products

'Tritech Precision Products' (TPP) was established in 1982 as an investment casting facility working with aluminium and steel in Wrexham in North Wales. A decade later the company expanded its business to machine tool technology and set up a separate machining facility. Today TPP forms part of the 'Tritech Group,' together with two smaller sister companies operating in the UK. TPP employs 150 out of the 250 total staff of the Group.

Especially the machining business of TPP has benefited from major investments on machine tools, and expanded rapidly in recent years. Other investment concerned a vacuum casting facility worth almost £ 0.5 million which opened up a whole new market place, and the introduction of LEAN production and management procedures. One of the founding members of TPP still serves as its Managing Director today. Reflecting the expansion into a Group of the company, however, the management structure has changed and grown over time. Regular management meetings are held and information is spread throughout the company.

TPP sales have always been focussing on the UK, with 88% concerning the domestic market, and only 12% international ones. Domestically, Airbus is by far their biggest customer, with 52% of the TPP output being sold to Airbus directly and 18% indirect. Also Thales Optics buys TPP products. Since TPP regards the UK market as increasingly saturated, however, it looks at selling more products internationally: to Europe, the USA and the Far East. Airbus and other customers such as Goodrich have requested the introduction of e-commerce in TPP. This increased the importance of the IT unit of the company, which operates different databases and administers all company information.

Regarding the relationship between TPP and Airbus, accreditation is the only obstacle to further expanding the business. TPP has also very good relationships with its suppliers, and exchanged knowledge, e.g., on a well-attended supplier event. While Airbus is crucial as a regional customer, with 'NTD Inspection Testing' only one supplier is based in Wales, since not many suppliers catering for the particular needs of TPP exist. Other regional and national contacts are with the WTI and the AWF, as well as the DTI and the North West Aerospace Alliance.

2.2. RESEARCH AND TRAINING INSTITUTIONS

Senior staff of 3 aerospace research and training institutions based in South Wales were interviewed by the Centre for Advanced Studies. The interviews were conducted by Dr Oliver Ehret in September and October 2005. As the below table suggests, in line with the IKINET methodology, the institutions include university departments and bodies of secondary professional education. All of the institutions examined are key players in the Welsh aerospace sector.

Research and Training Institutions Investigated

NAME & LOCATION IN NORTH OR SOUTH WALES	MAIN INVOLVEMENT IN AEROSPACE
ICAT at Barry College, Rhoose, SW	Aerospace Training and Higher Education
Engineering at Swansea University, Swansea, SW	Aerospace Research and Higher Education
MEC at Cardiff University, Cardiff, SW	Manufacturing Engineering also in Aerospace

2.2.1. Barry College International Centre for Aerospace Training

The 'International Centre for Aerospace Training' (ICAT) is a part of 'Barry College' in South Wales, a Further Education College providing vocational training for school leavers, operating below the university level. The College has offered education for the aerospace industry in Wales for more than 25 years, initially within its general engineering department. Reflecting the growth of the regional aerospace industry and the increasing role the College assumed in training industry staff, however, in 1992 a purpose-built 'Centre for Aircraft Maintenance Training' was opened next to 'Cardiff Wales International Airport.' The Centre was recognised as a 'Centre of Excellence for Aerospace' by the Welsh Assembly Government in 2002, received extra funding as a result, and was renamed into ICAT.

The Centre enjoys the advantage of geographical proximity to major hubs of the Welsh aviation sector. Not only is the main airport of Wales near by, but also the 'British Airways Maintenance Cardiff' facility (BAMC), and the 'Defence Aviation

Repair Agency' (DARA). Both the latter firms are amongst the largest employers of trained aerospace personnel in Wales; and DARA is located at the 'Aerospace Wales St Athan' business park discussed below, hoped to develop into a major magnet for aircraft MRO in the future.

Today ICAT has about 25 staff and offers a number of full and part time, as well as flexible learning, courses. These range from apprenticeships for school leavers in conjunction with the aerospace industry, to BEng and BSc degree programmes, taught and awarded in cooperation with the 'University of Glamorgan,' located not far away. Practical experience, gained through training on small planes and aerospace equipment, complements class-room education at ICAT; and some courses are run in conjunction with BAMC and DARA.

The Centre is the only Welsh institution that has gained approval from the British 'Civil Aviation Authority' and 'European Aviation Safety Agency' as a 'JAR 147' aircraft maintenance training organisation. All staff of the aerospace industry is legally required to receive training from an approved organisation before being permitted to carry out MRO work, according to the new JAR 147 and related requirements. Since ICAT is one out of just three such institutions in the UK, it enjoys an excellent reputation as a training facility.

In line with the wider aerospace community, the Centre expects strongly increasing training demands, arising also from a predicted substantial growth of aviation. To better serve this knowledge market, ICAT has recently introduced an e-learning initiative, enabling aerospace staff to study for JAR recognition more easily from remote desks. The interviewee suggests that a substantial and worldwide shortage of aerospace engineering skills exists, and regards ICAT as well placed to exploit the growing market opportunities. He believes that Wales as a whole and especially its south enjoy good prospects for benefiting from available aerospace skills.

This, firstly, relates to a growing demand for MRO, arising again from the predicted growth of aviation. Given the presence of a large pool of qualified labour in particular in South Wales that is scarce elsewhere, the interviewee sees significant chances for the region to economically prosper from undertaking more MRO work. Secondly, he thinks that Wales and especially the south should benefit from engaging in more aerospace training and R&D, to serve growing knowledge markets. This is to be based on existing skills again. Yet, skills would simultaneously be upgraded, guaranteeing knowledge competitiveness also in the longer term. The interviewee suggests that the current coordination between relevant industrial, educational, and academic stakeholders is insufficient and needs to be improved.

A 'Wales National Aerospace Technology Strategy,' to be agreed amongst all affected parties, would represent a step in this direction, by providing more orientation and avoiding duplication of work. In addition, a common port of call for industry, where queries for research and training cooperation are concerned, should be established between all training and academic actors. Given its standing as an institution and its good industry contacts, ICAT wants to play a key role in these developments.

2.2.2. Aerospace Engineering at the University of Wales, Swansea

Aerospace Engineering is one of the focal topics of the School of Engineering at the University of Wales, Swansea, South Wales. The School has four research centres, of which the centre for computational methods has repeatedly achieved the top 5* rating in recent UK Research Assessment Exercises. The School has around 60 staff, most of whom are specialised or work areas related in aerospace. It has continuously generated substantial income from R&D cooperations with British and international aerospace companies, including industry leaders such as Rolls Royce and BAE Systems. While the School has also extensively cooperated with Airbus UK, this concerned the Airbus' Filton Branch just outside of Wales.

Aerospace Engineering at Swansea has also continuously attracted significant research funds from UK Research Councils as well as governmental bodies such as the WDA. It runs a wide range of under and postgraduate, as well as a PhD, aerospace engineering programmes, one feature of which is a close collaboration with the industry. The School can thus claim with some justification to make Swansea 'the Welsh premier university for aerospace engineering.' It seeks to further raise its profile as a leader in aerospace engineering research.

While the interviewee regards North Wales as a location primarily for aerospace manufacturing, he sees particular potential for South Wales to flourish in the more knowledge-intensive sectors of research, higher education and training, alongside with MRO. One problem in realising this potential is the lack of coordination between different academic and training institutions, matched by the absence of a clear science strategy of the Welsh Assembly and the WDA. Pointing to the standing of his institution, the interviewee would like to see Swansea University to play a significant role in coordination activities.

Given that research ratings and income are key to defining the influence any institution can exercise in the academic world, also from the perspective of this report Swansea should be given weight in any coordination activities. This would also allow other academic, as well as training, institutions to benefit from the School's well-developed industry contacts, thus opening up channels linking national and international knowledge demands with the research and training potential of Wales, hopefully stimulating the development of the latter.

2.2.3. Manufacturing Engineering Centre at Cardiff University

The 'Manufacturing Engineering Centre' (MEC) forms the first and to date only autonomous research centre of 'Cardiff University' in South Wales. The MEC was founded in 1996 and employs 90 staff today. The Centre conducts basic, strategic and applied research, as well as technology transfer. MEC focuses on three themes: intelligent manufacturing, concurrent engineering and rapid manufacturing. The Centre enjoys international standing as a research institution and has continuously generated very substantial research income in the past, from sources including the European Union, the UK Engineering and Physical Science Research Council, and Welsh gov-

ernmental bodies. Research and contract work for private companies operating in a range of industries, such as aerospace, provides a further and vast source of income for the MEC.

In terms of research, the Centre has an international reach, with Networks of Excellence led by the MEC involving some 50 partners across the EU. The Centre also maintains longer-term research partnerships with more than 30 companies, ranging from small local firms to multi-national corporations such as Rolls Royce, around the world. While the centre of gravity of the cooperations varies over time, most of the MEC partnerships relate to private and public organisations based in the EU. Still, the Centre also stresses its commitment to Wales, and is a Centre of Excellence in Manufacturing Engineering under the 'Centre of Excellence for Industrial Collaboration Programme' managed by the WDA.

Due to the 'thousands of projects' undertaken for or with a very large range of industrial and academic partners, it is difficult to specify the involvement of MEC in aerospace. While the Centre does not have the clear focus on aerospace characteristic to the other Research and Training Institutions examined in this report, however, aerospace is one of the more important destinations for the activities of MEC.

Worth mentioning is the suggestion of the interviewee that the very knowledge-intensive approach of the Centre can safeguard jobs in developed countries. Rather than on the cheap labour of the low-cost countries, developed countries are to compete on the high efficiency of their advanced technology. The interviewee thinks that the public support for knowledge-intensive sectors is insufficient and would like to see improvements here.

MEC has a very flat management structure and relies on team-work and continuous knowledge exchange between staff at all levels. The Centre communicates largely virtually with its partners and customers and seems to regard physical travel as something rather obsolete. Contacts due to geographical proximity are not very important, since locally not many potential cooperation partners of interest exist. A pointed comment of the interviewee concerns the relevance of technology-specific criteria, qualifying the significance of geographical proximity. MEC cooperates with partners such as Airbus Filton just across the English border, simply because the Airbus R&D facilities of interest to the Centre are located there rather than in Wales. Trust, however, is crucial in any cooperation activity in the opinion of the interviewee, since no contract can cover all issues at stake.

Given the main orientation of MEC towards organisations outside of Wales, an interest in R&D cooperations that does often not mix with the focus on manufacturing of the Welsh aerospace industry, and the limited emphasis on aerospace, the Centre has no vision for the development of an aerospace cluster in Wales.

2.3. PUBLIC INSTITUTIONS

Senior and top level staff of 2 Welsh public institutions supporting the development of the aerospace sector, based in South Wales, were interviewed by the Centre for Advanced Studies. The interviews were conducted by Dr Oliver Ehret in September and October 2005. As the below table implies, in accordance with the IKINET methodology, the institutions include a technology transfer agency, and an initiative by a regional economic development body. Both institutions are pivotal in terms of public support for the development of the Welsh aerospace sector.

Public Institutions Investigated

NAME & LOCATION IN NORTH OR SOUTH WALES	MAIN INVOLVEMENT IN AEROSPACE
Aerospace Wales Forum, Bridgend, SW	Coordinator of Aerospace Activities
Aerospace Wales St Athan, St Athan, SW	Major Aerospace MRO Development

2.3.1. Aerospace Wales Forum

The Aerospace Wales Forum started in 2003. Regional government, WDA and industry forum formed it. WDA aerospace sector leader Paul Lindsay runs it day to day as deputy director based in south Wales 'cluster'. Chairman is John Whalley, based in the north Wales 'cluster', formerly manager of the NW England aerospace organisation connected with Airbus.

AWF operates to a stylised 'Dating Agency' function. There is perceived to be potential to develop the regional aerospace supply industry. Moreover it is technologically and geographically close to the Wales automotive supply industry. However, aerospace standards e.g. quality, safety, reliability standards and tolerances are much higher in aerospace, so necessary upgrading by automotive suppliers is needed and adaptation by aerospace firms to lesser automotive standards also. Hence standardisation knowledge flows within and between sectors is important in policy terms and not something firms can satisfactorily perform without 'associative' involvement by governance actors

The Aerospace sector in Wales has not yet been 'mapped' either by industry or governance actors. This project (IKINET) is seen as important in doing this by helping identify potential for building up the aerospace supply industry, getting to know key actors etc., and simultaneously to bring these actors together. It has been noticed frequently that although co-located in the north and south Wales 'clusters', nevertheless there is little contact between the actors. That is, outside of those limited links between direct customers and suppliers. In other words there is not a 'community'.

In cases where actors brought together, some horizontal rather than more typically vertical relationships have been formed around joint-projects to share knowledge. Forum trying to get firms to share knowledge about the industry and production potentials, ways of co-operating to further firm and industry performance. Many visits conducted to firms, knowledge grows and one outcome is a database on aerospace sector in Wales. This is accessible to members and affiliates. Mapping exercises are also being conducted with assistance from this project.

Organised a large showcase meeting in Cardiff, 2004/5 displaying Wales aerospace offer. Network meetings occur regularly. Deputy director is chairman of South Wales branch of UK Royal Aeronautical Society, an aeronautics service organisation, with members including firms but also aeronautics research and training organisations plus other service organisations like standards accreditation firm SGS (UK).

2.3.2. Aerospace Wales St Athan

'Aerospace Wales St Athan' refers to the flagship development of the Welsh Assembly Government and the WDA in terms of supporting the current standing and future growth of the Welsh aerospace sector. Aerospace Wales is located in St Athan in South Wales near Cardiff Airport, and is essentially a large airfield with a long runway and extensive aircraft Maintenance, Repair and Overhaul facilities. The site was purchased by the Welsh government from the Ministry of Defence (MoD) in 2004, and represents an investment worth more than £ 10 million.

St Athan is home to the headquarters and MRO facilities of the 'Defence Aviation Repair Agency,' which maintains and modifies the aircraft fleet of the Royal Air Force, Royal Navy, and the Army. DARA uses a new and very large 'Super Hangar,' financed by the MoD, which can accommodate up to 50 fast military jets, or six passenger jets of Airbus A321 size, at one time. The runway is long enough to cater for most military planes, as well as for medium-size civil aircraft such as Boeing 767. There are also other hangars and aviation facilities on the site. While three further and important aerospace developments promoted by the Welsh government exist across Wales, they cannot compare to Aerospace Wales in terms of public investment, scale of the operation, and concerning the availability of a long runway.

The interviewees suggest that Wales has higher per-capita employment in aerospace, which is not to be confused with aviation also including the operation of aircraft in addition to the engineering dimension of aerospace, than any other region in the UK. In spite of the absence of relevant cluster studies, the interviewees are convinced that the Welsh aerospace sector has to be characterised in terms of clusters. They believe that a major reason for aerospace firms to locate in Wales is the presence of an existing aerospace cluster, which offers a range of advantages related to geographical proximity to newly settling companies.

The interviewees essentially divide Wales in two clusters: a South Wales cluster that is especially strong in MRO and R&D, and a North Wales cluster that boasts special strengths in manufacturing. Reflecting the location of St Athan, the interviewees

stress the presence of a highly skilled and comprehensive aerospace workforce in South Wales, which they regard as a great asset, given the international shortage of skilled aerospace personnel.

One main reason for the Welsh government for acquiring the airfield was the announcement of the MoD to withdraw parts of the MRO work for its aircraft fleet from St Athan, causing Assembly and WDA to take action to safeguard aerospace jobs. DARA has reduced employment in recent years and this trend is set to continue. Yet, Aerospace Wales hopes to attract substantial new MRO business to St Athan, occupying existing facilities that will become available, and possibly expanding on existing infrastructure. Apart from the well-developed facilities on the site, for developing St Athan the local availability of a skilled workforce plays a key role.

The interviewees are aware that there is a tough international competition for MRO services, with countries such as China being able to offer labour at a much lower price. The low-cost countries do not normally have a reputation for undertaking high-standard MRO, however, and will find it thus hard to gain the trust of the highly safety-conscious aircraft operators. More importantly, the interviewees believe that the low-cost providers lack the technological expertise and skills to service the most advanced types of aircraft. While low-cost providers will well be able to service older Boeing 737 models, for instance, they will struggle to handle modern Boeing 777s. Thus, by specialising in leading-edge MRO undertaken by the local workforce and utilising the advantageous infrastructure, Aerospace Wales hopes to safeguard and expand the South Wales aerospace sector.

The importance that Aerospace Wales attributes to skills is also visible in the idea to establish an ‘aerospace training academy’ at St Athan, which might provide R&D equipment to be jointly used by the Welsh HE institutions concerned with aerospace. The vision is to ‘share knowledge, create synergies and foster partnerships’ according to a brochure, to overcome existing fragmentation in the HE sector, and strengthen knowledge and innovation networks.

3. CROSS-ANALYSIS OF FIRMS AND ORGANISATIONS

This chapter cross-analyses the findings for the individual firms and organisations presented above, and synthesises the results towards a comprehensive picture of the aerospace sector across Wales.

Reflecting the fact that all interviews regarding industrial firms demanded by the IKINET methodology have already been completed, a sector map for companies is presented and explained. Also, the cross-analysis examines in detail, in which ways Investment and Innovation, Internal Organisation and Knowledge Exchange, and relationships with the Local Environment and International Economy, feature in and between the firms representing the aerospace industry.

Given that some interviews remain to be done with organisations, however, the presentation of a map would be premature. Equally, the different bodies will be cross-analysed in a less detailed way and focussing on but a few key characteristics of high policy relevance. This reflects the preliminary status of the work. Simultaneously, this approach allows for teasing out especially important issues, and provides interesting insights in the role that institutions do and may play in the Welsh aerospace sector.

3.1. INDUSTRIAL FIRMS

3.1. 1. The Structure of the Aerospace Sector in Wales

The aerospace sector in Wales is characterised by a division between the north and the south. North Wales is mainly a manufacturing region where aerospace is concerned. It is dominated by the Airbus wing plant at Broughton, and is home to a range of mostly component suppliers, mainly to Airbus. Though substantial manufacturing takes also place in South Wales, the main aerospace strengths are in MRO, R&D and training. Wales in general is characterised by a split between north and south, with separate industrial clusters often crossing the border to England, which houses the centre of clusters rather than Wales. Also in aerospace, there are cross-border connections between Wales and England. In terms of connectedness of the industry, there are some good reasons to regard North and South Wales as parts of the larger and separate 'North West' and 'South West' aerospace clusters of the UK (Hayward 2005). This would imply that there is a mismatch between the geographical and political entity of Wales as a devolved region also receiving European Development funding, and parts of the interactions of the aerospace sector Welsh and EU policies hope to affect.

Another question refers to the nature of the Welsh Aerospace sector. The organisation of the industry in the north of the region can essentially be characterised as a supply chain to Airbus according to the finding of the CASS research. The south is much more loosely structured, however, which suggest that the sector represents more of an agglomeration of firms and organisations than a cluster. Furthermore, there is a strong vertical interaction between Airbus and all firms investigated in the north in that all are linked through the Airbus supply chain. Though Airbus is an internationally oper-

ating company, at least in terms of the wings Broughton manufactures, North Wales can be said to host the hub of the relevant Airbus activities. In the south, however, the commitment of industrial actors to Wales is less pronounced. While most firms do interact with other companies and organisations in Wales, three firms operate without special ties to the region. Here, interactions are essentially with companies located in England and overseas, rather than Wales.

The figure or 'cluster map' portraying the Welsh aerospace industry below shows the nature of the relationships between the firms investigated in the CASS research.

The map reveals that the Original Equipment Manufacturer Airbus at Broughton represents the dominant aerospace company in North Wales. The plant produces wing components for the whole range of Airbus planes and is also responsible for final assembly. Broughton is one out of two major Airbus sites in the UK and employs over 6,000 people. Airbus Broughton undertakes no formal R&D, which is done at Filton as the second large Airbus plant in Britain. As the detailed discussion of industrial firms of section 2.1. suggests, the 7 Airbus suppliers in North Wales are branches of groups of companies or independent SMEs, supplying aircraft elements and occasionally services to Airbus. To establish the precise nature of the 'strong continuous' relationships between Airbus and suppliers the map suggests, some key characteristics of the suppliers and their trade with Airbus are recalled.

'Cytec Engineered Materials' (CEM) is a branch of a US group of companies and has 160 staff at Wrexham. It develops and sells composite materials such as 'GLARE' mainly to the aerospace industry. Airbus buys up to 40 % of the CEM materials, and accounts for much of the recent CEM growth. 'Ellison Sensors International' is a pri-

vately owned company employing 25 people at its Wrexham site. It designs and manufactures products including sensors and gauges for aircraft manufacturers, and offers on-site strain-gauge bonding services. While Airbus at Broughton has been a key customer for the last couple of years, Ellison also serves a range of other domestic and international clients. 'Magellan Aerospace UK' at Wrexham is a part of a larger Canadian corporation, and has a workforce of 400. It supplies precision components to the aerospace and high tech industries; and Airbus absorbs 60 % of the output. The 'Metal Improvement Company' (MIC) in Broughton is a branch of a US group of companies. MIC provides metal treatment services for the aerospace and other industries, and employs over 100 staff. Almost 90 % of all work is done for Airbus; a figure MIC expects to increase still.

'RD Precision' is a private company, producing smaller precision-engineered components and spares for the aerospace industry. It achieved a turnover of £ 5.1 million in 2004 at its Queensferry site, and expected to reach £ 7.2 million in 2005. RD is both a Tier 1 and a Tier 2 supplier to Airbus, the business with which accounts for much of the current firm growth, and absorbs more than 75 % of the output. 'Thales Optics' at St Asaph is part of an internationally operating French-owned group of companies. It has a staff of 450, and specialises in the design, development and manufacture of modules and components for aerospace and other markets. The firm has strong ties to Airbus, and one of its subdivisions supplies the whole cockpit and Head Up Display for the Airbus A380. 'Tritech Precision Products' (TPP) is part of a small and privately owned group, specialising in investment casting mainly for the aerospace industry. It employs 150 people in its Wrexham casting facility for aluminium and steel. Airbus is by far the biggest customer, with 52 % of the TPP output being sold to Airbus directly and 18 % indirect.

To conclude, for all of the 7 suppliers to Airbus, the OEM represents a key business partner. Between 40 and 90 % of all trade of the suppliers giving relevant figures is done with Airbus, and the OEM is an important customer for the firms giving only qualitative indications as well. It is striking, however, that with the exception of Thales and Tritech, maintaining 'weak continuous' relationships according to the map, no contacts between the Airbus suppliers seem to exist. While Thales buys some products from TPP, no other horizontal interactions of significance take place in the Airbus supply chain, as far as the firms investigated by CASS are concerned. The almost exclusive link between the companies involved in the supply chain is Airbus, and business relationships are largely vertically structured.

Turning from North to South Wales, only one 'strong continuous' relationship linking the two parts of the country exists. This concerns a connection between Airbus and the 'Prematec Corporation,' based in Llantrisant, and owned by a Japanese group of firms. Prematec manufactures large airframe components for Original Equipment Manufacturers with a staff of 75. Airbus has developed into the most important customer in the last few years, entering into long-term strategic contracts, and substantially boosting order books. Only one further link between North and South Wales could be established by the CASS research, concerning a 'weak continuous' relationship between Airbus and 'GE Engine Aircraft Engine Services' (GEAES), a part of the 'General Electric Corporation.' GEAES services, repairs and overhauls jet engines of various manufacturers at its Caerphilly site, staffed by 800 and representing one of the largest aircraft engine MRO centres in the world. GEAES regularly services

powerplants used on Airbus planes, and was appointed the first service facility for the engines powering many of the new A380s.

GEAES has 'strong continuous' relationships with two other companies located in South Wales. The first firm is 'Nordam Europe,' a specialist aircraft overhaul and repair centre fixing engine components amongst other things. Based in Blackwood, Nordam is partly owned by GEAES, and employs 400 staff. GEAES is also amongst Nordam's major customers, for which Nordam repairs nacelles and thrust reversers. The second of GEAES' major relationships is with the privately owned 'Cottam & Brookes Engineering' firm, which is an equally important partner of Nordam at the same time. Cottam employs a fairly large workforce and supplies tooling mainly for aircraft engines to the MRO industry. GEAES and Nordam are Cottam& Brookes' main customers and account for 70 % of the business. Since the three parties also engage in joint design improvement exercises, there are 'strong continuous' relationships between all of them.

Three further aerospace companies based in South Wales have been examined by CASS. They operate in isolation from all other firms investigated in the whole of Wales, however, and do also not show interactions between themselves.

'Contour Premium Aircraft Seating' is based in Cwmbran and belongs to a group of firms. It manufactures first class, business, and premium economy seating, and seeks to achieve an annual turnover of £ 100 million. Contour produces for airlines as the end users of aircraft directly and also undertakes some seating-related MRO work. Yet, it barely interacts with the remainder of the Welsh aerospace industry. Also the 'Doncasters Blaenavon' plant at Pontypool is part of a larger group. It manufactures forged components for aerospace and other applications, and offers machining and project management services. Again, however, the main business connections are outside of Wales, essentially with England and overseas. 'Gardner Aerospace Wales' represents another member of a group of firms. It produces components for the aerospace industry and employs 90 people at its Maesteg base. Garder is a second tier supplier to Boeing, but has no linkages to the aerospace firms in Wales examined by the present research.

3.1.2. Investment and Innovation

All companies investigated in North Wales have been investing mostly substantial amounts of money to introduce process and product innovations in recent years. The simultaneous engagement with both types of innovation is not surprising, as these are typically closely intertwined (Freeman and Soete 1997).

Airbus opened four new and very large-scale production facilities at its Broughton site in 2003, expanding not only the existing 'East Factory,' but adding a wholly new 'West Factory,' at a total construction cost of £ 423 million. This investment in production process technology was to enable the manufacture of new products, namely the wings for the A380, and to cater for the increase in manufacturing wings for a range of other Airbus planes. The expansion ultimately reflected the worldwide in-

creasing demand for Airbus aircraft, and the growth of Airbus SAS. Given the great importance of Airbus Broughton as a main customer for its 7 suppliers in North Wales established above, the Airbus enlargement also represents the main trigger for investment and innovation within the supply chain.

The expansion of 'Cytec Engineered Materials' is closely related to the Airbus growth and the introduction of the A380. The process innovation 'Priform,' for instance, was developed to produce materials for the A330 and A340. CEM also developed and market-introduced the material 'GLARE' for use on the A380. The situation is similar with 'Magellan Aerospace UK,' whose ability to afford the investments necessary to join Airbus in the development of the A380 as a risk-sharing partner represents the foundation of its tight business relationship with Airbus. Also, Magellan invested several £ million in recent years to upgrade its production facilities, to keep up with the rising demand by its main customer Airbus.

The connectedness between the investments and innovations of Airbus, and the ones of its suppliers, is most pronounced in the cases of 'Metal Improvement Company' and 'RD Precision.' While MIC has not altered its mature shot peening process technology much in the last few years, it massively expanded its metal treatment facilities, closely following the growing Airbus demand. To be able to handle the ever larger wings of aircraft such as the A380, MIC even moved its plant close to the Airbus site. Also the growth of RD Precision is strongly related to its main customer Airbus. Most of the company's investments concerned process innovations geared towards expanding and upgrading production facilities. RD aims to further expand in the future, again mainly to cope with additional Airbus demand, and is helped by Airbus to achieve this task.

'Ellison Sensors International' realised a number of product innovations such as a 'silicon on sapphire' sensor in recent years. The firm also introduced process innovations, in that it started undertaking comprehensive strain-gauge bonding services for Airbus and the A380. 'Thales Optics' is implementing process innovations in its glass shop and assembly facilities; and seeks to introduce LEAN manufacturing and design throughout its site. New products include the cockpit and Head Up Display for the A380. 'Tritech Precision Products,' finally, invested in its expanding machining business, a vacuum casting facility, as well as in the introduction of LEAN production and management procedures. These process innovations largely served Airbus as TPP's biggest customer by far.

Investment and innovation in the aerospace firms of South Wales naturally proceeds more independently from Airbus, given the weak links between the Original Equipment Manufacturer and the south. The 'Prematec Corporation' is the only southern firm with close ties to Airbus. Historically, Prematec has evolved from a commercial to an aerospace machine shop, and invested several £ million in specific aerospace machine tools. Currently, the firm increases its capacity to manufacture wings, with an investment worth £ 5 million. Airbus has been Prematec's most important client for years, and specified the characteristics the process innovations had to fulfil.

'GE Engine Aircraft Engine Services' is the second company with which Airbus maintains some, although weaker, links. Regular process innovations have been introduced over the years, allowing GEAES to service ever changing powerplant designs.

The firm has removed divisions between MRO teams according to engine types, and all staff is now involved in servicing any incoming powerplant model. Innovations relating to quality improvement and LEAN manufacturing have also taken place. Historically, many novelties followed changes in the design of the engines used on Airbus planes. The currently most important connection lies with the appointment of GEAES as the first facility allowed to service engines of the A380. However, any powerplants serviced by GEAES are produced by system suppliers to Airbus, rather than Airbus itself, while airlines as the aircraft owners normally decide where to service their planes. For these reasons the linkages between Airbus and GEAES are only weak; and is innovation at GEAES only partly influenced by Airbus.

With 'Nordam Europe' and 'Cottam & Brookes Engineering' the Airbus influence on innovation essentially disappears. Nordam introduced process innovations, in expanding the scale of its operation and gaining a prestigious 'JAR 21' MRO accreditation. Cottam & Brookes has gradually changed from an automotive to an aerospace supplier, and in this context invested substantially in new machinery over the last five years. The firm also set up a new quality management system, and seeks to introduce LEAN manufacturing. Given the absence of connections between Airbus and both Nordam and Cottam & Brookes, the dynamics for technological change must lie with the wider aerospace industry.

'Contour Premium Aircraft Seating' places great emphasis on product innovations, such as the recently introduced 'flying beds,' since the corporate strategy is to be first to the market with novel types of seating. As Contour produces for airlines directly and operates in isolation from other aerospace firms in Wales, international airlines can be seen as the parties mainly influencing innovation at Contour. 'Doncasters Blaenavon' invested substantially in recent years, to upgrade production facilities and be able to supply customers with more sophisticated products. In late 2005 the firm announced to invest several additional £ million towards improving its production machinery. As also Doncasters has no links to other members of the Welsh aerospace industry, the drivers for the process innovations are with the wider aerospace industry. 'Gardner Aerospace Wales' has recently invested in process innovations concerning the upgrading of production machinery, since this was required to manufacture the wing components Gardner, via BAE Systems, ultimately produces for Boeing. Gardner also invested in a 'Total Manufacturing Service' that helps customers to meet supply needs more efficiently. While Gardner does not interact with other Welsh firms investigated by CASS, innovation will be most strongly influenced by BAE Systems and Boeing.

3.1.3. Internal Organisation and Knowledge Exchange

Knowledge exchange at Airbus SAS is organised in 6 'Centres of Excellence,' which relate to R&D and unite technological expertise across the 16 key production sites the company operates in Europe. The Airbus plant at Broughton, essentially a production site, together with the one at Filton in England, mostly involved in R&D, makes up the 'Centre of Excellence Wing.' In general, coordination and decision making at Airbus appears to be poorly organised and difficult. Thus, while the presence of the Centre of Excellence Wing suggests a smooth exchange of information also within the Broughton site, there are doubts whether knowledge is efficiently exchanged.

Regarding the transfer of knowledge between Airbus Broughton and its supply chain in North Wales, given the close business relationships established above, it is plain that a substantial exchange of information must take place. It can often not be established exactly, however, how deep the flows of knowledge run. Common features of the suppliers discussed below, are that management structures are mostly flat, IT plays an increasing role, and that knowledge is easily shared internally.

'Cytec Engineered Materials,' a product development and manufacturing site, has abandoned its previously hierarchical management style, and the management structure is now relatively flat. The development of staff skills is important to CEM. Good internal communication is regarded as very important, and various new schemes fostering knowledge exchange have been introduced. Major investments in IT have been made over the past five years. All communication systems regarding routine business activities are now globally networked between all CEM operations. While Airbus usually sets the targets and specifications CEM has to produce towards, the companies also engage in some limited joint R&D.

'Ellison Sensors International' is another company both engaging in product design and manufacture. To achieve high quality standards, the skill levels of staff have been raised. The management holds regular meetings and exchanges information via intranet, which is also accessible to lower-level staff. 'Magellan Aerospace UK Limited' enjoys mostly good relationships with Airbus, which implies a reasonable flow of information between the companies. Internally, knowledge is exchanged in regular management meetings, and IT plays an important role.

The 'Metal Improvement Company' management meets Airbus staff regularly, and seems to be happy with the flow of information and prospects for future business. It appears, however, that the services MIC provides are not very knowledge-intensive, with the Airbus interviewee indeed regarding many applications as likely to become obsolete soon. The management structure at MIC is lean and very hands-on. The firm runs a networked IT system for administrative purposes. Knowledge is exchanged by word of mouth, with the management frequently chatting with production staff. Yet, the MIC interviewee stresses that most of the standards regulating the aerospace industry are of an international nature. The main sources of technological knowledge the firm draws on reside at the global level, and are shared between all divisions of the MIC group. 'RD Precision' mentions, as the only interviewed firm, that it is connecting to a new Airbus electronic orders system. Internally, RD has completed a range of knowledge management and IT innovations, such as the introduction of a 'Manufacturing Planning and Control System,' helping to better organise production.

The management structure is very flat, and knowledge is easily shared in the close-knit company environment with open-plan office.

'Thales Optics' is a firm undertaking product development next to manufacturing. Thales has different panels meeting on a regular basis, where knowledge is exchanged. As part of a global corporation, the company often relies on group-wide contacts and knowledge resources. The management of 'Tritech Precision Products' meets regularly and sees that information is spread throughout the firm. Airbus and other customers such as Goodrich have requested the introduction of e-commerce in TPP. This increased the importance of the IT unit of the company, which operates different databases and administers all firm information.

The relationship between Airbus and 'Prematec Corporation' in South Wales is hierarchical, with the specifications for the airframe components that Airbus buys from Prematec being set by the customer. Prematec enjoys no design authority, and no deep knowledge exchange seems to materialise between the companies. Within Prematec, however, information is exchanged effectively within an extremely flat management structure, and also passed on to lower-ranking staff. There are regular business reviews, for example, where the management tells the workforce what is happening in the company. All common IT facilities, such as Internet and E-mail, are used to process information.

When the management of 'GE Engine Aircraft Engine Services' announced the signature of the contract for servicing engines for the Airbus A380, it stressed the significance of the 'experience and skills' of the resident aerospace workforce for securing the deal. Also, the above-mentioned reorganisation of the way in which MRO staff work went along with a comprehensive retraining of the workforce, and an overall upgrading of skills. The introduction of such knowledge-intensive innovations was helped by GEAES 'very flat' management style. There is a steady flow of information between different company departments and levels of staff, relying on Intranet, Internet and Email amongst other things.

'Cottam & Brookes Engineering' also believes in the value of skills and knowledge exchange. It regards the skills of its workforce as a core asset that is to be continuously developed and hedged, and is very reluctant to lay off staff. The management structure is flat and knowledge is easily shared in the small company by word of mouth, with news travelling fast from management to shop floor. Also, Cottam & Brookes has a networked computer platform with a structured system for orders, specifications and drawing, which is available to all staff.

When 'Doncasters Blaenavon' relocated from Leeds to Pontypool, the CEO declared that a major reason for the move was "the availability of a locally trained and skilled workforce," echoing thus his colleague from GEAES. 'Gardner Aerospace Wales,' finally, is keen to share information with the other aerospace divisions of the wider Gardner Group. All plants are developing common standards and systems for issues such as performance measurement, aided by the extensive introduction and use of IT.

3.1.4. Local Environment and International Economy

As established above, the Airbus plant at Broughton dominates the aerospace sector of North Wales. All of the other 7 companies investigated by the Centre for Advanced Studies in the area are based at our near Broughton and thus in the vicinity of Airbus. The 7 firms are suppliers to Airbus, with the Original Equipment Manufacturer representing the main customer for most of the smaller companies. Thus, the investment and innovation activities of the suppliers are closely related to Airbus, with a reasonable exchange of knowledge taking place between OEM smaller firms.

Striking is the difference in policies and perceptions regarding the relevance of long-established and trustful business relationships between Airbus and its nearby suppliers. As detailed in section 2.1., the Airbus interviewee stresses the European or international, rather than Welsh or British, nature of Airbus SAS. He emphasises that Airbus pursues an increasingly centralised approach towards sourcing, where economies of scale arising from global procurement play a central role. Airbus also seeks to aggregate its supply chain, by reducing the number of companies the OEM interacts with, whilst simultaneously enhancing the responsibilities of System or Tier 1 Suppliers. The latter are to deliver more complex assembled components to Airbus, share some risk in aircraft development, subcontract out work to lower-tier suppliers, and play a greater part in managing the overall supply chain. The interviewee is sceptical with regard to the standing of two local suppliers, in particular, within the Airbus supply chain. Both the 'Metal Improvement Company' and 'RD Precision' show themselves happy with their relationship to Airbus in the respective interviews conducted with CASS. Both firms moved closer to their primary customer Airbus during their company history. This was especially important for MIC, to enable the firm to deal with ever larger aircraft parts. The interviewees regard their long-established business contacts with Airbus as an asset, and believe that trust and mutual support play an important role for maintaining good current and future business links. This contrasts with the assessment of the Airbus interviewee, however, who describes the Airbus commitment as lower than the suppliers believe. The Airbus interviewee reports that MIC is specialising on products that will soon lose much of their current importance to the OEM, since composites will replace much of the metal MIC currently treats. And RD he ranks only 'in the back of order territory' due to the shifting and unpredictable nature of the orders Airbus procurement gives to the supplier, much in contrast to the continuous support for growth RD Precision reports to receive from Airbus. It can be established that geographical proximity in general plays a lesser role in the organisation of the increasingly international Airbus supply chains. Concerning the relationship between Airbus Broughton and its suppliers MIC and RD, however, geographical proximity does seem to be quite important for fostering business links. On the other hand, personal and long-established relationships are probably not as relevant as the suppliers think.

With regard to local procurement and international relationships, the following can be said. Airbus at Broughton is part of the European owned and globally trading 'Airbus SAS.' While the Welsh supply chain sketched above is important for the Broughton plant, Airbus SAS also sources from many other suppliers across the world. The bulk of the work the Welsh branch of the Metal Improvement Company undertakes is done for Airbus as a domestic customer. On the other hand, MIC buys most of its supplies overseas. The knowledge and standards MIC relies upon, moreover, are of an interna-

tional nature and shared around the globe. Also RD Precision has no important suppliers in Wales. The interviewee regards the requirement to have approvals from Original Equipment Manufacturers as a major barrier to entry into the supply sector. Whereas many Welsh companies have the capability required to supply aerospace parts, he believes, they are barred from trading since they cannot get an approval from Airbus or other OEMs.

In the case of 'Cytec Engineered Materials,' close contacts and geographical proximity to Airbus Broughton do seem to play an important role for forging and maintaining business relationships, mainly with regard to GLARE. Also in the relationship between 'Ellison Sensors International' and Airbus, the geographical proximity of the two business sites proved significant for fostering business, by allowing Ellison teams to provide the requested bonding services more flexibly and quickly. The stance of 'Magellan Aerospace UK' towards Airbus was more ambiguous according to the interviewee: While "the benefit of being close to your biggest customer is that you can get work on the basis of the close proximity; the downside is that when he's recruiting he's got no qualms about pinching your labour and it's causing us problems." Also, the interviewee felt disappointed about an incident when Airbus did not deliver to its earlier promise to share financial aid received by the government with its suppliers. While 'Thales Optics' and 'Tritech Precision Products' maintain important business contacts with nearby Airbus, it is not clear what role geographical proximity and personal relationships play in this.

Cytec Engineered Materials sells its products to British and international customers. Since the main production input CEM requires is only manufactured overseas, the firm has only one relatively significant Welsh supplier. Also Ellison Sensors International serves domestic and overseas clients. Yet, it does not have a Welsh supply base. Magellan Aerospace UK sells mainly to the nearby Airbus plant, but has also other British and international customers. While for both Thales Optics and especially Tritech Precision Products Airbus is an important client, many of their customers are based outside of Wales. Thales has one important supplier in North Wales, but otherwise mainly sources overseas. While Thales has tried to use Welsh companies wherever possible, there were often problems concerning skills and product approvals. Also TPP uses only one supplier in Wales, since not many suppliers catering for the particular needs of TPP exist.

The aerospace industry of South Wales is not structured by the presence of Airbus, and much more fragmented than the sector in North Wales. Linkages with Airbus and issues of geographical proximity play a lesser role.

The 'Prematec Corporation' has sold most of its products to Airbus in recent years, but also manufactures for the American 'Boeing Corporation.' Prematec's relationship with both OEMs is described as hierarchical rather than based on trust. Geographical proximity cannot play an important role. The interviewee regards the fact that Airbus and Boeing seek to reduce their supplier base as a major obstacles to building up a Welsh supply industry. Since Prematec has to use approved suppliers and not many of these exist in Wales, most supplies are purchased elsewhere.

The relationship between Airbus and 'GE Engine Aircraft Engine Services' is not defined by strong continuous business relationships and geographical proximity. Only

weakly connected to Airbus, GEAES services powerplants of planes owned by many airlines around the globe, and sources from 900 international suppliers. GEAES subcontracts a limited amount of work to a number of Welsh firms, most notably the nearby 'Nordam Europe Ltd.,' partly owned by GEAES, and the local 'Cottam & Brookes Engineering.' Still, the overall amount of GEAES' regional procurement remains small. Building strong relationships with any supplier, wherever located, is very important to GEAES; and a high level of personal interaction and trust is regarded key to maintaining these relationships.

Nordam serves an international market for MRO services. Cottam & Brookes does 70 % of its business with GEAES and Nordam, but increasingly attempts to also take advantage of sales opportunities overseas. As pointed out above, there are longstanding and strong business relationships between the three companies, maintaining which is clearly made easier by the proximity of the operations, according to an interviewee. Both Nordam and Cottam & Brookes lack a Welsh supply base. Nordam would like to use more suppliers in Wales. Potential suppliers are mostly unable to offer the fast turnaround times that many of the Nordam contracts demand, however, and also struggle to compete with companies elsewhere in other respects such as price. While many Welsh firms have the potential to become suppliers, they seem to often fail to grasp existing opportunities, with many citing a lack of machinery and accreditation as reasons for not getting involved in the aerospace sector. In the opinion of the interviewee, however, it rather is a lack of entrepreneurial spirit, a failure to perceive existing market opportunities, and a lack of knowledge of the aerospace sector and its supply requirements, which explains the continuous absence of a Welsh aerospace supply industry. Cottam & Brookes experienced problems where suppliers in Wales are concerned, mainly related to the old machinery of firms that is unable to meet aerospace standards. Thus, Cottam & Brookes has turned to manufacturing over 95 % of its products in-house.

It has already been noted that the companies 'Contour Premium Aircraft Seating,' 'Doncasters Blaenavon,' and 'Gardner Aerospace Wales' do neither maintain business links between themselves, nor with any of the other Welsh aerospace firms examined by the CASS research. This implies that issues of longstanding and trustful business relationships, as well as of geographical proximity, are irrelevant here.

Contour produces seating for domestic and international airlines such as 'British Airways' and 'Cathay Pacific.' Contour relies on a worldwide network of 180 suppliers, but seeks to reduce the number to 100. The strategy is to source from a group of 25 'premium suppliers' wherever possible, which increasingly take over more demanding system integration tasks. The USA and France are the leading supply countries; but deliveries from low-cost countries such as South Africa and Poland are becoming increasingly important. Contour has also supply links with firms located just across the English border, and elsewhere in England farther away. Contour only uses a few Welsh suppliers, as it experienced problems in the past and found that potential new suppliers mostly lack the equipment and skills required. While Contour sees a potential for low-volume and high-standard supply production in Wales, potential suppliers are often not willing or able to afford the necessary investments.

Gardner sells most of its products to 'BAE Systems' and another large, American, Tier 1 aerospace supplier. These customers use the Gardner parts to manufacture

more complex aircraft components that are then delivered to Boeing. Gardner reports that it often receives help from Boeing for dealing with certain R&D issues, which suggests that some kind of trustful relationship exists between the two companies. Gardner is looking to outsource some of its activities and is establishing supply chains in low-cost countries. Overall, however, Gardner has very few suppliers, since it prefers to rely on in-house resources that are more suitable to match the requirements of Gardner's very specialised business field. Gardner only sources one key product from a Welsh company. This is because usually there are no Boeing approved suppliers for the products Gardner requires. While Gardner see advantages of sourcing in Wales, such as shorter lead times, most potential suppliers lack the approvals required to qualify them as suppliers.

It remains to add that most of the aerospace companies both in North and in South Wales examined above had contact with the Welsh Assembly Government at least at some stage of their firm history. Airbus, Gardner, GEAES, Doncasters and Prematec received Regional Selective Assistance grants to support business expansion or the purchase of large capital equipment. A range of smaller firms benefited from the export support provided by 'Wales Trade International.' The companies include Cottam & Brookes, Ellison, and RD Precision. It is striking, however, that the bulk of the financial support of the Assembly Government was directed at the large branches of groups of companies mentioned above, rather than the SMEs the Government proclaims to mainly assist. According to a personal communication from the 'Aerospace Wales Forum,' all of the above firms also participate in activities organised by the AWF to varying degrees. Several of the companies examined in section 2.1. also maintained contacts to Welsh or English universities or training institutions involved in aerospace. CEM, Ellison GEAES, and Magellan are amongst these firms.

It would be premature to try and establish in detail the relationships between the companies investigated by CASS and the Research and Training Institutions, as well as the Public Institutions, involved in aerospace in Wales. This should only be done once all of the remaining interviews with relevant organisations have been completed. However, it will be helpful to address a few key aspects of these relationships, which became apparent throughout the interviews with research, training and public institutions that CASS has already undertaken. This will be done below.

3.2. ORGANISATIONS

The most important issue that was brought up in the interviews with Research and Training, as well as Public Institutions, was the one of skills and their potential for fostering the development of the Welsh aerospace sector.

As mentioned in the introduction, in line with central findings of this report, interviewees representing three institutions suggest that the Welsh aerospace sector is characterised by a north-south divide. While North Wales is dominated by the manufacturing supply chain to Airbus, South Wales is much more loosely structured, and more involved in MRO, R&D, and training than in aircraft production. The interviewees also believe that the south has the potential to flourish from undertaking more air-

craft MRO, R&D, and training, given the existence of a large pool of resident and trained aerospace personnel. The vision is to develop capacities in Maintenance, Repair and Overhaul attracting a domestic and international clientele for relevant services in the light of a worldwide rising demand. As there is a global shortage of relevant skills, the interviewees regard the Welsh aerospace sector to be in a good position for satisfying the demand. They also seek to encourage the expansion and upgrading of aerospace training and academic R&D, to be able to maintain the Welsh advantage in skills also in the future. The focus of such activities is South Wales, reflecting the need to make up for the redundancies that the 'Defence Aviation Repair Agency' recently made, and likely also the fact that aerospace in the north currently experiences a boom anyway, hardly suggesting that resources should be used there rather than in the less fortunate south.

Two interviewees represent the 'Barry College International Centre for Aerospace Training,' and 'Aerospace Engineering at the University of Wales, Swansea,' respectively. This might warn against taking their assessments at face value, given that vested interests might conflict with the expert knowledge of the sector the interviewees undoubtedly possess. However, the high-level interviewees representing 'Aerospace Wales St Athan,' as the flagship aerospace support project of the Welsh Assembly Government, share the same point of view. As the detailed analysis of sections 2.2. and 2.3. shows, there is substantial agreement between these three, and other, institutions interviewed, on the state and prospects for Welsh aerospace. Aerospace Wales wants to enhance the cooperation of the different aerospace actors in Wales, for instance, much in line with the ideas of ICAT and Swansea Engineering. Moreover, Aerospace Wales seeks to establish an 'aerospace training academy' at St Athan as the site to which the government hopes to attract new and leading-edge MRO in the future, in harmony with statements of ICAT and Swansea again.

One key policy question arising from the above is then whether the skill sets available are as valuable as proposed by the champions of a Wales betting on aircraft MRO, R&D, and training, as a pivotal mechanism of future economic growth. One would need to ask: are the skills sufficiently well developed to actually attract these knowledge-intense economic activities the champions would like to see based in Wales? Both GEAES and Doncasters, for instance, stressed the importance of 'the availability of a locally trained and skilled workforce' for settling in South Wales. It is less clear, however, which role skills played in comparison to the substantial financial aid the government granted for relocation. To help better informing policy making, such issues ought be thoroughly explored.

Also, there are tensions between the different perspectives on skills broadly sketched by the proponents of a knowledge-based aerospace in Wales. On the one hand, skills are regarded as a current asset that has the potential to attract knowledge-intense activities already today. On the other, there is an admission that skills need to be further improved, to reach a level also competitive in the longer run. No doubt, the experts will be aware of these issues and be in a position to differentiate between different types and levels of skills, each calling for different and specific policy reactions. But it would be of help to consider and make transparent these issues also in wider policy debates on the future of Welsh aerospace.

Another concern relates to manufacturing. Although aircraft production is not regarded as the key strength of South Wales, the Assembly Government sees also chances for the industry in this part of the country to profit from the massive worldwide growth in aircraft numbers predicted for the future. One task of the 'Aerospace Wales Forum' is accordingly to help potential aerospace suppliers to actually engage in aircraft manufacturing and become part of relevant supply chains. However, since the activities of the Government mainly aim at promoting MRO, R&D, and training, it is not quite clear which form the support for potential suppliers is to take. There is also the issue that current governmental support seems directed mainly at helping larger companies producing in Wales, rather than developing the indigenous SMEs that are the most likely candidates for turning into the aerospace suppliers of tomorrow.

The previous section has revealed that a lack of skills, featuring also in difficulties of Welsh firms to become approved suppliers, is indeed a major obstacle for potential suppliers to engage in aerospace manufacturing. On the other hand, it also emerged that the trend to aggregate supply chains is set by the OEMs and very hard to counteract by small companies. Finally, it has become clear that tangible material and economic factors, such as old production facilities and a lack of financial resources, represent further major obstacles for SMEs to turn into aerospace suppliers. This suggests that improving the knowledge base of SMEs alone will not suffice to overcome the present problems. Rather, it seems that a combined approach, targeting both skill and other, more tangible problems, would be required to develop a more substantial Welsh aerospace supply industry.

REFERENCES

Aerospace Innovation and Growth Team (2003) *An Independent Report on the Future of the UK Aerospace Industry,* London: Department of Trade and Industry

Aerospace Wales Panorama (2005), Vol. 1, No. 1 (magazine produced by the Welsh Development Agency)

Freeman, C. and Soete, L. (1997) *The Economics of Industrial Innovation,* 3rd edn., London and Washington: Pinter

Hayward, K. (2005) *UK Aerospace: Position & Prospects,* Rhoose: British Airways Maintenance Cardiff: lecture organised by the Cardiff Branch of the Royal Aeronautical Society, 13 October

House of Commons (2005) *The UK Aerospace Industry*, Fifteenth Report of Session 2004–05 of the Trade and Industry Committee, London: Stationery Office