Welsh Assembly Government Research Grant Pilot

Auditing Welsh Industry: A Clusters-Based Approach – Aerospace

Institute of Welsh Affairs
CASS (Cardiff University)
Welsh Enterprise Institute (University of Glamorgan Business School)

Final Report October 25th 2007

Nick Clifton
Rhys David
Oliver Ehret
David Pickernell

CONTENTS

STATEMENT BY THE RESEARCH PARTNERS

THE INSTITUTE OF WELSH AFFAIRS, CASS AT CARDIFF UNIVERSITY, AND THE WELSH ENTERPRISE INSTITUTE (WEI) AT THE UNIVERSITY OF GLAMORGAN BUSINESS SCHOOL HAVE STRONG EXPERTISE IN THE WELSH ECONOMY, LOCAL AND REGIONAL ECONOMIC DEVELOPMENT ISSUES, ENTERPRISE AND SMALL BUSINESSES, AND THE IMPACT OF FOREIGN DIRECT INVESTMENT. AS A PARTNERSHIP THEY ARE ABLE TO PRODUCE HIGH QUALITY RESEARCH THAT WILL LEAD TO A BETTER UNDERSTANDING OF THE ECONOMIC CHALLENGES FACING WALES.

EXECUTIVE SUMMARY

The Project

- This research tests and examines the clusters approach to the Aerospace industry. Using a cluster analysis framework developed further from previous work for the Welsh Assembly Government, the framework is aimed at providing information on how businesses in Wales fit into increasingly globalised production systems of goods and services and how they link together in clusters and networks of varying sizes.
- Aerospace has been chosen because of its importance to the Welsh economy and the prospects for substantial future economic benefits from three component elements within Wales, namely manufacture; maintenance, repair and overhaul (MRO); and research, development and training (RDT), and also because of the challenges posed by the introduction of new materials, such as composites, that could devalue the existing metal expertise of many existing Welsh aerospace companies.
- The report seeks to rectify a dearth of information on current aerospace competencies in Wales and on the opportunities for cluster and network arrangements that could improve the position of firms in the region occupying the three sectors listed above.
- A two stage process has been followed involving a general quantitative, statistical audit of the Welsh aerospace sector, drawing on a wide range of economic and employment data, and a second survey based stage which relies on expert opinions, split into three sections, examining industry capacity, risk and trade. This is supplemented by interviews with a small number of keystone firms and organisations to elicit their views on the industry's future in Wales and the issues facing it.

The Context

- Wales has secured a surprisingly large aerospace industry, which, with the decline of other former mainstays of the Welsh economy, has become one of the country's principal technological, employment and export assets.
- About 150 firms in Wales serve aerospace markets, employing more than 20,000 people and generating an output of around £2bn a year. Companies range in size from wing maker, Airbus UK at Broughton, to much smaller enterprises. There are agglomerations of manufacturing in North Wales and of MRO, (plus manufacturing) in South Wales. The biggest concentration of RDT activity is in South Wales.
- Aerospace activities are more prevalent in Wales than in the UK as a whole and are dominated by manufacturing activities, which are seven and a half times more concentrated in North Wales than in the UK as a whole.
- One company (Airbus) accounts for a large share of total employment. The rest of the industry is disproportionately found in smaller companies, compared with GB as a whole.
- The sector has relatively high levels of employee compensation and gross added value well above Welsh and UK averages for all industries but below the GB average for aerospace. The contribution made by the sector to the Welsh economy includes a large surplus on the trade balance.

Overall Conclusions

- The industry in Wales is now in many ways at an important crossroads. In addition to competition from other advanced economies, including many of the industry's current partners, over time a strong challenge from lower cost countries can be expected to impact on the industry, making it necessary to ensure it remains technologically advanced and able to draw on adequate resources of skilled labour.
- The paradigmatic change to composites now taking place across the industry will threaten the viability of both Airbus and its supply chain, if appropriate technological reorientation fails to occur. The South Wales industry has in some cases already strengthened its composites expertise and may be better geared for this technology shift.
- Competition for maintenance and repair operations in South Wales, particularly for long haul aircraft, is emerging from low cost countries, such as China, where investment in facilities and in the provision of relevant skilled personnel has been gathering pace. China, in particular, is also expected over the longer term to provide growing competition for the manufacture of airframes.
- **Manufacturing** needs to develop stronger internal and external relationships, develop common resources, and increase the interactions between industry and institutions. There is also a need for the government's role to be reduced relative to institutions in particular, most likely in terms of facilitating the increased relationship between institutions, such as universities, and the industry, in developing the skills, knowledge, resources and relationships required for its future success. The sector would ideally move towards a more sophisticated "Marshallian" / "Italianate district" hybrid (vd Table 1), enjoying shared use of common

resources, particularly those arising out of higher education, possibly as part of a transition towards a more "hub and spoke" type arrangement.

- **MRO** needs to develop stronger internal and external relationships for knowledge creating and disseminating purposes (but at a more UK-level). This, it appears, however, can be built upon more stable existing structures than exist for manufacturing, with more of a nuanced change towards "Italianate District" type arrangements whilst recognising the importance of shared resources, and corprorate governance along side that of networked governance.
- The **RDT** sub-sector, which supports both manufacturing and MRO, is characterised by some fundamental issues, in terms of the perceived need both for more formal (Italianate-type) networking and collaboration and for a more commercially-focused approach from institutions, and possibly government policy to facilitate this, at both Welsh and also UK levels. The nature of the organisations themselves, as well as their relationships with each other, other sectors of the industry, and government, needs restructuring.
- Strong government support, reflecting the competencies and power available at both levels, is required from government in London and Cardiff. The Welsh Assembly Government needs to ensure industry's skills requirements are understood and met, and at a UK level continued strong support for UK science and engineering is maintained.
- Continued financial support also appears to be vital for the launch of major new airframe products, not so much for market failure reasons but to demonstrate continued commitment on the part of the UK to a consortium that no longer includes formal UK shareholder participation.

1. INTRODUCTION

This research aims to test and examine the clusters approach to the Aerospace industry, by further developing a framework to analyse networks and clusters outlined in a previous report under the Welsh Assembly Government's Economic Research Grant scheme. This was entitled, "Auditing Welsh Industry: A Clusters-based Approach", by Clifton et al (2005) (http://www.wales.gov.uk/subiresearch/content/eru/projects-e.htm . The robust methodological framework developed previously in that report provides economic development policymakers with new information, facilitating decisions on support for current areas of strength, the development of new/latent sectors and measures to ameliorate problems in sectors where decline is likely. It also began the process of providing information on how businesses in Wales fit into increasingly globalised production systems of goods and services, and how individual sectors link together in clusters and networks of varying size, strength, growth, and geographical concentration that can then be treated in a holistic manner.

Clifton et al (2005) also highlighted, however, the need to examine in more detail processes of relationship development, learning and innovation, and the management processes of relationships necessary for effective clustering. A wide range of firms, institutions and linkages need to be evaluated as part of the 'triple helix' of successful regional innovation systems (see for example Cooke, 2001), because this is often how clusters develop beyond geographically and sectorally based agglomerations to become self-sustaining and adaptive competitive systems, the prime goal of support policy. This report therefore also identifies and quantifies the supporting and enabling mechanisms for the triple helix, building them into the clusters and networks framework developed in Clifton et al (2005) to complete a full multi-level, multi-method, framework from which policy can then be enacted.

There is also a need, however, to evaluate how a geographically concentrated (i.e. within Wales) group of companies fits into the wider economic context, highlighting the need to also examine cross-locality networking activities and enablers as part of the analytical process. In addition, the roles and importance often undertaken by certain "keystone" companies within an industry in a region also require evaluation in this regard. The project undertaken here, therefore, provides a framework capable of delivering rapid analysis of the industrial sectors, generating an innovative and appropriate response, whilst providing a value-for money approach based on earlier research funded under the Welsh Assembly Government's Research Programme and complementing other WAG funded work.

The industry highlighted as of relevance and importance to the investigation (as a case study sector) is the aerospace sector in Wales. This has been chosen because of its importance to the Welsh economy (around 150 firms, 20,000 people employed and £2bn to the regional economy; WAG, 2006), and the complex overlapping activities that constitute this sector in Wales (from manufacture, through maintenance, repair and overhaul (MRO), to Research Development and Training (RDT)), which highlights the ability to examine sub-sectors using the methodology. In addition, the inter linkages of the industry with other parts of the world through cross locality networks, and its complex inter-relationship with government(s), also allows the methodology to be fully tested.

Substantial prospects for growing future economic benefits and employment for Wales arise from the predicted global growth of aviation, entailing increasing demands for a) aircraft manufacture, b) MRO, and c) stand-alone RDT (Department of Trade and Industry [DTI] 2003). Building on its current strengths in these three, and to some extent inter-related, aerospace sub-sectors, Wales might be able to upgrade its technological capabilities and skills, and increase its shares in growing future markets.

There are also challenges, however, first and foremost relating to the introduction of composites. These will replace metals as materials for the wings, currently manufactured by Airbus Broughton and its supply chain. The advent of composites devalues the metal expertise of many UK and Welsh aerospace companies and thus endangers the long-term viability of the industry if appropriate degrees of reorienta-tion towards com-posites fail to occur. The need to ensure the UK remains competitive has been identified by Government in the National Aerospace Technology Strategy, a partnership between industry, Government and academics. A total of 13 Aerospace Innovation Networks has been identified, including advanced aerospace materials and structures (www.sbac.co.uk/pages/07343691.asp). The key issue for Wales, however, is to ensure technologies and expertise developed through these programmes is introduced into the Welsh manufacturing environment.

It is also unclear to what extent the sale of the BAe Systems stake in Airbus in 2006 will entail a weakened commitment of the international Airbus corporation to its UK operations, and result in the loss of work share and jobs to overseas (Bristol Evening Post 28.02.07; FI 17.07.06).

Secondly, Welsh aerospace faces increasing competition from overseas countries, including low-cost countries such as China (Dowdy 2006). Though growing international and low-cost competition also affects aircraft manufacture, for MRO it represents the most pressing concern. Third, there is the generic question of how any Welsh advantage in R&D and skills can be maintained or enhanced in the face of tough international knowledge competition, both from developed and developing countries.

Few aspects of the issues raised above have been examined in depth by stakeholders or in the academic literature, and knowledge helping governmental bodies to devise policies in support of the industry is patchy and often anecdotal. As detailed in section 4, there are few sources of information regarding issues such as current aerospace competencies in Wales compared to competing regions, trends in aerospace knowledge and skill requirements affecting the Welsh industry, and opportunities for cluster and network governance arrangements that promise to improve the position of the region. Academic contributions explore a range of diverse phenomena observed in the global or UK aerospace industry, but none focuses on Wales or specifically discusses the sectors of manufacturing, MRO and RDT that are of particular relevance to the Welsh industry.

Key issues for the present study thus include a) the current and likely future situation of Welsh metal-based component manufacturers in the light of the rapidly growing significance of composites, b) the state of and prospects for Welsh MRO in the face of stiff competition from other regions and low-cost countries, c) strengths and weaknesses in the R&D and skills profile of Wales, and the provision and availability of training.

This study also complements the research already being undertaken by the Welsh Assembly Government's Economic Research Programme. In particular, in addition to building upon a project previously funded by the WAG research programme, it also provides support for research into:

- Business and the economic infrastructure
- Economic evidence base (specifically increasing knowledge concerning the contribution of non-statistically standard industrial sectors; foresight and futures thinking; analysis of Welsh comparative advantage)

The report is thus structured as follows. The next section examines the theoretical contexts of the management and geographical importance of clusters and networks in which the study is conducted. For the purposes of building a theoretical framework for analysis the focus is on issues of importance highlighted by the literature related to competitiveness, clusters and networks, from which a framework of classification and analysis is derived. The methodology adopted is then described in some detail, along with the sub-sectors of aerospace chosen, before results are described. Finally, conclusions are drawn and recommendations made.

2. THEORETICAL CONTEXT: ISSUES TO BE ADDRESSED FROM THE LITERATURE

The State of Play

Growing amounts of related literature provide overlapping ideas that are relevant to the concept of geographical clusters - See in particular Clifton et al (2005). There is a crucial need, however, to build three overlapping areas into the research framework previously developed. These are: more in-depth analysis of the role of different sets of stakeholders in the development of industrial sectors; the consequent management and governance of the network/cluster; and also the use and importance of cross-locality networks (CLNs), which have become increasingly important for knowledge-intensive industries, requiring the levering of innovations across geographical boundaries. As Clifton et al (2005) have pointed out, the nature of competition in many industries can be seen to be changing in the following ways:-

- More globalised - i.e. more intense, reduced 'room to hide', greater need to focus on what you are good at and doing it better
- More emphasis on innovation - greater emphasis on innovation as a competitive weapon, i.e. the need to compete on more than just price alone
- Greater need for flexibility - the need to be more agile, responsive, and faster to adopt new ideas

Within this changing competition and support policy climate, clusters can potentially provide:-

- Productivity gains through mechanisms such as:-
    - use of specialised inputs and services, and
    - potential for local sourcing;

- Perhaps most importantly :-
    - innovation gains through enhanced supplier-customer interaction
    - Proximity to knowledge centres
    - Easier exchange of tacit information

- Also, there are possibilities to realise higher levels of new business formation due to:-
    - Better information on niches, and new opportunities (therefore lower entry barriers)
    - Better informed Venture Capital system (i.e. reduced transaction costs)

A key objective of UK government policy, therefore, is to deliver a knowledge-driven economy, within which clusters can play an important part (though clusters can also be seen as being more generally found in older traditional industries and services) because of their potential importance in facilitating the creation, dissemination and utilisation of new knowledge and innovation in particular. The conventional process for fostering organisational learning and innovation was based primarily on individual behaviour and linear models (Weick, 1990). However, as theorists (e.g. Lundvall, 1992) have indicated, these old 'go it alone' models are increasingly the exception rather than the norm, this shift based on an increasing understanding that learning and innovation occurs through a highly interactive and iterative approach (Weick, 1990; Cooke, 1998).

Current paradigms in research and development intensive industries, therefore, emphasize the need for multi-disciplinary and interactive knowledge production among governments, universities and research institutions, and relevant industries. Leydesdorff's (2000) conceptualisation encapsulates these stakeholder relationships in his 'triple helix model.' The increasingly porous nature of the boundaries among these various types of stakeholders enables enhanced system interface for the purpose of information sharing, knowledge, resource and people transfer, and results in the formation of new innovation.

Over the past decade, knowledge challenges have, therefore, increasingly been met through the synergy created via cooperative and collaborative research and the developmental arrangements that have emerged as a result of the formation of inter-organizational networks. In the network model knowledge is not directly transferred but continuously created and recreated through networking interactions as individuals come to share a common understanding or frame of reference. From this perspective networking is not a case of linear information transfer but a process of interrelated sense making (Weick, 1990).

This lessening of the emphasis on organizational barriers that previously existed also fosters the development and uptake of innovative techniques and practices that might have otherwise not occurred within individual sectors (Swan et. al. 2003). Drivers of innovation recognizably may come from a variety of single sources, or

combinations of sources working collaboratively, thereby generating examples of collaborative innovation and impacting upon industry. Varying levels of complexity, ambiguity and uncertainty, however, also highlight the critical need for appropriate networking/clustering enablers - that is, appropriate governance - to promote an effective interface and productive cross locality networks (CLNs), given the increasing need to lever (particularly knowledge) resources.

Overall, therefore, innovations are not fixed entities to be imposed from above and to which firms must adapt, but rather must be seen as more fluid and subject to transformation through the generation and adoption process, as stakeholders contest and reshape activities. Moreover, as Lowndes and Skelcher (1998) and more recently Keast and Hampson (2005) have noted, the need for transformation is likely to be driven by the stage of development of the network or partnership arrangement. Thus, an ideal scenario might see an array of key stakeholders from industry in the supply chain, government, and institutions (including universities and government research departments), utilising these interconnected mechanisms to generate and disseminate information, innovation, skills, and training, and to operate management and governance structures. This suggests, therefore, the need to build these into any analytical framework for examining these issues, particularly in industries characterised by innovation and multiple stakeholder groupings. Derived from Clifton et al (2005), table 1 classifies the eight basic types of clusters, but also conceptualises differences between these cluster/network types in terms of their structures (horizontal/vertical, formal/informal, transactions/agglomeration/relationship based), management (returns sought, goals, conduct, basis of participation, network management), and learning, systematising the network differences highlighted from the extensive literature. This systematic approach to classification of networks can assist theorists, practitioners and policymakers in comparing theoretical "ideal" network types against the present reality (Pickernell et al. 2005).

Outlining types, 1,3, 6, and 7 in more detail, cluster type 1, for example, is indicative of the processes required for a successful traditional formal and vertical cluster and network. The strategic focus is narrowly cost and individual firm based, and is thus built on tight transactions based relationships within a hierarchical structure. The network management is thus likely to be focused on short to immediate term network creation. These networks are characterised by single-loop learning to increase efficiency. These elements can also be seen as indicative of clusters based around traditional vertical supply chains. Cluster type 3, in contrast, is indicative of the processes required for more informal vertical cluster and network types. The strategic focus is more widely based around disseminating knowledge and by so doing reducing mutual cost bases. The goals are thus more collective, and are thus built on wider trust-based collective action relationships, though still within a hierarchical structure. The network management is thus likely to be focused on medium term network building though, of course, initial network creation skills are also important. These networks are characterised by an emphasis on single-loop learning with ad hoc double-loop learning to both increase efficiency and to enable knowledge interchange. These elements can be seen as indicative of some types of Italianate-type clusters, and also some types of cluster associations. Cluster type 6 is indicative of the processes required for informal horizontal cluster and network types, such as social networks of entrepreneurs with low power dependence, as exist in some cluster associations. The strategic focus is based around knowledge sharing and dissemination, as would be expected where small firms collaborate to generate scale effects. The goals are again collective, but can be wider, allowing for the growth of the network itself, and thus built on wider team based open network action relationships, without hierarchical structures. The network management is thus likely to be focused on long term network growth. These networks are characterised by a combination of single-loop learning and double-loop learning to facilitate the wider survival of the network through knowledge based exchanges. Clearly in this cluster type, network creating, sustaining and building skills are important, highlighting this as an area of particular importance, requiring a capacity-building focus. Finally, cluster type 7 is indicative of the processes required for more formal horizontal cluster and network types, such as virtual organizations. The strategic focus is based around specific cost-reducing knowledge, as would be expected where small firms collaborate to generate scale effects. The goals are again collective, and thus built on wider trust based collective action relationships, though still within a hierarchical structure. The network management is thus likely to be focused on medium term network building. These networks are characterised by single-loop learning to facilitate a cost focused knowledge interchange network. It may not be the most suitable arrangement for cluster associations where innovation outcomes are sought.

The literature (e.g. Van Dijk and Sverrisson, 2003) also suggests, that there may be the potential in certain circumstances for networks to develop, moving from one type to another over time as strategic requirements change. The most obvious movements are from type 1 to type 2 for networks wishing to develop mutual knowledge bases that ultimately reduce cost, as exemplified by changes in the UK automotive industry as Japanese car makers set up production and supply chains in the UK during the 1990s. In addition, the loose processes described in type 6 could develop into the more formal structures of type 7, if the network participants

determine that a virtual organisation would best suit their strategic objectives, this formalisation also closing the network in terms of participants to create a much more formalised arrangement. Policy can also impact here given that, for example, type 1 arrangements may themselves generate creation of type 2 arrangements, through the creation of supplier clubs of proximate firms at the same stage in the supply chain, often facilitated by larger companies up the production chain, or regional development agencies (or their equivalents).

Table 1: Clusters and Networks Classification Framework

	STRUC-TURES	MANAGEMENT					LEARNING
Description	**Structures**	**Purpose**	**Firm Focus**	**Firm Mode**	**Network Mode**	**Management focus**	**Learning Processes**
Cluster /Network Type	**Structure**	**Returns**	**Participant Goals**	**Participant Conduct**	**Participant Basis**	**Network System Management**	**Type of Learning**
1 Industrial Complex	formal, Vertical, Transact-ional	Cost	individual survival	control	transact-ions	start – creating	doing things better
2 Hub and Spoke	formal, Vertical, Relational	cost/knowl edge	collective survival	collective action	cognitive trust	survive-connecting	doing things better/doing things differently
3 Italianate District	informal, vertical, relational	cost/knowl edge	collective/ wider survival	collective action/co-operative learning	cognitive trust/team work	survive-connecting/s ustain/devel oping	doing things better/doing things differently/ doing different things
4 Marshall-ian	informal, vertical, agglomer-ational	Cost	individual/ collective survival	control/co-operative learning	transact-ions/cognit ive trust	start – creating /sustain-developing	doing things better
5 Urban hierarchy	informal, horizontal, agglomer-ational	Cost	individual survival	control	cognitive trust	start – creating	doing things better
6 Social Network	informal horizontal, relational	Knowledge	wider survival	co-operative learning	teamwork	sustain-developing	doing things differently/ doing different things
7 Virtual Organiz-ation	formal, horizontal, relational	Knowledge	collective survival	collective action	cognitive trust	survive-connecting	doing things better/doing things differently/ doing different things
8 Satellite Industrial Platform	formal, horizontal, transact-ional	Cost	individual survival	control	transact-ions	start – creating	doing things better

Source: Clifton et al. (2005)

The classification outlined in table 1 was developed specifically for geographically concentrated clusters and networks, to provide a basic framework for analysis. There is also a need, however, to examine the role of CLNs that might be linked into such geographically based clusters and networks. This highlights key additional issues from the perspective of social capital theory. Social capital is an important element in developing and sustaining

CLNs, as well as local clusters and networks. In situations where there is social capital and a learning environment among participants, it is important to focus not only on the strength of the network, but also on the issues of bonding versus bridging social capital.

This approach is of particular merit in that it shifts the focus of analysis from the behaviour of individual agents to the pattern of relations between agents, social units and institutions (Schuller et al. 2000). One of the most extensive reviews of the subject, sensitive also to developmental issue was that of Woolcock (1998). Crucially, important distinctions are drawn about social capital in relation to another social economy concept - that of 'embeddedness' (Granovetter 1985, Grabher 1993). Ideas of 'relational embeddedness' (Granovetter 1992) and 'firm capabilities' (Penrose 1959, Teece and Pisane 1994) have asserted themselves in the literature. In this regard, while Granovetter warned of the effectiveness of weak ties and loose coupling over the weakness of strong ties between network contacts, Grabher (1993) warns similarly of the negative impact of social capital arising from 'lock-in' relationships caused by over-dependence on a too-narrow range of business or social contacts. In addition, Woolcock (1998), following Evans (1995), took this further in arguing that the concept of embeddedness itself, while important in providing initial support, including financial support for business development, needs complementing by 'autonomy' for economic development beyond a highly circumscribed scale to be feasible. This evolution, from embeddedness to autonomy - that is, exercising the social capital involved in non-local professional, industrial or social networks - allows four key kinds of social capital to be exercised:

- Integrity - by activating reputational resources associated with membership of a professional association.
- Integration - continued community benefits at low or no cost, deriving from embeddedness but activated through expressing autonomy.
- Linkage - membership of local and non-local networks by virtue of assets deemed to be of consequence to the interests of these.
- Synergy - capabilities to link also to governance bodies, including government programmes and policies (Woolcock, 1998).

Putnam (2000) tackles the embeddedness-autonomy issue from a slightly different angle, making the key distinction between two forms of social capital - 'bonding' and 'bridging', such that low levels of autonomy are consistent with the dominance of the former over the latter. Bonding social capital represents an 'exclusive' set of relationships, characterised for example by special interest groups, families, or based along ethnic lines, and so on. Conversely, bridging social capital is more 'inclusive', and could exist for example within civil rights groups, and other cross-cultural organizations.

With respect to economic development, Putnam suggests that the primary use of bonding social capital is to 'get by', while that of bridging social capital is to 'get ahead'. As such, the former is typically employed in situations of group solidarity, for example community finance and start-up, ethnic business, etc. The latter, however, can provide access to new political contacts, new job opportunities and the like. It is important to note here that the over-reliance on bonding social capital carries with it the potential for negative consequences for the user. For example, once a business has reached a certain size, it may find itself obligated to inefficient suppliers within its 'home' network, or unable to access new markets and sources of large-scale finance. Echoing Granovetter, this emphasises the 'strength of weak ties', in that although less strong than contacts that are used every day, these connections can reach outside one's own immediate network or social circle, and into new areas of information and opportunity.

A recent study of the effects of social capital on the performance of small and medium sized enterprises (SMEs) generally in twelve UK regions found that innovative firms tend to make greater use of collaboration and information exchange, are involved in higher trust relationships and make greater use of non-local networks (Cooke et al. 2005). This finding thus illustrates the potential importance of CLNs (and their related social capital concepts) to regional and industry development. In particular it highlights the potential dangers from too great a focus on internal (in this case Welsh) links, at the expense of CLN links, in terms of increasing rather than reducing vulnerability to external shocks. It also potentially emphasises the dangers of too great a reliance on local-networks because of issues related to intellectual property / secrecy / and maintaining competitive advantage, all of which may make CLNs more desirable for firms, as opposed to local collaboration and resource allocation to local fora activities.

There is, however, no clear framework for the governance of clusters/networks, whether they be cross locational or local. Instead, potential definitions can draw on both institutional and network governance approaches. For the purposes of this investigation network governance will be considered as that which refers to the mechanisms

used to resolve problems of adapting, coordination and safeguarding network participant exchanges. Drawing on these understandings, a broad working definition for such networks is here conceptualised as:

> The pattern of formal and informal relationships and linkages within firms and networks in a locality and the pattern of informal and formal relationships and linkages between firms and networks in another locality or localities.

Given the above working definition, there is the need for an integrative framework that conceptualises the diverse forms of networks (local and non-local), with the governance systems that are available and the stakeholders that are involved. (Griffith and Zammuto 2005, Keast et al. 2005, Pickernell et al. 2006).

The Importance of Governance Issues in developing a Framework for Analysis: Learning, Structures and Management

There are key issues for governance for both local and non-local governance, specifically in terms of facilitating the desired learning to be undertaken through the cluster/network, via appropriate structures (which create the places, or 'fora' for learning) and management protocols. Knowledge is a crucial input into the innovation process in particular, and contains explicit and tacit elements. Explicit, codified knowledge can be encapsulated in formats and transferred to users who are able to interpret and utilise it independently from the context in which it was created, (Howells, 2002) notes. The transfer of codified knowledge is not seen as strongly dependent on geography as codified knowledge can be transferred across geographic regions fairly readily, and reductions in transport costs and improved communications increase access to codified knowledge, rendering it less important as a source of competitive advantage.

In contrast, communication and transfer of tacit knowledge (Polyani, 1962) is more complex, requiring shared experience, dialogue, interaction and learning. Tacit knowledge, it has therefore been argued, does not travel well, making it a key source of 'the *geography* of innovation' (Asheim and Gertler, 2005). This includes knowledge flows between firms, research organisations, institutions and public agencies embedded in a regional context. Frenz and Ougthon (2006), therefore, argue that, since proximity facilitates the transfer of tacit knowledge transfer and learning - both of which are important determinants of innovation - innovation activity takes on a strong regional dimension that may be reinforced by agglomeration economies in production and pools of skilled labour/human capital.

Boschma (2005), by contrast, identifies five dimensions of proximity that can have an impact on learning: cognitive, organizational, social, institutional and geographical. Some authors suggest that the need for geographical proximity for learning to occur is weak when there is a clear division of precise tasks that are coordinated by a strong central authority - organizational proximity - and the partners share the same cognitive experience - cognitive proximity (for example, Boschma 2005: 69). He further suggests that spatial lock-in may be solved or even avoided by establishing non-local linkages, such as CLNs. Also, findings from several empirical studies suggest that local as well as non-local relationships are important sources for interactive learning (Jaffe et al. 1993, Feldman 1994).

Boschma (2005) also suggests that shared formal institution structures [such as laws, rules and regulations that are the subject of governance] are not necessarily bound by geographic proximity. Institutional structures can reflect a kind of balance between institutional stability (reducing uncertainty and opportunism) openness (providing opportunities for newcomers) and flexibility (experimenting with new institutions). To satisfy the need for co-presence to exchange tacit knowledge, CLNs could bring people together through travel, for example (Boschma 2005).

However, the quality of the learning environment during periods when people are brought together through travel is likely to be a precursor for the quality of the interactive learning that occurs in CLNs. Philosophical interpretations such as those of Polanyi (l966) would suggest that entrepreneurial creativity [including cross locality networks] may begin with the tacit intuition of an individual who is flooded with unconscious insight. Many authors espouse that the entrepreneurial process begins with making this tacit insight explicit and sharing it with one or two individuals (Nonaka, 1994, Floyd and Woolridge 1999, Rowe and Christie, 2006). There are variations in the quality of the learning environment during these exchanges. Behaviour-based control during these interactions can act as a powerful signal of which behaviours are considered appropriate or inappropriate, right or wrong, encouraged or discouraged to maximise learning and innovation.

Past research in a study in the electronics components industry, for example, found a positive link between

behaviour-based control and innovative organizational cultures (Oliver and Anderson 1994). It has also been found to be directly influenced by commitment to learning and open mindedness (Rowe 2002). In addition, behaviour-based control has a mutual influence on the learning environment with the sharing of tacit knowledge (Rowe 2004). Sharing of tacit knowledge is thus an initial step in the process of integrating new knowledge by making it useful to the network/cluster.

While the management of tacit knowledge is relatively unexplored, particularly when compared to the work on explicit knowledge (Leonard and Sensiper 1998), Rowe's (2004) empirical study of the impact of sharing of tacit knowledge on the learning environment of top management teams, found that exploitation of tacit knowledge has a direct and positive impact on learning values and practices that are critical to double-loop learning, as opposed to single-loop learning. Single-loop learning occurs where goals, values, frameworks and strategies are set and the emphasis is on existing techniques and making these techniques more efficient. In contrast, double-loop learning, involves questioning the issues which underlie the goals and strategies. In situations such as these, where there is a willingness to shape insights, knowledge and wisdom 'inside our heads', a collective double-loop learning environment can develop.

Stakeholder activity needs to be closely coordinated, therefore, to ensure that the governance structures are in place to facilitate the type of learning processes required to produce the desired outcomes. Learning is thus the key process through which the performance outcomes of networks in general and cross-locality networks (defined in terms of returns sought) in particular are derived. The relationship between learning and cross-locality networks is crucial, structures and governance modes providing the mechanisms to bring participants (and the various stakeholders) together to share resources and knowledge not occurring internally or individually. This relationship is clarified in table 2.

Table 2: Relationship between the purpose of the Network/Cluster, learning processes, sharing of tacit knowledge and behaviour-based control

Organizational characteristic	**Purpose of Cluster = cost (single-loop learning)**	**Purpose of cluster = knowledge (double-loop learning)**
Sharing of tacit knowledge	Low innovation - doing things better - not much sharing of tacit knowledge	High innovation - doing things differently and doing different things - high sharing of tacit knowledge
Behaviour-based control	Focus on adherence to norms; discourage/constrain episodic non-normal and deviant behaviour that leads to innovation; focus on routine activity; focus on minimising variation in ideas creation and contradictions in viewpoints; focus on conventional management practices (rewards, performance appraisal, staffing, training); focus on disciplined behaviour that reinforces conventional management practices	Focus on questioning of norms; encourage/facilitate episodic non-normal and deviant behaviour; focus on episodic non-routine activity; focus on maximising variation in ideas creation and contradictions in viewpoints; focus on development of appropriate social interaction process among learners that leads to two-way communication characterised by collaborative, mutually constructive, critically reflective and emergent engagement of relationships among self, others and the world; focus on undisciplined behaviour that is counter to conventional management practices, visibly disruptive to organizational routine and psychologically and politically challenging

Source: Rowe and Christie (2006)

There is, thus, a key issue here for the framework, in terms of the structures put in place to facilitate learning via appropriate fora and management, particularly (though not exclusively) where cross-locality networks may be geographically dispersed over large distances. In some cases the fora may be very simple, particularly where simple diffusion is required e.g. in simple knowledge-spillovers, and not require specific action to create, develop or encourage. In other cases, where processes of knowledge creation, dissemination and utilisation are necessary, then the precise type of fora for stakeholders and knowledge being brought together, becomes much more important. There are, however, several mechanisms for this. One option is the use of the "hub" firm as an alternative to more complex relationship structures. Dhanarej and Parkhe (2006) for example, argue that pure low-density innovation networks can often be viewed as loosely coupled systems of autonomous firms, proposing that 'hub' firms essentially manage network activities to ensure the creation and extraction of value without requiring explicit hierarchical authority. In high-density networks in contrast, high levels of interaction

effectively replace active coordination by a 'hub' firm. Their identified management activities consist of knowledge mobility, innovation appropriability, and network stability, rejecting the view of network members as inert entities responding to inducements and constraints from their network ties, and instead highlighting a player-structure duality in networks (i.e. taking into account both the structural inducements and constraints of the network, as well as organizational action that perpetuates the network). Their work also highlights, however, the potential for the structures of the network - that is, firms with different role in the network - impacting on the governance mode at work within it.

Specifically linked to the classification of network type, and drawing the issues together, is the governance mode at work. In this respect, there are three basic modes or mechanisms of social integration that are potentially of use: the hierarchy, the market and social networks (Keast et al. 2005), where hierarchies can be either state or corporation based (Griffiths and Zammuto 2005). The classification framework in table 1 does not focus specifically on governance modes and the respective governing activities that provide an overview of characteristics that can facilitate or constrain change in business contexts in response to cross-locality network learning over time. An integrative governance framework is thus required, to bring together the issues highlighted in table 1 with the practical governance activities that will be required to operationalise the network to produce the desired outcomes. This integrative framework enhances our understanding of the systematic differences in the types of governance activities that are most likely within the three basic governance modes, and (in the case of network modes) highlights the activities most likely to facilitate the outcomes sought. Table 3 sets out the key aspects of each of these governance modes and their idealised characteristics in relation to the network elements outlined in table 1, also drawing together structures (including fora) and learning-related issues. The governance aspects that relate to the network elements of structures (advantages of), returns, participant goals, and types of learning are drawn from the strategic management literature and the political economy literature (synthesised in Griffiths and Zammuto, 2005). A further structural network element, namely stakeholders (linked to horizontal/vertical aspects in table 1), is also derived from Griffith and Zammuto's (2005) conceptualisation. Those government aspects that relate to the network elements of participant conduct, participant basis and network systems management are drawn from the transaction costs economics literature and social networks theories literature (Keast et al., 2005). Finally, the network structure element of governance structural mechanisms (which can be linked to formal/informal aspects in table 1) is conceptualised from Keast et al.'s (2005) analysis.

Table 3: Model of network/cluster elements and governance systems factors drawn from the transaction costs economics literature and the social networks theories perspectives

Network/Cluster element	Governance Mode	Hierarchy	Hierarchy	Market	Networks
	Institutional Profile.	State governance	Corporate governance	Market governance	Social governance
Structural **Stakeholders (Who)**	Institutional capabilities * State involvement in industry governance * Corporate involvement in industry governance	High-corporatist style structures to bring key economic players together, negotiated outcomes Low	Low-intervenes to address competitive imbalance High	Low-minimal tariffs/trade agreements Low	Low-intervenes to facilitate only transformational capabilities Low
Structures **Structures (How)**	Characteristics. * Value chain * State involvement * Coordination of economic activities and decision making * Competitive orientation – cost/value added	Fragmented High State High/high	Integrated Low Corporations (through managerial hierarchies) Low/moderate	Fragmented Low Market forces Low/low	Integrated Low Collaboration High
Structural **Governance structural mechanisms : Fora (Where)**	Institutional arrangements	Committees, working parties, interdepartmental committees	Committees, working parties, interdepartmental committees/ Business associations, corporate boards	Business associations, corporate boards	Network arrangements, informal collaborations, social charters and compacts and roundtables
	Condition of best fit. * Economic conditions	Long term growth, fosters national identity during	Rapid industry growth	Economic stability or growth that encourages	Works well under conditions of econ-omic growth and

Returns (Why)	* Speed of adjustment to industry changes	tough economic times Slow	Fast	industry expansion Slow-if adjustments are made at all	stability and under conditions of economic turbulence Fast
Participant goals (Why)	Stakeholder adjustment	Costs of adaptation are distributed across industry participants, focusing on 'sharing the pie'	Weakest members of the value chain bear the costs of industry adaptation	Weakest members of the value chain bear the costs of industry adaptation	Costs of adaptation are distributed across industry participants, focus on 'growing the pie'
Participant conduct (How)	Influence orientation Integration relationship orientation	Dependent Authority relationships	Dependent/independent Authority/ exchange relationships	Independent Exchange relationships	Interdependent Social/ communal relationships
Participant basis (How)	Key integration mechanisms	Centralised and legitimate authority, rules, regulations, procedures and legislation	Centralised and legitimate authority, rules, regulations, procedures/Formalised legal contractual arrangements.	Formalised legal contractual arrangements. Arms length transactions, bargaining	Interpersonal trust, mutuality and reciprocity
Network systems management (How)	Management focus Management strategy and core tasks	Administrative management Top-down, command and control, planning, organizing, staffing, directing, coordinating, reporting, budgeting	Administrative/contractual management. Top-down, command and control, planning, organizing, staffing, directing, coordinating, reporting, budgeting/ Arms-length transactions, negotiated interactions, performance specification, bargained outcomes	Contractual management Arms-length transactions, negotiated interactions, performance specification, bargained outcomes	Relational management Activating, mobilizing, framing, synthesizing
Type of learning (How/Why)	Rate of innovation (rate/focus)	* Slow-industry enhancing * Transaction-al processes * Focus on routinisation, adhering to norms, conventional management practices * Not much sharing of tacit knowledge	* Fast-firm specific * Transaction-al processes * Focus on routinisation, adhering to norms, conventional management practices * Not much sharing of tacit knowledge	* Slow-firm specific * Transaction-al processes * Focus on routinisation, adhering to norms, conventional management practices * Not much sharing of tacit knowledge	Fast-development of future-oriented industry capabilities * Social processes * Focus on episodes of non-routine activity, questioning of norms * High sharing of tacit knowledge

Source: Adapted from Pickernell et al. (2006); Keast et al. (2005); and Griffiths and Zammuto (2005)

Explaining table 3, In terms of governance, markets are sometimes perceived as unable to adequately bundle the relevant resources and capacities between science and industry, while completely vertical integration of the hierarchy restricts flexibility and incentives (Menard 2002). Also, pure networks of relationships based solely on trust and reciprocity are often insufficient forces to secure necessary directed outcomes (Rhodes 1997; Keast and Brown 2002). Given the mix of stakeholders in many networks (with varying strengths), it is probable that a mix of governance modes will be employed in reality in both geographically based and cross-locality networks.

Hybrid arrangements (Borys and Jameson 1989) allow for the interaction, often simultaneously, of governance modes. This can result in combinations and recombinations of contract, formal structure and interpersonal relations as the linking process for these new institutional arrangements (Schaeffer and Loveridge 2002). The

complexity involved in governance modes makes it imperative to understand the type (and often mix) of modes in operation, in order that beneficial development policies can be enacted utilising the appropriate strategies. This analysis also aids in a deeper understanding of the management issues that surround network activities. This is also of crucial importance in highlighting areas where government action may be required, in situations where keystone companies may not have the ability to organise the industry to mirror the preferred structure, existing market-based, corporate or network-based modes do not have sufficient ability to engender necessary changes, or where the role of government and institutional stakeholders is of crucial importance, but is not likely to be changed solely by industry based actions. The integrative framework developed draws on a multidisciplinary literature and provides a lens through which shifts in business contexts and governance systems can be explained and evaluated. The classification frameworks in table 1 and table 3 thus facilitate analysis of whether what exists at present represents a coherent cluster/network, in comparison with the 'ideal' arrangements for the industry, and where policy could be targeted to strengthen existing arrangements or generate changes to forge new, more beneficial ones. This also has benefits in terms of resource allocation, because it identifies cluster/network conduits for policy where they exist, and also highlights where such conduits would need to be built before policy can be implemented. If we then use the analysis in table 3, in concert with a table (4) of cluster attributes derived from Clifton et al (2005)we can identify very basic possible governance structures (including hybrids combining governance modes) for each of the basic cluster types, illustrated in table 5 below. This is designed to provide a basic framework, through which discussion of "hybrid" cluster types, which do not necessarily match the eight basic cluster types, can also occur.

Table 4: Cluster/Network Types

Type	Attributes:
Structural	
Industrial Complex	• Structure Dominated by one or several government controlled institutions (e.g. university, military, with high Economies of Scale (EOS) • High links to local suppliers only, but low commitment • Labour in-migration and loyalty to institutions, then district, then small firms • No specialised services, weak trade associations • Weak local government role
Hub and Spoke District	• Structure dominated by one or small number of large firms • Vertically integrated and surrounded by suppliers (with lots of trade between them), but also many links outside district • Long term contracts and cooperation • Labour market internal to district with worker loyalty to large firms, first, then small, then district. • Specialised services located within large firms, absence of trade associations • Strong local government
Italianate District	• As Marshallian but also personnel exchanges between buyers and suppliers • Cooperation between competitors to share risk • High innovation • Strong trade associations to create shared infrastructure • Strong local government
Marshallian Industrial District	• Small local firms, low EOS • Large intradistrict trade between firms • Long term local contracts • Strong internal labour market, with labour loyal to district rather than individual firms • Specialised services available to firms in district
Urban hierarchy	• Geographically based external (to firm and industry) EOS from sharing of common infrastructure, utilities, services, etc. • Different industry based
Social Networks	• Relationship and trust based clusters, based on informal (as opposed to formal transactions) ties to create joint ventures, reorganise relationships and act in a group for common benefit. • Spatial benefits of networks based on "weak ties"
Virtual Organisations	• Relationship based on formal ties to create joint venture "virtual large organisation" from groups of SMEs • Spatial benefits of networks based on strong ties
Satellite Platform District	• Structure dominated by large externally owned firms with high EOS • Low links to local suppliers and absence of long term contracts and cooperation • Labour market external to district, with workers committed to large firm only • External sources for specialised services • Strong local government role (incentive based)

Source: Derived from Clifton et al (2005)

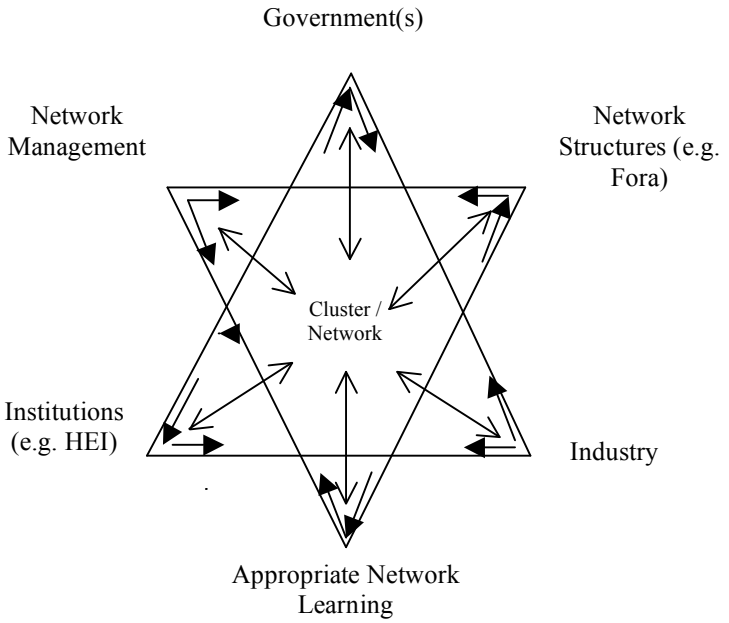
Table 5: Possible Governance Modes and Hybrid combinations for Basic Cluster Types

Cluster Type	Probable Governance Mode/Hybrid
1 – Industrial Complex	Hg-Hc \/ n
2- Hub and Spoke	Hc | n-Hg
3 Italianate District	N | Hg
4 Marshallian	N | m
5 Urban hierarchy	M-n
6 Social Network	N
7 Virtual Organization	M/H-N
8 Satellite Industrial Platform	Hc-Hg V m

Note: Hg = Strong Hierarchical Government based governance mode; Hc = Strong Hierarchical Corporate based governance mode; n = weak network based governance mode; N = Strong network based governance mode; M = strong Market based governance mode; m = weak market based governance mode

Figure 1 thus illustrates the complete set of actors and issues of likely importance, placing the cluster/network at the centre of a governance-related framework which encapsulates potential stakeholders (from Leyesdorff's Triple Helix) of government, industry, and institutions, with the governance-related issues of learning activities, network management, and appropriate facilitating structures (e.g. fora) discussed.

Figure 1: Cluster/Network Governance Framework



This structure thus places the cluster/network at the heart of the process. The two-way nature of the arrows highlights the multiple-direction of information flows necessary for effectiveness in the system. The diagram also highlights the range of stakeholders and governance-related issues requiring analysis. This is of particular

import, given that the relationships between actors in a CLN may be different to those within the separate initially geographically-designated networks for the industry. The framework thus identified in figure 1 and issues highlighted in tables 1, 2, 3 and 4 therefore provide an integrative analytical framework, identifying the issues of importance when exploring the 'fitness for purpose' of the clustering /networking occurring within an industrial sector (both locally and cross-locationally). The classification frameworks in table 1 and table 3, in particular, provide a useful lens through which to take a snapshot of different types of networks' and, crucially, their governance structures in relation to the outcomes sought. The highlighting of the need to identify "hub" firms is also important in this process. The framework also allows insight into the dynamic development of networks over time, to the extent that sought outcomes will require changes to governance activities in order to be achieved.

3. METHODOLOGY: OPERATIONALISING THE FRAMEWORK

The challenge now is to begin to test this framework. Such research can make a contribution to the analysis of localities and regions by focusing on the effects and importance of the management and governance of clusters and networks to facilitate more effective outcomes. It can also make a contribution by exploring new ways to examine innovation processes. This research agenda, however, requires industry analysis in innovation-rich sectors such as aerospace, as well as (ultimately) broader evaluations of regional economies as a whole.

The work of Florida (1996) was utilised initially in determining this appropriate broad methodological framework. This work examined clustering through secondary source data, supported by primary interviews and survey work. The secondary data concentrated on factors such as output, investment, productivity, value added, employment, wages etc. As Florida (1996) also asserts, however, such data is not suitable for examining relationships between production organisation and regional economic transformation. Florida utilised interviews with experts from government, business support, industry, and academia, as well as surveying companies.

This study follows this same basic approach. The outputs required are derived utilising a 2 stage analytical process. The first comprises a general quantitative, statistical audit of Welsh Aerospace, (in terms of employment, number of firms, size of firms, GVA, growth rates, location quotients (LQs) (relative to the UK), supported by available secondary literature on the aerospace industry. The stage one analysis thus builds upon the DTI (2001) framework, augmented with the broad statistical analysis framework utilised by the WERU (2002) study, but also defines a number of sub-regions (North Wales, Mid and West Wales and South-East Wales). From stage one, therefore, a brief statistical summary of each of the clusters is provided, utilising the available quantitative evidence.

The stage one statistical analysis relies primarily upon the wide range of economic and employment data available through NOMIS and National Statistics, supported by existing literature and secondary data sources (for example from WAG, WDA, industry bodies and associations) to highlight the existing statistics and knowledge related to the aerospace industry and its constituent sectors in Wales. In addition, available input-output data is utilised to highlight linkages, as well as data restrictions from this approach. In particular, statistical techniques such as LQs and input-output may highlight "clusters" which are merely the outcome of geographical proximity or normal customer-supplier links, rather than falling within the categorisation of clusters as defined in tables 1,4 and 5. There is therefore a crucial need to examine the nature of the relationships within the potential clusters, through more in-depth analysis. Hayward's (2005) mapping of UK regional 'clusters' in aerospace, because it includes the two and largely separate North Wales and South Wales agglomerations as part of larger clusters merging with the aerospace industry in the South West and the North West of England, also highlights the issue of CLNs and wider geographies to consider, making it crucial to evaluate how Wales fits into the wider aerospace industry and the appropriateness of cluster-type analysis in this context.

We thus utilise the frameworks identified previously in Clifton et al (2005), and extend the cluster/network analysis identified here, to build a second, survey based stage of perceptions of industry experts in a number of areas, split into 3 sections. The first follows (with some adjustments to highlight the roles of industry, government and institutions) the MSQA analysis conducted in Clifton et al (2005) related to industry capacity, risk, and trade. The second stage focuses on cluster and network analysis, beginning with the broad questions developed by Clifton et al (2005) and highlighted in table 1, but then building the more in-depth examination of management processes highlighted in the literature earlier and summarised in table 3, for both internal (Welsh) networks, but also for the CLNs that are increasingly important in many industries. Finally, a small number of "keystone" firms and organisations are interviewed to examine their perceptions of the Welsh industry, its future and the issues facing it. The approach thus follows the ideal methodology highlighted by Clifton et al (2005). It thus includes:

- Statistical analysis;
- Perceptions of the industry from senior stakeholders within the cluster;
- Mapping of companies and individuals' relationships and activities, to fully determine the existence and status of the cluster.

Time and cost constraints precluded the third of these within the Clifton et al (2005) study. This current research, however, seeks to at least partially rectify this, through interviewing key companies in each of the sub-sectors of aerospace. The statistical element, thus, concentrates upon the first two types of analysis, utilising Location Quotients (LQ), and broad input-output analysis. The methodology adopted thus endeavours to also examine the nature and importance of cluster structures and processes, as well as competencies, risks and trade potential,

through the use of MSQA, as well as areas for change, and the potential difficulties and rewards from changing cluster structures towards those perceived as being more beneficial to the Welsh industry. This is especially important given that, for example, Smith and Ibrahim (2006), examining the aerospace cluster in the East Midlands, conclude that it had the characteristics of a hub and spoke cluster and that measures to develop more local Marshallian type cluster arrangements may be counter productive in these circumstances.

The methodology adopted is also capable of being updated relatively easily on a regular (e.g. annual or bi-annual) basis, and thus given the dynamics of the knowledge-intensive industries of which aerospace is an example, can track possible changes in the "ideal" cluster type over time. This is clearly of important in guiding public sector interventions where desirable and / or cautioning against such interventions where this may hinder natural industry adaptation and evolution. It is also important to note that where "hybrid" cluster types are identified as existing by the data (as opposed to those fitting within the 8-type typology highlighted by the literature), in most cases this will indicate the lack at present of a coherent cluster, but also the degree to which a coherent cluster may be possible in the future (depending on the nature of the hybridity and how near to a specific cluster type it is). Ultimately it must be remembered, however, that the methodology generates additional information for use in policymaking, but is not designed to derive specific policy implications. Issues related to government intervention and market failure will be of particular importance here, given that market failure of some kind is normally a necessary justification of public-sector involvement. In addition Cooke (2003) highlighted in his examination of regional innovation systems, that faster growing regions tend to have 'entrepreneurial' innovation systems, whilst more peripheral regions have 'institutional' ones.

In terms of the industry experts chosen, Roberts and Stimson (1998) suggest, as an ideal, panel groups of industry sector actors, both internal and external to the region, derived from either "expert samples" or random samples from lists of private and public sector individuals. Clearly the more extensive the coverage of participants in these Delphi-type exercises, the greater the likely validity of the assessment produced (Roberts and Stimsom, 1998). They also acknowledge, however, the time and cost implications of such a procedure. Because of these time and resource constraints, the methodology adopted by WERU (2002) was therefore followed, focusing on identifying and asking the person identified as offering the most informed opinion on the cluster in question, in this sense purposive sample (Patton, 1990) i.e. one in which subjects are selected for a particular characteristic. Clearly, the issue then becomes the accuracy in identifying "experts" to answer the questionnaire. This study identified experts on the development of Welsh aerospace in particular (but also with a broader view of trends in UK and worldwide aerospace) via consultations, examination of industry and government organisational structures, and published literature. These were sought from senior company directors in the selected aerospace sectors, academics with expertise and knowledge of Welsh aerospace, government and quasi-government personnel with responsibility for developing policy in the selected sectors, and those with experience from and with relevant aerospace associations. Specifically, the study sought to obtain the views and perceptions of one expert for each on each of the sectors, from either the industry itself, academia, or from a relevant government agency, highlighted in table 6. One expert per questionnaire was chosen to avoid issues of inter-rater reliability in this type of research highlighted by authors such as Schwartz and Teach (2000) and Pagel and Krause (2005), though it obviously also means that the quality of these results depends crucially upon the quality and knowledge of the experts chosen. We believe that the process of determining these experts was robust, however, and thus that the views expressed are valid, though clearly they are perceptions and thus the results must be seen in this light.

Table 6: Questionnaire and Expert Types

Questionnaire one: Activity Capacity, Risks & Relationships	**Expert Type**
Manufacturing	Government
MRO	**Government**
R&D/Training	**Academic**
Questionnaire two: Cluster/Network Structures & Processes	
Manufacturing	**Government**
MRO	Industry
R&D/Training	**Academic**
Questionnaire three: Keystone Companies	
Manufacturing	**Industry**
MRO	**Industry**
R&D/Training	**Industry**
Manufacturing	**Industry**

MRO	**Industry**
R&D/Training	**Industry-Academic**

Graphical representations of the summarised MSQA results are produced from the experts' perceptions, together with a commentary provided for each section and additional analysis of areas of specific relevance. This did, however, necessitate some adjustment of the data gathered from the questionnaires (see Appendices for detailed outlining of exact questions and context). For questionnaire 1 the section Activity, Capacity, Risks and Relationships data was gathered into 9 reported themes. Essentially, each of the competencies "accuracy" (of the question statement) data was converted from a +1 to +5 scale to a +2 to -2 scale via simple subtraction, which, when multiplied by the importance variable gave a scale from +10 to -10. For each of the themes the values for the criteria within that theme were averaged to generate the 9 reported results for competencies. Important individual criteria were also discussed, where appropriate. For trade in exports, imports and the initial scales were reported, for current trade importance of each designated market (1-5 where 1 = irrelevant and 5 = very important) and future trade potential (1-5 where 1 = little potential and 5 = very high potential), and a rescaled overall index of 0-10 (from the 1-25 scale given by multiplying together the current and future trade scales), where 10 indicates great current and potential for / from that market and 0 indicates no current or future potential.

For questionnaire two concerning cluster structures and processes, the results were compared with those necessary for each of the eight basic cluster types to determine the Welsh-cluster structure in existence. The nine initial questions asked generated a 9 point scale for each cluster type, with 9 indicating a perfect fit to a cluster type. This was undertaken both for the current position of the cluster and the ideal structures and processes the experts believed would be necessary to maximise the potential of the cluster (i.e. the structures and processes that should exist). The "ideal" cluster type determined by the experts' responses was then compared with the current results for that cluster type and its score. The importance of the current and ideal structures and processes for the Welsh cluster were also reported and compared. This comparison was a key element of analysis of the state of the cluster, allowing the type and importance of the cluster to be evaluated, areas for future improvement identified, and issues for policymakers and further research to be pinpointed. In addition, questions concerning the stakeholders involved were also asked in this initial section. In part B of this questionnaire, more detailed questions were asked concerning the cluster and network governance and management structures, management and learning, in both actual and ideal situations, and the importance placed by respondent experts to the current and ideal perceived situations. In part C these same questions were asked concerning the cross locational networks.

Finally, for the keystone companies, the basic interview questions asked were: -

- Why did your company/organisation establish its current operations in Wales in the first place? Of these which are the most important reasons?
- Why does your company/organisation currently remain in its operations in Wales? Of these which are the most important reasons?
- What do you think is likely to be future strategy of the company/organisation with respect to its Welsh operations? Of these what are likely to be the most important?
- What government /industry/university-related policies would be of assistance in facilitating your continued location in Wales? Of these which are the most important reasons?

4 RESULTS

Stage 1: Location Quotients, Input-Output, and Business-Size Data,

Table 7 shows that, with an overall LQ of 1.16, aerospace activities are more prevalent in Wales than in the UK as a whole. This activity is dominated by the manufacturing element, which in turn has an LQ of 2.55. The regional LQs reveal the concentration of the industry within North Wales; similarly this is almost entirely as a result of manufacturing activities, which are over seven and a half times more concentrated in the region than they are in the UK as whole.[1] With regard to aerospace as a whole, South East Wales is on par with the UK average, again this is predominantly manufacturing-related, but unlike the North not exclusively so. Finally, the table shows that aerospace activity is effectively absent from Mid and West Wales.

Given the capital-intensive nature of the industry, the high average unit size is unsurprising; it is also worth noting the large disparity in size between manufacturing and service activities, which is in turn reflected in the overall average, given the dominance of manufacturing within the cluster in Wales.

The cluster has relatively high levels of employee compensation, more than 50% above the Welsh average. Gross Value Added (GVA) increased at over 17% during the period 1999 to 2004, which is in line with the Welsh average for all industries. The important high value-adding nature of the sector is highlighted by the GVA per head figure, which is well above the Welsh and UK averages for all industries; of some concern however is the fact that Welsh aerospace GVA/head stands at only 83% of the GB level, mirroring the average across all industries (Employee Compensation Data and GVA from National Statistics, Regional Accounts Data, 2004).

The input-output data in this section is derived from the Welsh Economy Input-Output Tables for 2000, (Welsh Economy Research Unit, 2004)[2]. Within the 74 sector groupings that the tables employ, the most appropriate figures available are those for the Manufacture of Other Transport Equipment; as discussed above this can be regarded as a reasonable approximation to the Welsh aerospace cluster. This means however that no comment can be made on 'internal' cluster transfers other than they account for £63m (the largest purchases outside the grouping are those from Pressings and Metal Products (£53m) and Engineering Services (£23m)).

The total value of output for Manufacture of Other Transport Equipment (i.e. our proxy for aerospace in Wales) is just over £1.4bn. The sector is very open in terms of (geographically) external trade linkages, which might be expected given the nature of the product - imports from the rest of the UK total £213.1m, while from the rest of the world they are £351.4m. This represents 40.3% of output, the Wales average being 23.5%. Unsurprisingly, the vast majority of this output is exported to the rest of the UK, officially accounting for just over £1bn, while those to the rest of the world stand at £168.9m (in total 85.4% of output being exported, the all-Wales industry average being 18.1% of total output). Given the importance of Airbus wings in exports, however, this relative importance of the UK compared with the rest of the world may indicate a scheme whereby Airbus products are counted as being exported to the rest of the UK first, before being shipped on to the rest of the world. Overall, however, the contribution of the sector to Welsh economy can be seen as highly beneficial in terms of the trade balance, with a significant trade surplus of around £640m.

[1] In crude terms, the DTI (2001) cluster mapping exercise defined any sectoral agglomeration with a location quotient of 1.2 or above as a cluster, under which criteria aerospace in Wales qualifies. One company (Airbus) is dominant within this, accounting for around 7,000 employees.

[2] Welsh Economy Research Unit (2004) Welsh Economy Input-Output Tables for 2000, Cardiff, Welsh Economy Research Unit.

Table 7: Aerospace Cluster Overview

Cluster	Total Employ-ment	Location Quotient (LQ)	Mean Unit Size (employees)	Employee Compen-sation (per head) (£)	Change in Wales GVA 1999-2004 (per cent)	Index: Wales Overall GVA per head = 1	Index: Overall GB GVA per head = 1	Index: GB GVA per head for Industry =1	LQ South East Wales	LQ Mid and West Wales	LQ North Wale
Aerospace Total	**11,139**	**1.16**	**182.6**	**-**	**-**	**-**	**-**	**-**	**0.99**	**0.04**	**3.18**
Manu-facturing	10,317	2.55	234.5	31,105*	+17.2*	1.23	1.14	0.83	1.97	0.02	7.51
Air transport & supporting activities	822	0.15	12.6	-	-	-	-	-	0.28	0.06	0.02

Source: Employment Data from ABI, 2005. Employee Compensation Data and GVA from National Statistics, Regional Accounts Data, 2004.

NB: The available industry definitions for employment within aerospace are Manufacture of Aircraft (SIC 3530), Air Transport (SIC 62) and Other Supporting Air Transport Activities (SIC 6323). The latter two are combined in the table above. Given issues surrounding definition and categorisation, these will inevitably not tally exactly with 'actual' aerospace-related employment in Wales, but can be regarded as the best approximation available.

- These figures relate to SIC 35, Manufacture of Transport Equipment (i.e. not just aircraft but excluding motor vehicles) and are not available below two-digit SIC level. However, in Wales 93% of SIC 35 is accounted for by SIC 3530. Moreover, manufacturing in turn accounts for around 93% of the total for Welsh aerospace employment, and so it would also be reasonable to approximate the SIC 35 figure to that for the cluster as a whole.

Figure 2: Other Transport Input-Output Inter-Linkages

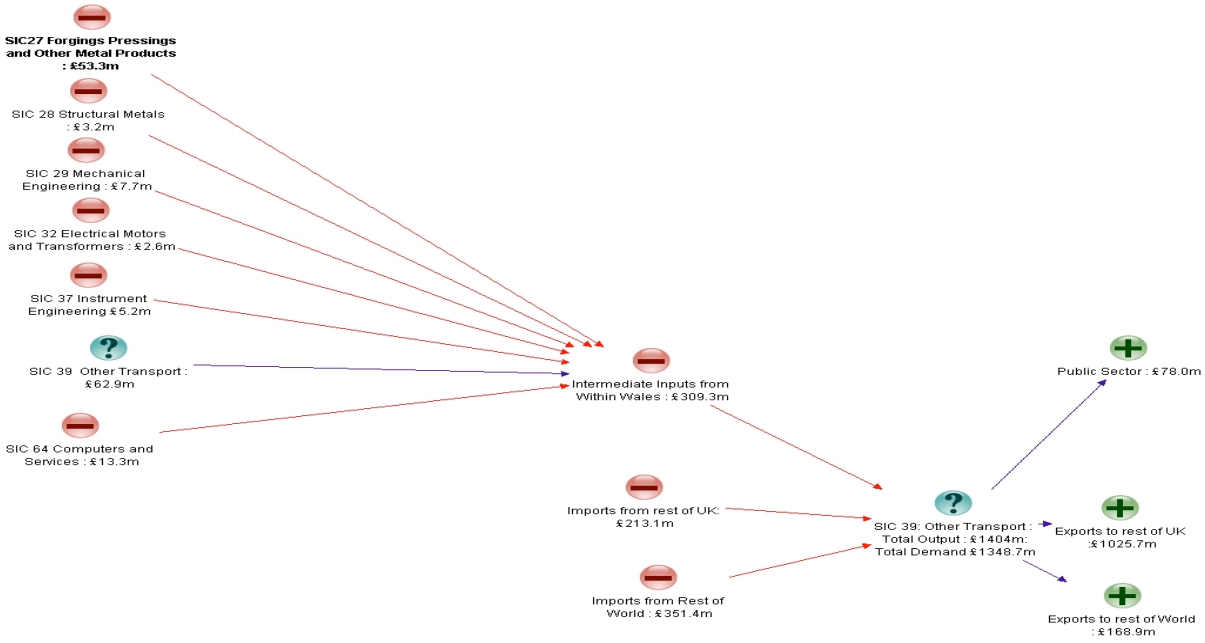


Table 8 :Wales: Aerospace - Business Unit Size

Size	1-10	11-49	50-199	200+	All Units
Manufacture of Aircraft (3530)	55 (81)	3 (4)	6 (9)	4 (6)	68
Other supporting air transport activities (6323)	36 (88)	4 (10)	1 (2)	-	41
Air transport (62)	18 (78)	3 (13)	2 (9)	-	23
Total	**109 (82.5)**	**10 (7.5)**	**9 (7)**	**4 (3)**	**132**

(Per cent in parentheses)
Source: Employment Data from ABI, 2005

Table 9 GB: Aerospace- Business Unit Size

Size	1-10	11-49	50-199	200+	All Units
Manufacture of Aircraft (3530)	580 (64)	118 (13)	117 (13)	93 (10)	908
Other supporting air transport activities (6323)	630 (75)	126 (15)	35 (4.5)	41 (4.5)	835
Air transport (62)	900 (71)	183 (145)	101 (8)	80 (6)	1,264
Total	**2,110 (73.5)**	**427 (14)**	**256 (8.5)**	**214 (7)**	**3,007**

(Per cent in parentheses)
Source: Employment Data from ABI, 2005

The available statistics (tables 8 and 9) also highlight that the Welsh industry is disproportionately (compared with Great Britain) focused in smaller companies; these figures are, however, likely to considerably underplay the actual size and importance of aerospace activities. It must be recognised that due to definitional difficulties, many firms with aerospace activities are classified into other sectors (such as automotive or electronics) in the official statistics. In reality, aerospace is an industry recognised to be of primary importance within the Welsh economy. Some 150 firms serve aerospace markets, employing in excess of 20,000 people in 2006. The industry has emerged over the last 20 years and is worth around £2bn. to the regional economy today (WAG, 2006).

Table 10: Employment in Aerospace by Geographical Area

	Mid & West	North	S. East	Wales	GB
Manufacture of Aircraft (3530)	49 (32)	5,708 (100)	4,239 (86)	9,996 (92.5)	88,994 (43)
Other supporting air transport activities (6323)	42 (27.5)	5 (0)	238 (5)	285 (2.5)	34,816 (17)
Air transport (62)	62 (40.5)	4 (0)	454 (9)	520 (5)	84,870 (41)
Total	**153**	**5,717**	**4,931**	**10,802**	**208,680**

(Per cent in parentheses)
Source: Employment Data from ABI, 2005

As Table 10 also shows, the Welsh aerospace sector, also displays a north-south divide, with largely separate agglomerations in the north and south and little in between. This does not indicate, however, the different concentrations of activities undertaken in the two sub-regions of Wales. North Wales (NW) is dominated by an aircraft wing component manufacture supply chain to Airbus at Broughton, one of the major Airbus UK production sites. In comparison, whilst substantial manufacturing also takes place in South Wales (SW), its main aerospace strengths are in maintenance, repair and overhaul (MRO), as well as research, development and training (RDT). Most of the overall Welsh employment is thus in aircraft production in NW, followed by MRO activities in SW (Flight International [FI] 20.06.06).

Companies range in size from Airbus Broughton employing about 7,000 people, via medium-size players including GE Aircraft Engine Services in SW, to small enterprises such as Cottam and Brookes Engineering in SW. There are also public sector R&D and training institutions, mostly based in SW, supplying the aerospace knowledge and skills base. Aerospace Engineering at Swansea University and Barry College International Centre for Aerospace Training are all examples of key institutions in SW, whilst Engineering at the North East

Wales Institute is pivotal in NW. Finally, there are public bodies crucial for supporting the development of aerospace that are mainly based in SW. Most important is the Welsh Assembly Government (WAG) and its Aerospace and Defence Team. The WAG has recognised the importance of aerospace by, for example, identifying aerospace as a cluster of key concern for International Business Wales, establishing the Aerospace Wales Forum (AWF), as well as offering grants to aerospace companies creating jobs in Wales (Ehret and Cooke forthcoming a and b).

The structure of the Welsh aerospace sector, however, has been little studied by stakeholders or academics. Studies by the Department of Trade and Industry (2003), the House of Commons Trade and Industry Committee (2005) and the Society of British Aerospace Companies (2005) examine the current and anticipate the future state of the UK aerospace industry. They provide a wealth of information about industry trends and performance indicators. They do not, however, clearly distinguish between a) aircraft manufacture, b) maintenance, repair and overhaul, and c) research, development and training. Hayward (2005) does map UK regional 'clusters' but includes the two and largely separate North Wales and South Wales agglomerations, constituting the whole of aerospace Wales, as part of larger clusters merging with the aerospace industry in the South West and the North West of England.

Consequently, there are no comprehensive aerospace cluster mapping reports for Wales, as have been completed for other areas such as North West England (Mair 2001), with specialist journals such as Flight International only occasionally covering the Welsh aerospace sector (20.06.06). Thus, whilst Aerospace Wales Panorama, published by the Welsh Assembly Government, and the website of the Aerospace Wales Forum, offer valuable information, no independent and comprehensive analysis of the whole of the Welsh sector exists at present, highlighting the need for the study undertaken.

From the small number of social science texts investigating aerospace at the UK level, Smith and Tranfield (2005) highlight the ongoing restructuring of the British aeronautics industry, with formerly highly integrated primes outsourcing more and more part and service production to suppliers. Reed and Walsh (2002) also examine supplier development programmes run by large UK aerospace companies, examining the theoretical and empirical issues, but do not create a holistic industry picture. Hickie (2006) investigates the relationship between knowledge and competitiveness in the aerospace industry, using the North West of England as a case study and concluding that knowledge plays an important role in the success of aerospace regions.

Smith and Ibrahim (2006), examining the aerospace cluster in the East Midlands, conclude that this cluster, in common with that of Boeing in Washington State, for example, has the characteristics of a hub and spoke cluster (the evidence gleaned from secondary as opposed to primary sources), that drawing knowledge in from outside the region is important, and that measures to develop local Marshallian type cluster arrangements may be counter productive in these circumstances. The remaining contributions discuss developments in various overseas regions, but broadly support the importance of knowledge gained from outside the region.

A paper by Niosi and Zhegu (2005) examining the relevance of local versus global knowledge spillovers to the success of international aerospace regions, for example, concludes that global spillovers are more important than local ones, warning against regional economic policy measures that pay insufficient attention to influences beyond regional borders. None of these papers explicitly distinguishes between aircraft manufacture, MRO, and RDT. Implicitly, however, the focus of most texts is on manufacture, with some also examining R&D as a related activity. In contrast, MRO and training do not appear in the literature to any extent.

Three forthcoming publications are thus utilised to provide a first analysis of the important features of the Welsh aerospace industry. Ehret and Cooke (forthcoming) examines the procurement decisions of various Welsh aerospace firms and concludes that the location of knowledge and skills explains many of the decisions. Ehret and Cooke (forthcoming a) discusses the outsourcing strategies of Airbus Broughton and the wider Airbus operations from the perspective of the lean supply model. Ehret and Cooke (forthcoming b) then elaborates on the distinctions between the two Welsh aerospace agglomerations and establishes the limited relevance of geographical proximity to the success of the industry. In the absence of other accounts on Welsh aerospace, the following discussion is based on these texts.

Aircraft manufacture is the core strength of Welsh aerospace and mostly takes place in North Wales, with the Airbus Broughton plant being pivotal to this, particularly given that, together with Airbus at Filton in England, it is responsible for the R&D and manufacture of wings for all Airbus aircraft and the overall design and supply of fuel systems. Broughton and Filton are the main sites of Airbus UK, which after the sale of the BAe Systems share in Airbus to the European Aeronautic Defence and Space Company (EADS) is fully controlled by the

latter. Airbus UK is an integral part of the EADS-subsidiary Airbus SAS, which unites the R&D and production capabilities of four European countries towards the work-sharing manufacture of aircraft. Broughton is a production and assembly plant with well-developed skills and tacit knowledge necessary for manufacturing metal wings.

These composites devalue the metal expertise of Airbus UK and may thus impair the long-term prospects of the wider British aerospace industry and its many Airbus suppliers, if appropriate reorientation towards composites at Broughton fails to create opportunities for domestic-located local businesses. In contrast, countries such as Spain and Japan have already acquired composite expertise superior to that of the UK, and the industry in Britain must therefore aim to speedily catch up if it wishes to maintain its current strength in wing production (Campbell 2006) and avoid transfer to Airbus manufacturing operations on the Continent. This is especially important since, with the sale of the BAe Systems share stake in Airbus, the UK government has lost the political leverage that has previously helped to keep Airbus work in the UK. It is, therefore, vital that Wales participates fully in the composites development programmes being pursued through the National Aerospace Technology Strategy and that the expertise and technologies developed is transferred into the Welsh manufacturing environment.

Though the supply chain to Airbus does not involve all the aerospace companies in NW, most of the Small and Medium Size Enterprises (SME) there are metal wing component product or service providers to Broughton. The majority build "to print" and rely on tacit knowledge and application skills. The Metal Improvement Company and RD Precision are examples of firms specialising in aerospace metals and depending on Airbus Broughton as their main customer. Clearly, the paradigmatic change to composites threatens the viability of both Airbus and its supply chain, if appropriate technological reorientation does not occur

Market forces would suggest that over the longer term Airbus might indeed re-allocate all or part of wing manufacture to other Airbus home countries where investment in composites technology has taken place, sometimes with Government support, and where expertise in wing manufacture is being acquired. The case for intervention by Government to support faster acquisition of composites technology and expertise in the UK is based, therefore, not on market failure but on the need to ensure the UK acquires and retains a technology vital to its continuing role at the forefront of international aerospace manufacturing.

A range of sizeable aerospace companies also exists in NW, that neither maintain contacts with Airbus Broughton nor other regional aerospace firms. These include Cytec Engineered Materials and operations until recently run by Thales Optics, selling composite materials and cockpit equipment respectively to Airbus SAS plants overseas. Finally, there are also aerospace production firms in South Wales, such as Contour Premium Aircraft Seating, and Cottam and Brookes Engineering. The ratio of design-build, as opposed to build-to-print, skills and knowledge appears to be higher in SW than in the north, suggesting a greater proportion of knowledge being codified in the south than in NW. The SW industry is also more diverse and fragmented, and thus less vulnerable to single threats, such as the greater use of composites.

Indeed, a number of SMEs in SW, operating in the MRO and RDT sectors as well as in production, have already strengthened their composite expertise, and are thus better geared for the technology shift than the more metal-based NW industry. This suggests a clear need to map the clustering and networking activities at work in the industry, and how these may need to change, if manufacturing is to survive and develop in Wales, given the highlighted importance of knowledge flows to the industry.

Maintenance, repair and overhaul (MRO), the second main strength of the Welsh aerospace industry, is concentrated in the south, with North Wales playing a minor role. British Airways Maintenance Cardiff (BAMC) is the biggest MRO firm and services Boeing 747 and 777 planes. GE Aircraft Engine Services and Nordam Europe are similarly important MRO facilities for aircraft engines. The Defence Aviation Repair Agency (DARA) formerly the largest MRO employer will shut down the remainder of its operations later in 2007. BAMC stresses the local availability of a skilled aerospace workforce as an important reason for settling in South Wales, as do a number of other large businesses.

In the light of a global shortage of aerospace engineering knowledge and skills, the Welsh Assembly Government, therefore, hopes to maintain and expand the current strength of MRO in SW, based on the present and well-developed pool of skills and, mainly tacit, knowledge. Other factors, such as the availability of non-congested airfields at Cardiff International Airport, the Aerospace Wales St Athan development, as well as relatively low labour costs, are also regarded as assets for growing MRO. Conversations held with the Aerospace and Defence Team in 2005 show confidence in the future prospects for MRO. In spite of tough international competition for MRO services, the WAG believed that Wales should be able to strengthen its foothold in MRO.

While countries such as China were regarded as capable of doing MRO for older planes, such as early Boeing 737s, they were expected to struggle with technologically advanced aircraft such as Boeing 777s.

By specialising in cutting-edge and high-value added work, therefore, it is hoped that Wales will continue prospering from MRO in the future, leaving less lucrative markets servicing older aircraft to low-cost competitors. Events such as the construction of Airbus A380 MRO facilities in China by Lufthansa in 2006, however, shows that the capability of low-cost countries to handle even highly advanced planes must not be underestimated. China also serves as a prime example for a country training aerospace engineers and lower-level technical personnel on a large scale, easing the global shortage of aerospace engineering knowledge and skills. In the short to medium-term, MRO for short and medium aircraft is still likely to be undertaken in the area of fleet operation, implying that large markets for British and European MRO will continue to exist, though more work for long-haul aircraft might well be done in low-cost countries in the future. This highlights, therefore, a key need to investigate whether skills-development strategy is developing the requisite skills, knowledge, and relationships required to facilitate this technologically-advanced based focus

South Wales is also home to most of the research, development and training (RDT) institutions. The engineering department at Swansea University, the prime aerospace RDT institution in Wales, undertakes substantial aerospace R&D and trains aerospace engineers up to doctoral level. Cardiff University also has two well-respected engineering divisions undertaking aerospace R&D. Both Swansea and Cardiff University also engage in composites research, which may provide opportunities for domestic-located businesses. The North East Wales Institute in North Wales and the University of Glamorgan in SW complete the list of aerospace RDT institutions in Wales. Barry College International Centre for Aerospace Training (SW) has attained national excellence in the training of aerospace mechanics, ahead of similar institutions such as Aeronautical Engineering at the Deeside College (NW).

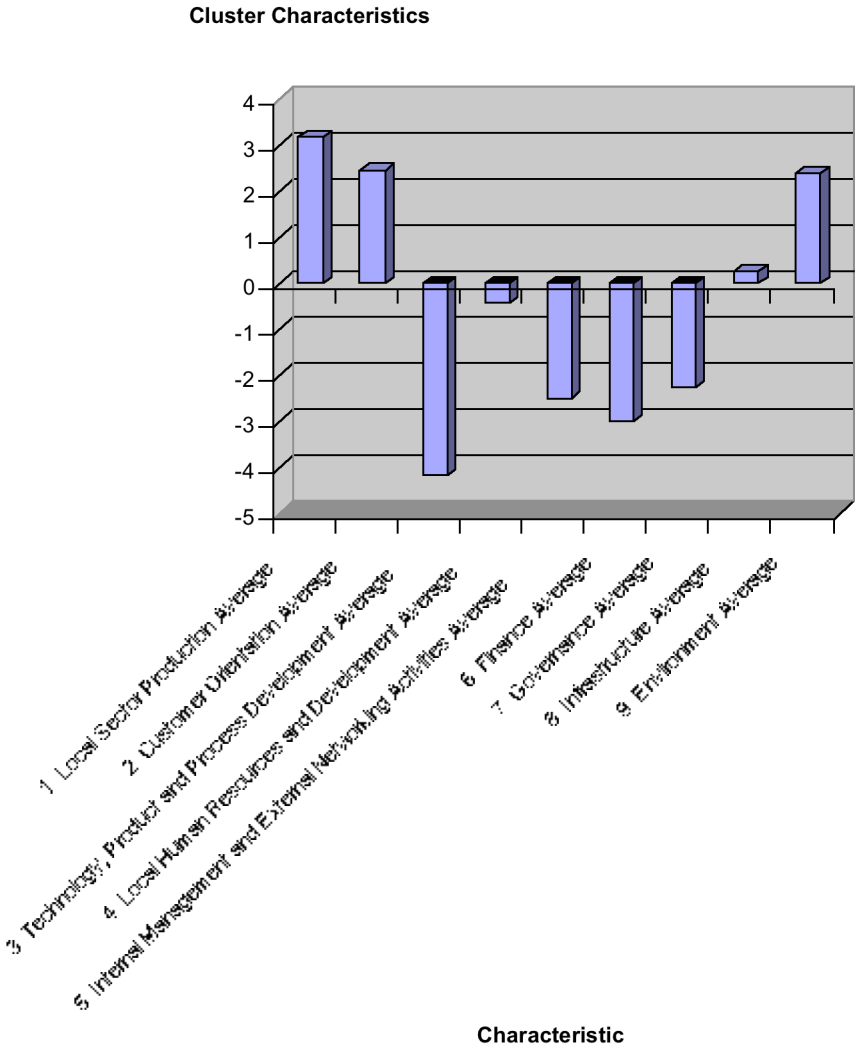
There are also a number of private sector companies and organisations carrying out aerospace RDT and especially training. These include Lufthansa Resource Technical Training (LRTT), the NDT Validation Centre, and South West School of NDT, all in SW. The activity portfolios of most RDT institutions are broad and do not combine into one, or a few, common strengths of Welsh RDT. There is, for example, no clear focus on developing metal or composite related knowledge and skills, which would allow the relevant capabilities of Welsh RDT institutions to be benchmarked against their counterparts in other aerospace regions, or precise strategies to be recommended for upgrading the knowledge and skills that would allow Wales to succeed against competing regions.

Several RDT institutions in SW have, however, developed pockets of composite expertise, working with MRO and production firms. Documents by the Welsh Assembly Government also reveal that the Aerospace and Defence Team has recently made much progress in mapping existing knowledge and skills, and identifying future requirements. Skills conferences held by Welsh aerospace stakeholders in 2006 and 2007, however, have proved general in their discussion of competencies and capabilities required for the future, suggesting that more detailed analysis is required, particularly in terms of the ways in which industry, government, and institutions interact to develop the policies and activities most conducive to success in RDT, both for itself and also in supporting manufacturing and MRO in Wales.

Overall this analysis of the statistics and available literature highlights a number of points:

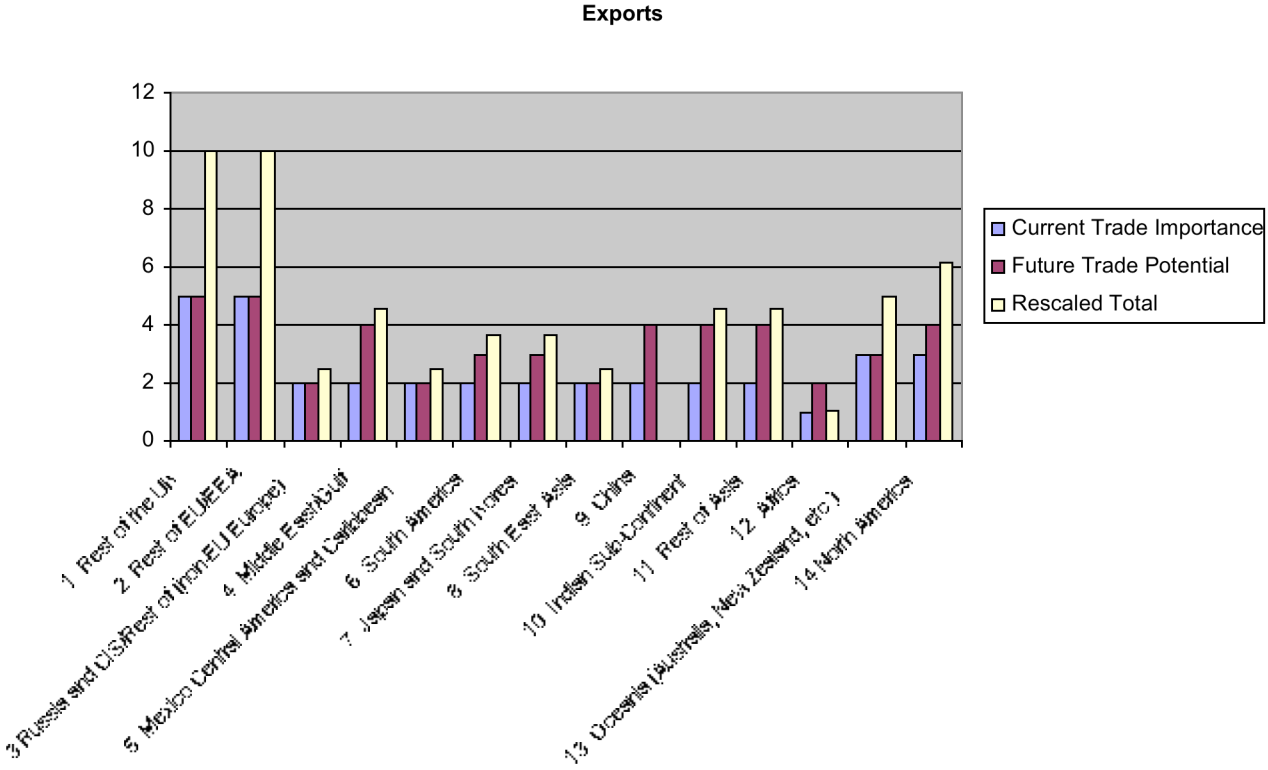
- there is a clear logic in separating aerospace in Wales into three constituent parts
- there is a dearth of current data concerning the individual sectors in Wales, highlighting the relevance of the approach taken in stage 2 of the analysis.
- there are issues related to the competencies, risks and trade of the industry
- there is a specific need to examine the clustering and networking activities of the sectors, and the relationships between industry, government and institutions, both within Wales and cross locationally, to identify what is being done at present and what needs to be done in future, for the industry to meet the challenges it currently faces.

Stage 2 Results: Aerospace Manufacturing

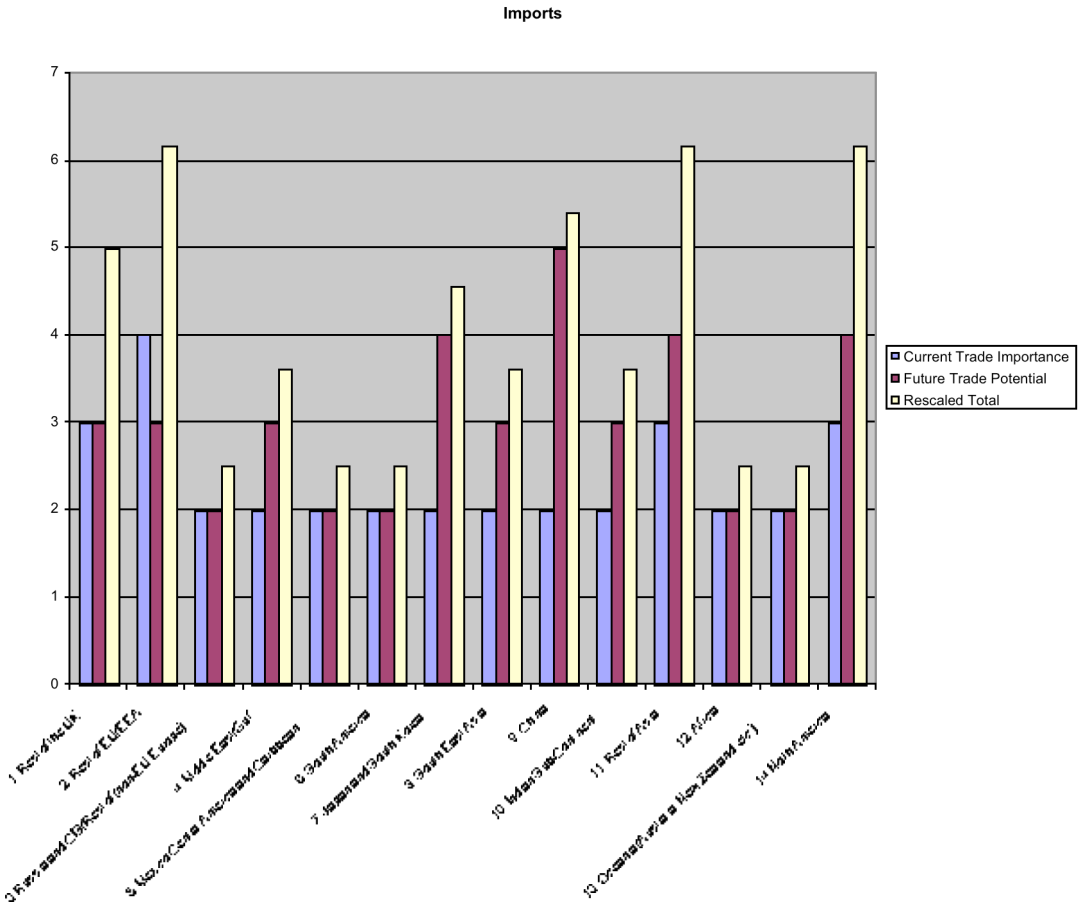


- Current strengths exist in production where there is high gross value added and concentration of the industry, customer orientation and environmental impacts of production;
- human resources and infrastructure are neither a strength or a weakness, which is a cause for concern;
- weaknesses are strongly evident in technology (particularly in terms of collaboration with industry and Higher Education, but also in technological product and process development expertise, and R&D spend)
- similar problems exist in management and networking (mainly as a result of an absence of local functions and weak local links with institutions, only partly counteracted by stronger links with local government); governance (lack of local autonomy and concerns over planning); and finance.

This analysis supports the available literature but also highlights specific issues surrounding technology, networking, finance, and governance that are likely to impair the future success and viability of the industry if not addressed.

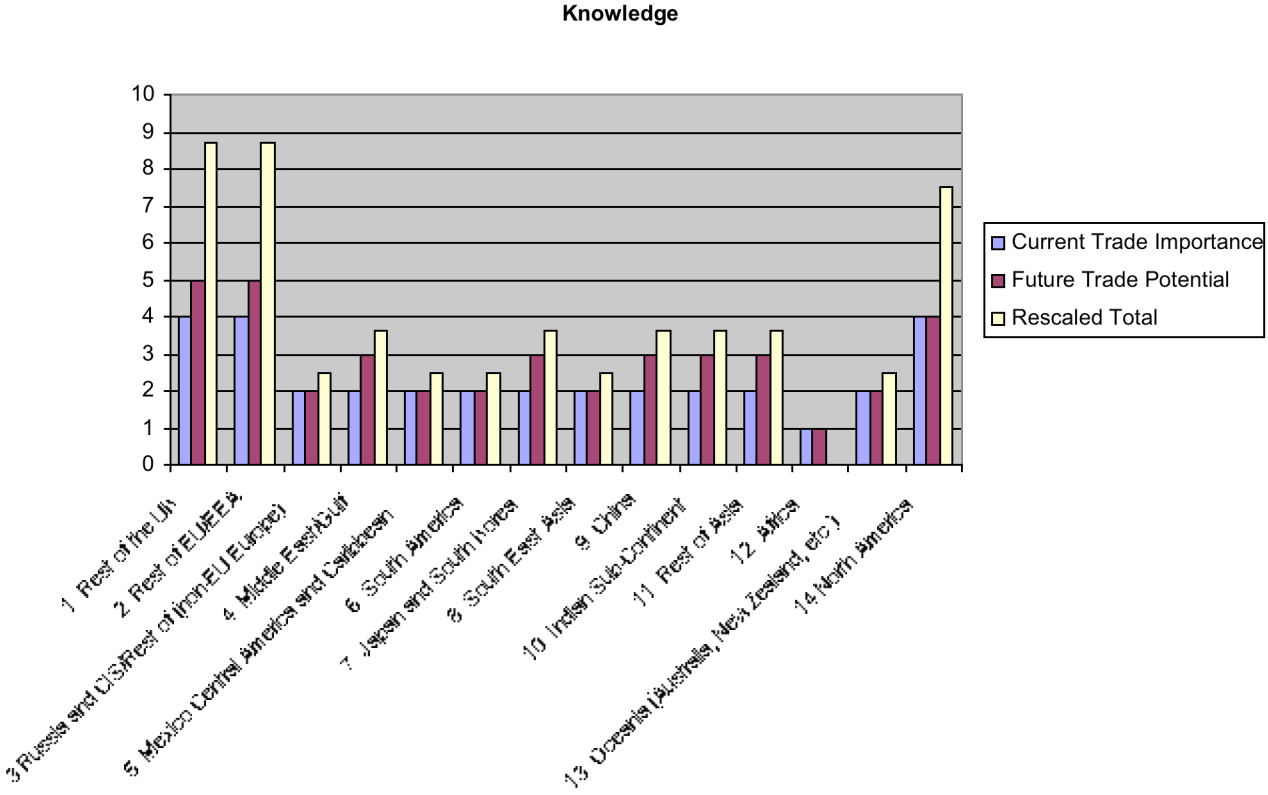


- The input-output analysis is supported by the findings for exports, where the rest of UK features prominently, as does the rest of the EU. In addition, the MSQA allows future potential to be evaluated, and the differential importance of a wide variety of overseas markets.
- In addition to rest of UK and EU, other important markets both now and also for the future are Oceania and North America, suggesting strongly a need to develop knowledge links with these markets.



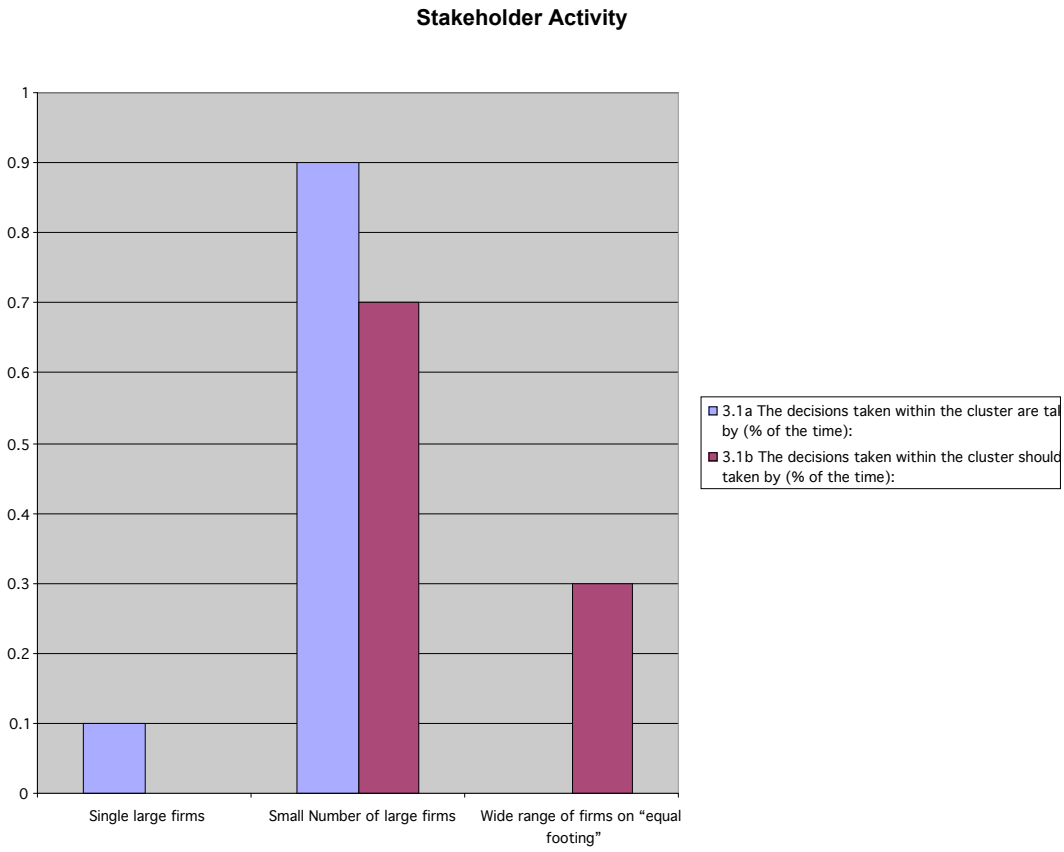
- Imported materials were derived from wider range of markets than received exports. Rest of UK, North America, rest of Asia, and particularly the rest of the EU are prominent.
- Japan, South Korea and China were seen as of future importance, possibly linked to the growing importance of composites, as well as increasing cost-based pressures (though of course, these threats from change may also provide opportunities for domestic-located businesses, if the domestic industry reacts sufficiently quickly).

This points to growing pressures on the supply chain, which, as the literature highlighted previously, may threaten the future development of the industry.

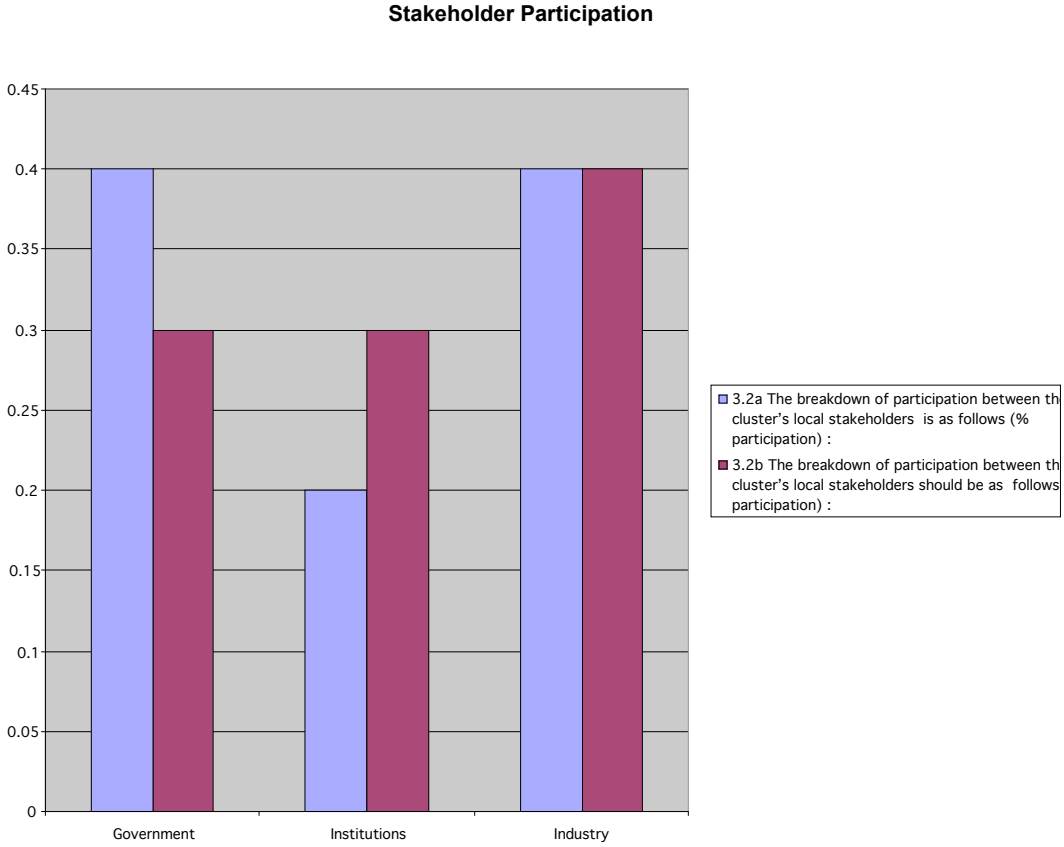


- Rest of UK and EU are the strongest current and future sources of knowledge flows, followed by North America. This is likely to be linked to the ownership structures of much of the industry.
- Asia, in particular Japan, China, India and the rest of Asia, are growing in importance as the aerospace sector develops in that region.

The extent to which this knowledge can be used successfully will depend in part on the fora for knowledge creation and dissemination, the related skills, and governance structures linking government, higher education, and industry.



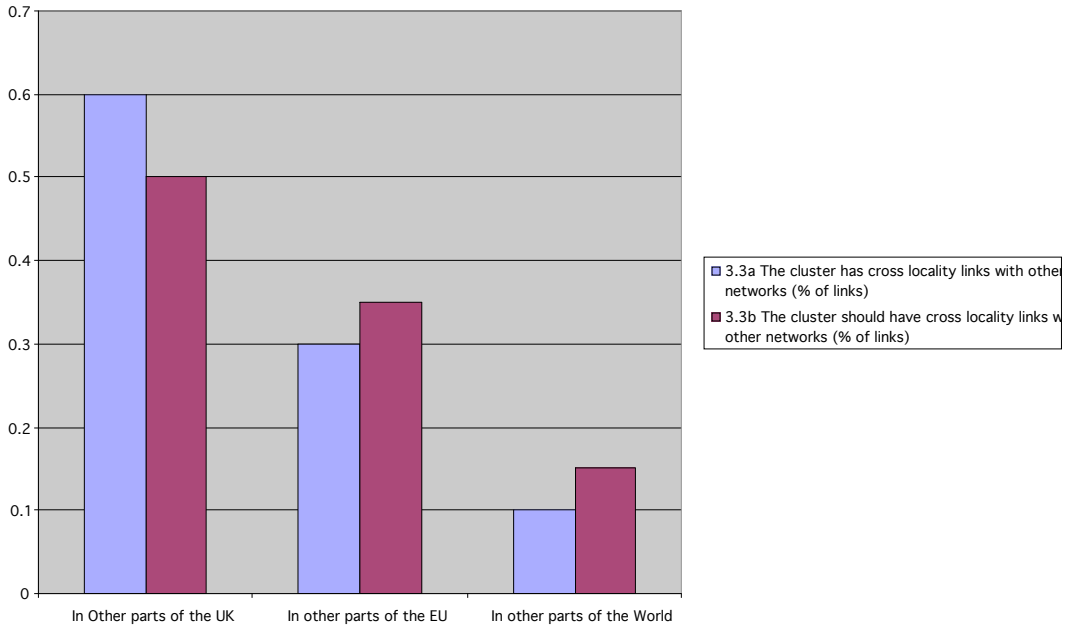
- A small number of large firms dominate inter-firm decision-making. The result highlights a perception that governance needs to be widened to embrace a wider range of firms on a more equal footing, in line with a more networked approach, though clearly the majority of decisions will still be taken by the large firms that dominate the industry.



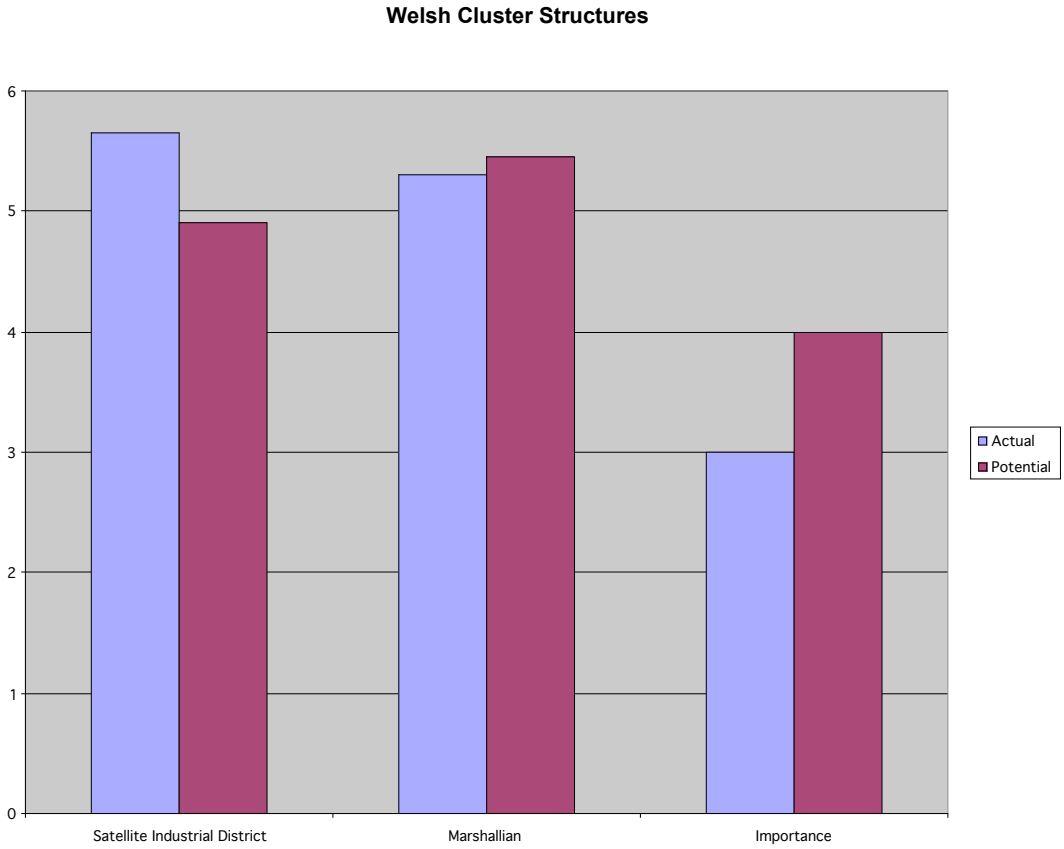
- Government matches industry itself as a participant, reflecting the overall importance of its role within the sector, while higher education currently has a weak role as a stakeholder but this balance needs to be changed, as evidenced also by the previous analysis.
- A rebalancing between government and institutions is needed, with institutions taking a stronger role at the expense of government.

There is a clear need to develop not only networks but also technology, in particular, as well as, to a lesser extent training. Firstly, however, there is a need to identify the type of cluster/network in operation, and whether change here is required, if other changes are to be facilitated.

CLN Linkages

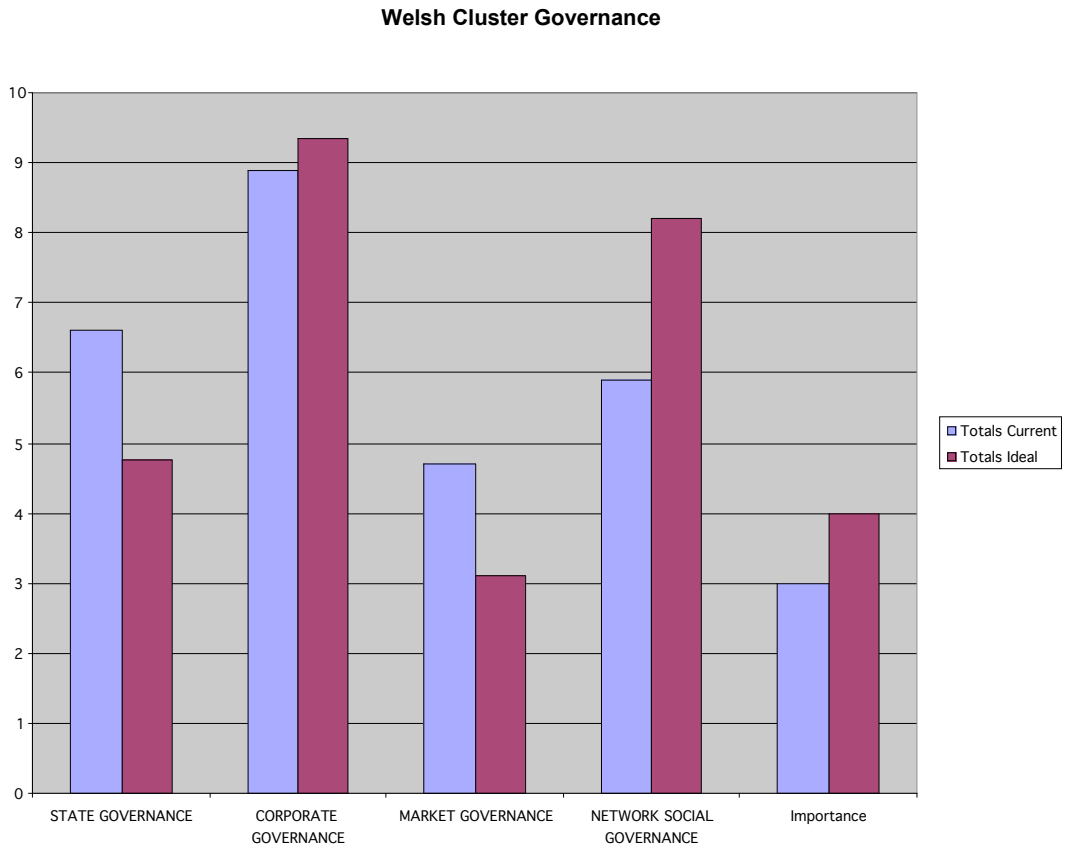


- Stronger linkages with other parts of the EU and rest of the world are needed relative to rest of UK. A wider range of knowledge sources and relationships is required, again emphasising the role of network management and development. The types of networking that need to be built upon to facilitate these outcomes should be evaluated.

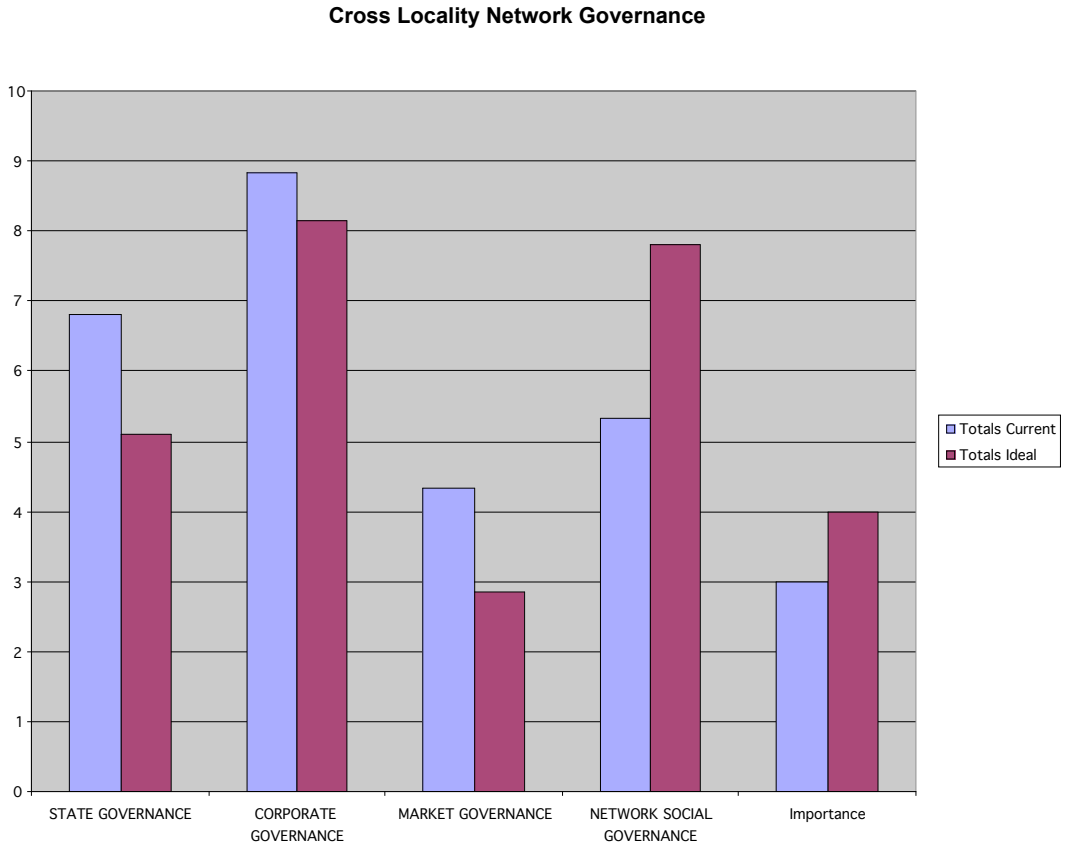


- Unlike, for example, the East Midlands, the Welsh aerospace manufacturing industry is not hub and spoke, but nearer to a satellite industrial district, with a small number of large firms relying on external regions for its knowledge base (as opposed to having a domestic knowledge base and importing additional knowledge in from external sources), as well as other resources. This can be seen as being supportive of the input-output analysis for "other transport" more widely, where there are high imports and exports and only relatively small domestic inputs and demand.
- Given the need to develop more local resources and knowledge, however, satellite industrial district is not the ideal structure. Better would be a Marshallian-type district, with its shared use of common resources, such as higher-education generated resources. The small difference between the two types of clusters/networks, and the fact that the "ideal" has a lower score (out of 9) than the actual, however, suggests that a pure cluster of any type is not seen as the ideal. A "hybrid" would seem more preferable, based on a stronger role for local activities that generate and disseminate knowledge but with a continuing strong role for the large multinational firms that dominate the industry.
- Hybridity as the choice is supported by the fact that the cluster type that saw the greatest increase between actual and ideal was, unsurprisingly in terms of previous results, the Italianate district type (from an admittedly low base). This reinforces the expressed need to move in the industry towards more vertical, relationship-based activities; teamwork; longer term-network development; and more advanced learning activities, moving overall from an "individual firm" to a more "collective" approach.

In these circumstances, one could argue that the "ideal" current hybrid, may in fact represent a necessary stage of development towards a more "hub-and-spoke" outcome (as for the East Midlands for example), where knowledge creating activities would be more locally sourced.



- While the role of large corporations in governance is seen to be in need of strengthening, stronger network governanceat the expense of government and market modes is also favoured. This supports the results highlighted earlier, where institutions such as higher education were favoured for a stronger role, and government a smaller one.
- This also seems to highlight a hybrid governance structure, falling between satellite industrial and Marshallian district, a higher role being sought for government to bring stakeholders together; stronger transactions linkages to act as a conduit for learning; and a greater focus on collaboration, growth, social exchange and sharing of tacit knowledge and relational management generally are advocated.



- The results for cross locality governance, emphasise the perceived importance of reducing in relative terms the role of large corporations, in favour of an increasingly network governance approach.
- A reduced but still strong role for government also emerges.
- This may also be suggestive of a move towards a hub and spoke governance structure in CLNs but via a hybrid of the Satellite Industrial Platform and more of an Italianate District type of governance. (This has elements such as stronger buyer-supplier relations; cooperation to share risk; high innovation; strong trade associations; and strong local governments)
- A move toward more Italianate district-type for Welsh cluster governance is also supported by the areas highlighted as needing change, for example the higher role sought for government to bring stakeholders together, stronger transactions linkages to act as a conduit for learning, and greater focus on collaboration, growth, social exchange, interpersonal trust and sharing of tacit knowledge and relational management generally.

Overall, this suggests perceptions that the industry should begin the process of both internal and external relationship and network development, as part of an ongoing process that will allow manufacturing to reduce its role as a mere satellite of other regions' aerospace industries, and play a fuller role in the development of the industry. Key to this, however, will be the role of the Broughton site, on which so much of the industry depends, strongly suggesting a need to examine the embeddness, current and future policies of this "keystone" company.

Interviews with Keystone Manufacturing Company : Airbus Broughton

An aircraft factory was originally established at its current location in Wales when Broughton was chosen to build a wartime "shadow factory'' outside the range of enemy bombers but within reasonable proximity to centres of population capable of supplying the skilled labour force needed for aircraft production. (The site went on to produce nearly 6,000 Wellington bombers between 1939 and 1945). The site passed in the post war period from Vickers Armstrong to De Haviland, and subsequently through mergers to Hawker Siddeley. So it was that, in 1971 the Hawker Siddeley site at Broughton delivered the first set of wings for the first Airbus, in the Anglo/Franco/German programme to build the new European jet airliner.

Much of the design work for the new Airbus wings, an area where Britain crucially had the leading expertise at the time in Europe, was originally carried out at Hawker Siddeley's other main UK base in Hatfield, with the bulk of manufacturing being assigned to Broughton. Hatfield was later shut and Airbus manufacturing activities within the then British Aerospace group (the nationalised merger bringing together Hawker Siddeley and rival airframe maker British Aircraft Corporation) were concentrated at Broughton. Broughton emerged as the more viable long-term site because it was free of any great constraints and experienced fewer difficulties in recruiting and retaining staff than Hatfield. In addition, it had an excellent geographical position, being close to main roads, ports and airports. The company draws on labour across the border between England and Wales with roughly 60 per cent of employees living in Wales and 40 per cent in England, raising issues over future skills development for the WAG, and the potential need for cross-border government cooperation. Of these reasons, the location, being close to ports, airports and main roads, and access to a pool of skilled labour, were the most important.

In terms of remaining in Wales, the interviewee explained that Broughton has established itself as a centre of excellence for the manufacture of wings, with a reputation for delivering on time, to cost, and to the highest standards of quality for the rest of the group. It continues to be able to draw on a highly skilled and stable local labour force. It also now has "long term tenure" advantage. Broughton has recently been publicly categorised as one of the four core sites of Airbus and is one of very few that have been in operation since the inception of the company, carrying out the same basic function.. Strong links into the sub-region are also important, giving the company access to good quality recruits and aerospace skills.

There are also established relationships with local educational providers, such as NEWI, Yale College and Deeside College, including college board representation, and a role in the development of courses in some cases. Local colleges work on a collaborative basis with Airbus and with each other to minimise overlap in the provision of courses, with Deeside providing the majority of training for apprentices. The company is able to put in matched funding to support the creation and provision of courses.

Currently, the company has around 400 apprentices under training, the largest number of engineering manufacturing apprentices in the UK by far, plus about 100 direct graduate entrants. Significantly, for cluster purposes, Airbus suppliers in the immediate area can piggyback on to the training courses that local educational institutions have provided to meet Airbus requirements. This highlights the "Marshallian"-type clustering that is currently taking place, and may also highlight the efficacy of the sharing of resources as a way forward and cooperation with institutions, rather than promoting more in-depth networking between the companies themselves.

Geographical location also remains important for logistical reasons, with easy access to the Dee (for onward shipment of some of the wings), to airports at Manchester and Liverpool, to ports, and to the main roads system via the A55 and M6. These links are vital because of the wide area from which components have to be drawn, including, for some materials, Australia, Japan and China. The chances of being gridlocked are considered to be much smaller than in other parts of the UK, especially the south east. As a result Airbus estimates that it "injects approximately £6.75m a week into the local economy" through wages and purchases. The city of Chester is also an important local asset, providing an attractive venue for entertaining and accommodating clients. Relationships with the main local authority in the area, Flintshire, are also good, as they are with the Welsh Assembly Government (highlighting the importance of government support in this industry).

Of the above reasons for the company remaining in its current location, the interviewee stated that continued support by UK Government for aerospace research and development is crucial if Britain is to remain a knowledge-based economy. It also has to amount to more than just information technology.

"Organisations such as Airbus do not invest in the UK for low cost labour but because they believe they can find a high skilled and innovative workforce. Our academic base, investment in new materials and our technology are

what make give Britain its competitive edge. Other parts of the world however, such as Asia, have well-educated people coming through, and far more people being trained in engineering skills than in the UK (25,000 in UK versus 450,000 in India for example). We have to sell the smartness of our brains rather than the speed of our arms, if we are to stay ahead."

The interviewee stated that the UK has a number of high quality centres of engineering excellence in academia and these are also key to Airbus's continued presence in the UK. Airbus works with a number of academic partners to meet specific research needs and to assist its design operations at Filton and its manufacturing at Broughton. These include Liverpool, Manchester, Bristol, Bath, Cranfield, and Southampton universities amongst others, as well as Cardiff, Swansea and Aberystwyth in Wales. This highlights both the importance of institutions, as well as their cross-locational nature.

In terms of the future strategy of the company with respect to its Welsh operations, the interviewee stated that Airbus's operations in Broughton will continue to focus on the high added value part of the wing. Some 75 per cent of the wings is made up of bought in materials (for example from aluminium manufacturers such as Alcoa or Pechiney), Broughton undertakes the complex work of machining the wing skins and of integrating the wings, spars and ribs, utilising the specialised understanding of how to manage this process. This is the key strategic area of manufacturing where barriers to entry – because of the inherited knowledge base and skills of the labour force – to other entrants from India or China, for example, are very high. The pressure they can exert in the short and medium term will be felt in the areas already outsourced to other suppliers (highlighting the threat to the supply chain in Wales demonstrated earlier, and highlighting the need for a stronger, more coherent chain below and of a more Marshallian type arrangement in this part of the Welsh industry).

The company will concentrate on key and core activities and distinguish between what should be made in high cost western economies and what should be made in low cost economies, possibly by breaking into these markets with products and sharing manufacturing, This will result in a progressive shift to higher added value work. Broughton's workload will include new projects such as the A380 and A350 but some older work such as the A300 and A320 series will continue to be exported (for example to China where Airbus now has a joint venture). Broughton will take on more work with composite materials and will aim to stay at the top of the "food chain", highlighting a danger for metal based manufacturers who currently have a strong input into the industry (highlighted in the input-output tables).

The A350 will have a fully composite wing, which Broughton will train for. However, current exchange rates between the company's costs in Euros and its income from aircraft sales in US dollars have weakened the company's finances position and there is a major a drive to reduce overhead costs. One consequence of this is that where the group already has technological expertise elsewhere – in the case of composites fabrication, in Germany, France and Spain – the UK's case for duplicating this is weak. It is hard to argue for developing such skills when they have already been developed elsewhere, given the programme is likely to cost between Euros 5bn and 10bn.

Impact will chiefly be on Bristol, where a risk-sharing partner is currently being sought to develop a new composites manufacturing facility, but real responsibility lies with UK Government, which has taken the view that the market should be left to decide whether it can justify investing in the development of these technologies. This further emphasises an increasingly satellite platform role for the industry in future (at best), if it cannot successfully develop a local composite competence. "You can have a free market that is also managed to a certain extent. To give your industry a chance to be world class, we have to pump-prime the technologies,"

The interviewee thus stated it was vital for both the Welsh Assembly Government and UK Government to continue to provide support. Even though sums committed are relatively small in relation to the total investment, such a commitment is recognised at Airbus and other partner countries will be doing the same. Here in Britain Airbus is spending 300m Euros a year investing in Broughton. It was argued that this continuing support would determine whether aerospace remains a big sector in Wales, given that:

"Airbus is in effect aerospace manufacturing in Wales. If 5,000 jobs in MRO are put on one side, then Airbus and its suppliers account for the bulk of the rest of the 17,000 jobs. Airbus is likely to maintain around 5,000 employees at Broughton. Altogether on site there are about 7,500 including people working on other products such as the Hawker 125 programme and external service providers".

UK Government support for Airbus-owner, EADS to have a research facility in Britain is seen as essential by the interviewee, in order to match similar facilities the company has in other countries. The requirement could be 50

per cent of the initial cost. It was also stated that more attention needs to be paid to the development of vocational skills in young people coming out of secondary education with less emphasis placed on fulfilling the ambition of a 50 per cent university educated population. Airbus would instead prefer to attract people into full time employment at age 18 and see them trained at work, with as much weight placed on vocational as on academic work. Currently:

"Individuals emerging from university are not experiencing any pull through from industry because they very often lack relevant qualifications. Airbus is now benefiting from the re-establishment (without Government support) of its apprenticeship scheme. Airbus apprentices undertake a foundation degree with NEWI and Deeside College. Currently, two thirds of the senior management team are former-apprentices.

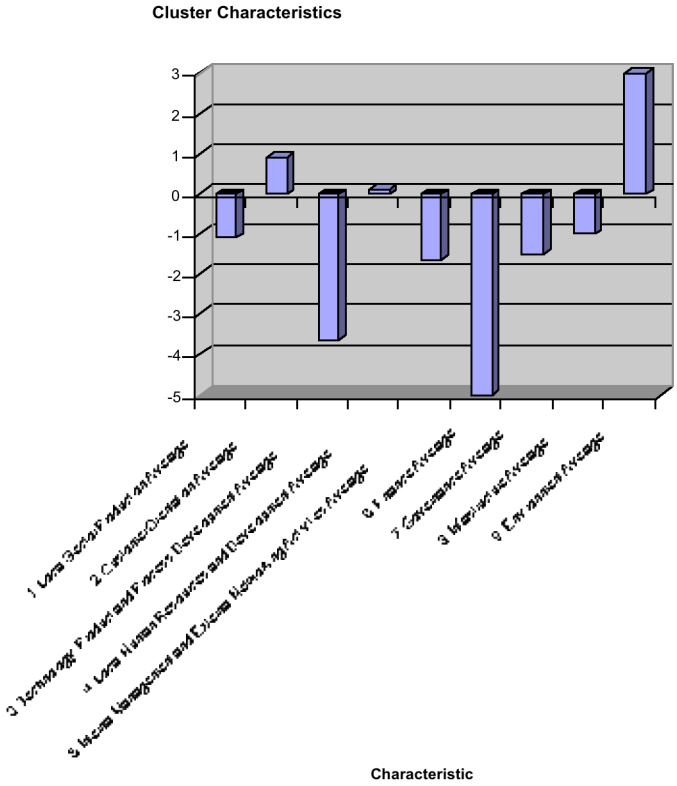
Conversely, issues such as productivity are best left to companies to manage and are seen not to be a part of Government responsibility. Whilst the UK is currently benefiting from the high value of the pound sterling in relation to the dollar and the euro when purchasing materials from abroad, over the longer term membership is important to avoid transaction costs. As a result, continuing Government direct and indirect support for the maintenance of a strong aerospace sector is seen as key (highlighting the importance of appropriate government support), particularly since:-

"When cutbacks have to be made or rationalisation is needed, there will always be pressures to maintain jobs from unions and governments. Wales has to make sure it continues to provide reasons for it to continue to play its key role as the provider of the highest technology part of the airframe. "We deliver to time, cost and quality. We must never open the door so that the wing technology is transferred away from here".

Conclusions for Welsh Aerospace Manufacturing

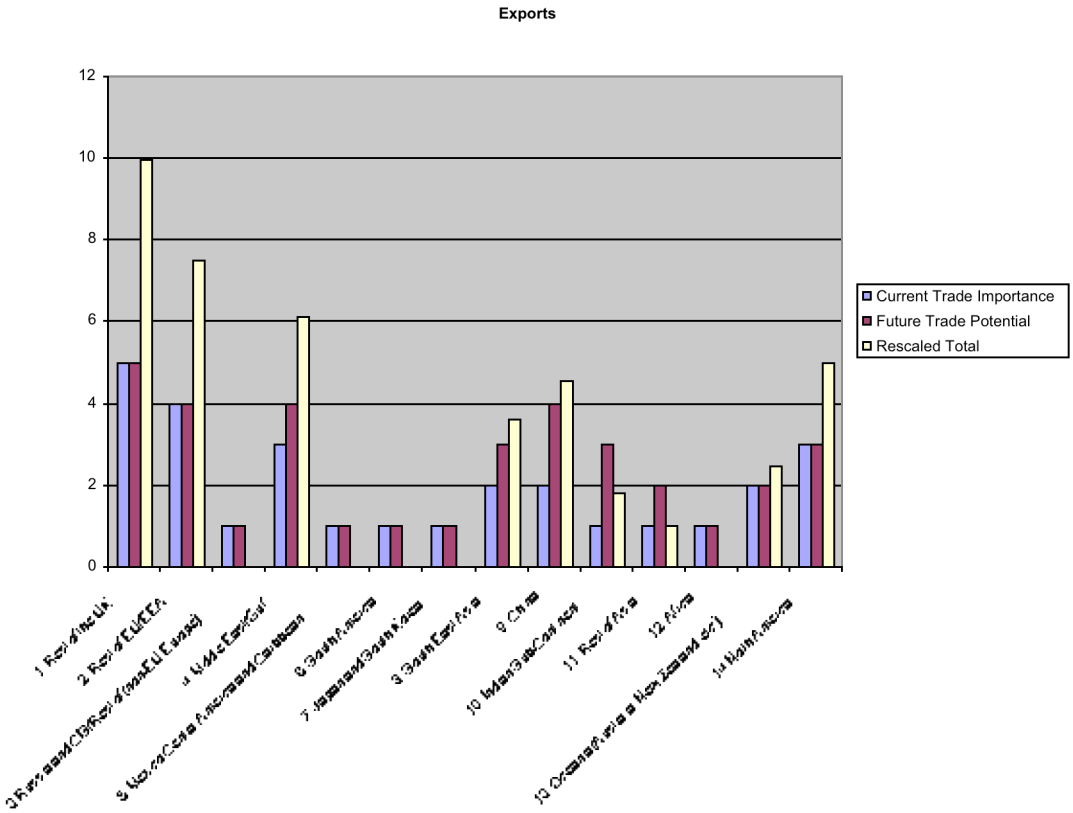
Overall, there is a clearly defined set of issues which the industry will need to deal with urgently if it is to succeeed in the increasingly competitive manufacturing sector. In particular, there is a need to develop stronger internal and external relationships, develop common resources, and increase the interactions between industry and institutions. Interestingly, there is also a need for the government's role to reduce relative to institutions in particular, most likely in terms of facilitating the increased relationship between institutions such as universities and the industry, in developing the skills, knowledge, resources and relationships required for its future success.

MSQA Results: Aerospace MRO



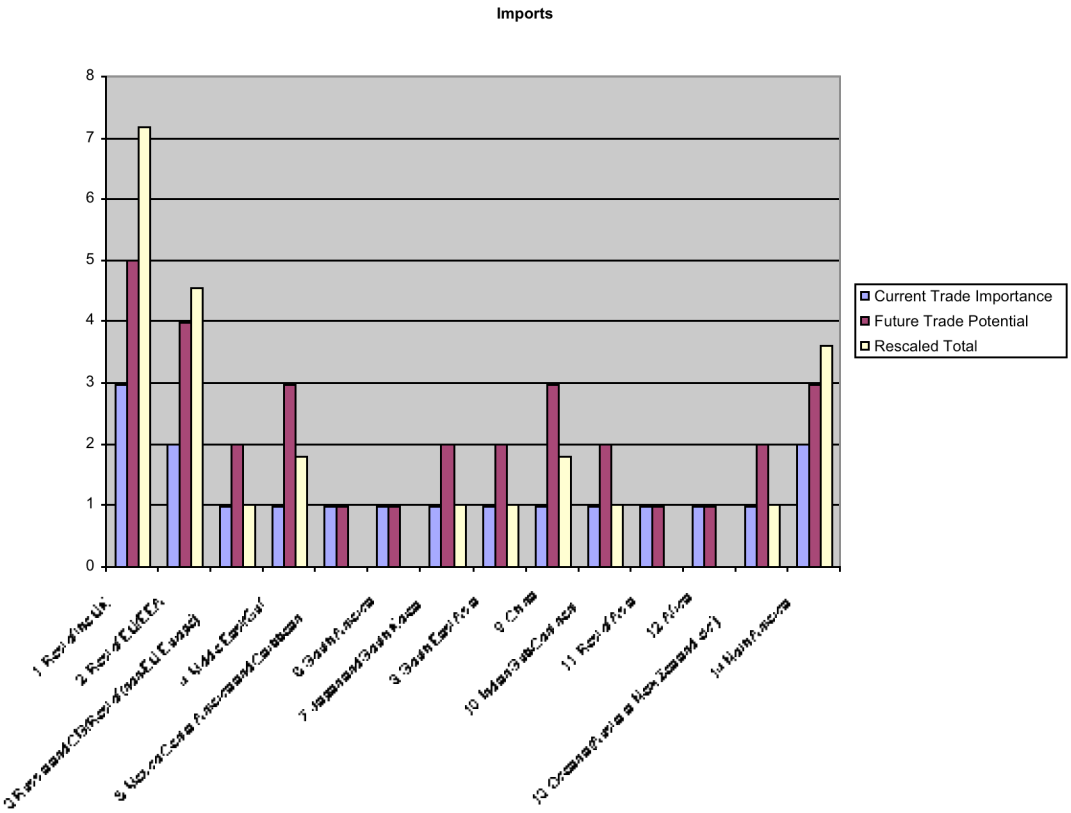
- The situation for MRO appears less strong than for manufacturing, in that only environmental impacts appears as a real strength, with a small strength in customer orientation (due to its perceived ability to cope with quality competition, and strong stable exporting but hampered by concerns over cost competition, and lack of growth prospects).
- Human Resource Development is neither a strength or weakness, the strengths in investment in training for employees and use of training facilities of local HEIs counteracted by perceived weaknesses in a lack of diversified occupations and insufficient use of local graduates
- In comparison, there are major weaknesses in terms of finance (because of exchange rate fluctuations and access to finance issues); technology, product and process development (in terms of R&D and technical capacity and relevant relationships between companies and institutions both within and outside Wales), and networking (where lack of autonomy in key functions is counteracted to an extent by links with government and associations within Wales, though not outside Wales).

This suggests key concerns, similar to those for manufacturing, including specific issues surrounding finance, technology and networking, and long term labour prospects, which are likely to impair the future of the industry, if not addressed.



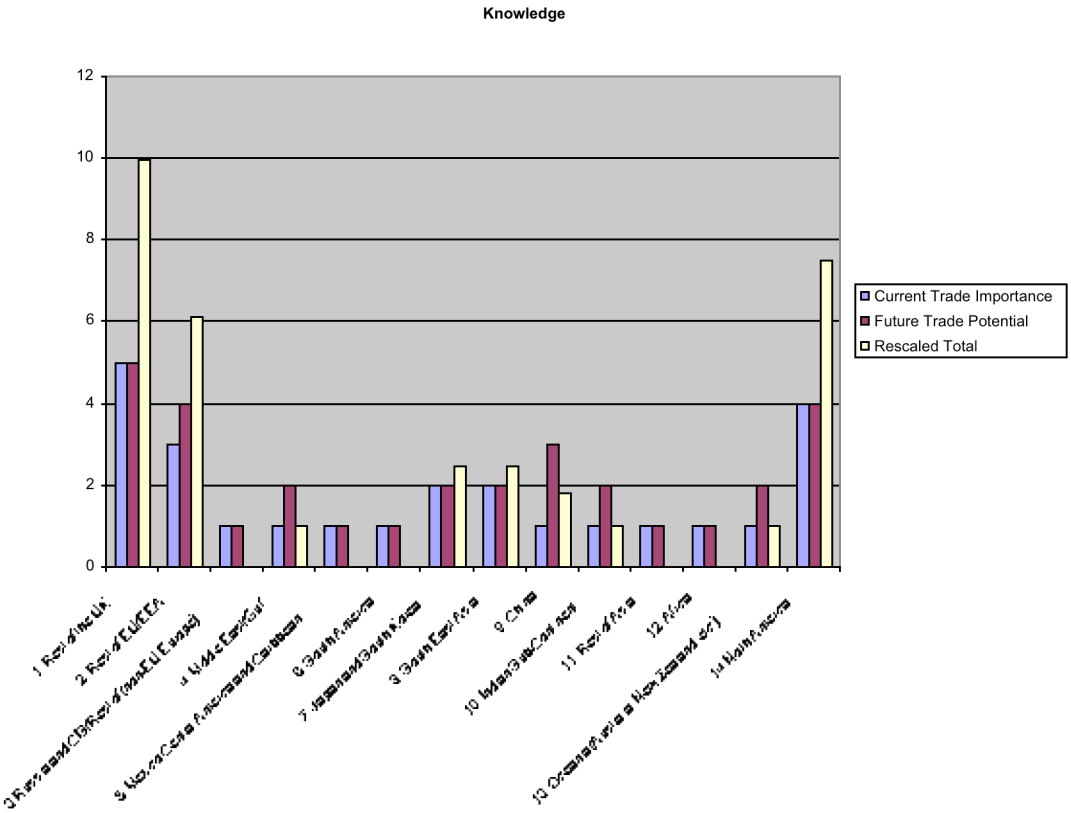
- Unsurprisingly, given the trend in the industry for regional hubs of MRO activity, it is the rest of UK and European Union that offer the greatest immediate and future opporunity for exporting, the Middle East also offering increase chances in the future, as does China (linked to the growth in MRO activities in China).

Generally, this suggests a continuing regional focus for exports of MRO activities, which also highlights issues such as the exchange rates (i.e. fluctuations of the pound against the Euro). The potential increase in competition for long haul aircraft MRO, coupled with the perceived weaknesses of the industry generally, highlighted earlier, also needs to be considered.



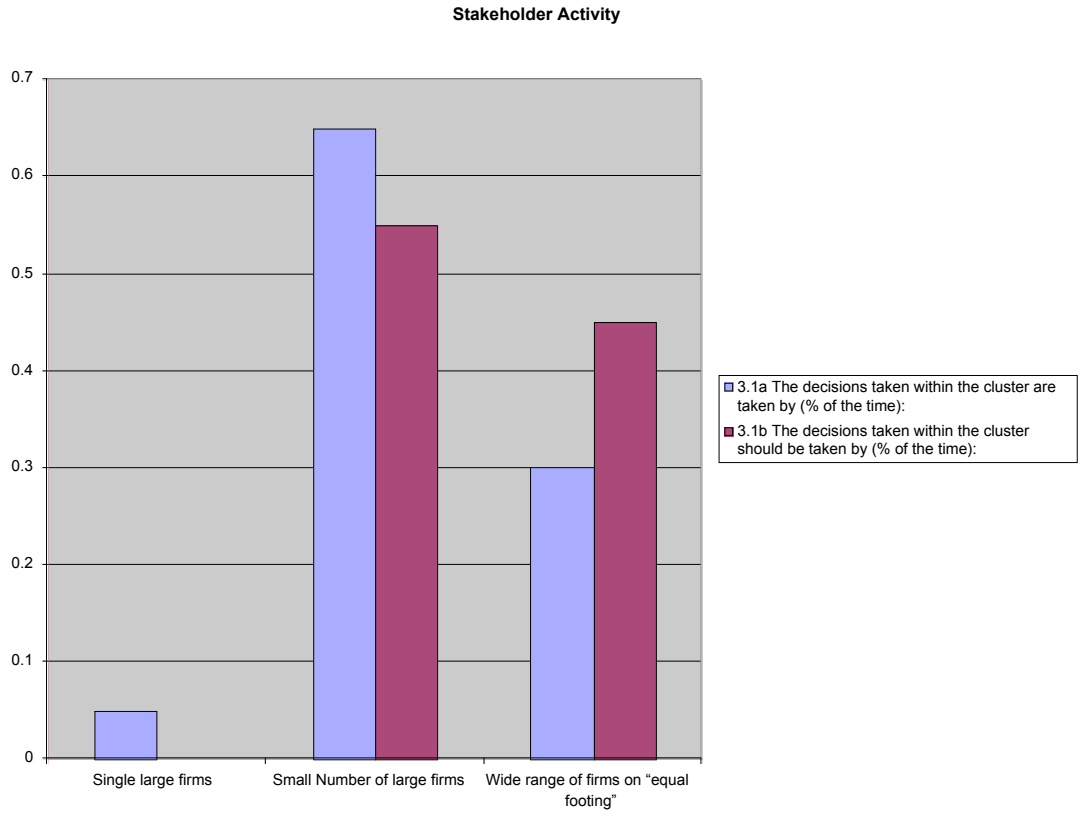
- The pattern for imports is similar to that for exports, with the strongest import sources being rest of UK and European Union, unsurprising given the location of aircraft manufacturing, with North America another key source. China is seen as an increasing potential source for imports (as its manufacturing capacity grows), as also, to a lesser extent, are Japan, South Korea, South East Asia and India.

This may also highlight issues for the manufacturing supply chain in Wales, with potential knock-on impacts for MRO more generally, in terms of its embeddedness.



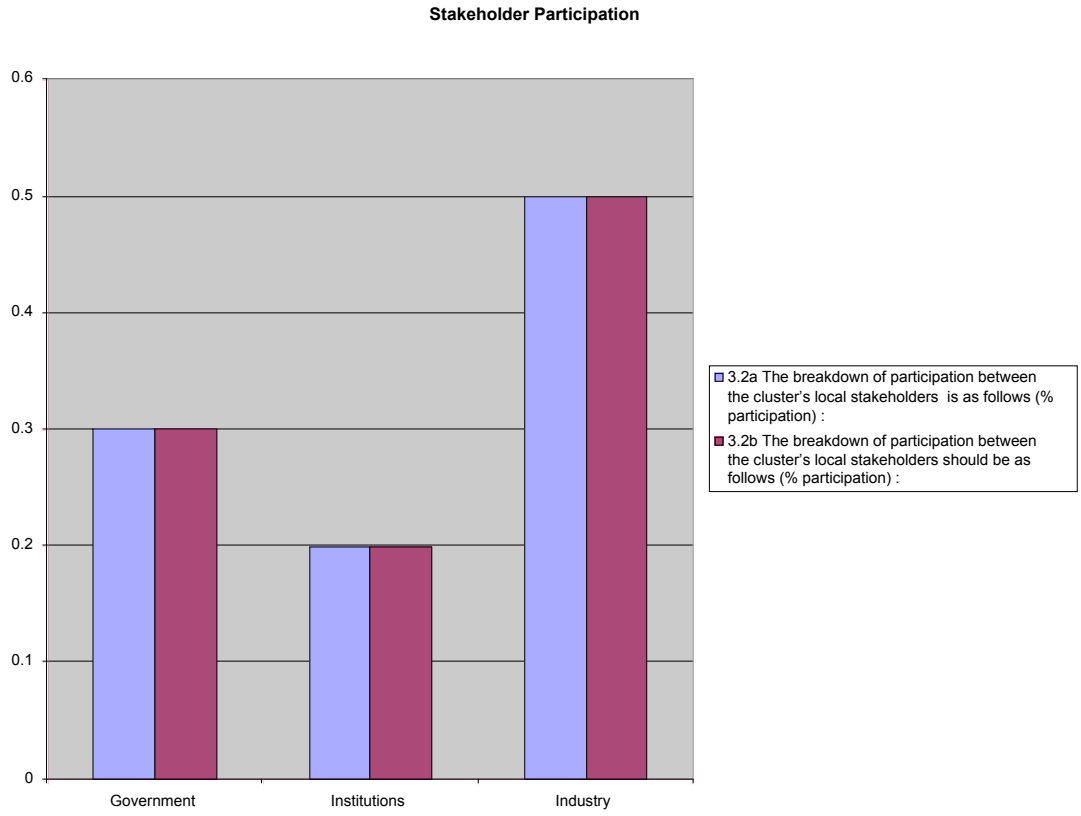
- Knowledge flows are consistent with the location of aircraft manufacturing that MRO companies are servicing, with rest of UK seen as of greatest importance, followed by North Amercia and rest of EU.

As is the case for the manufacturing sector, the extent to which knowledge can be used successfully will depend on the fora for knowledge creation and dissemination; the development of relevant related skills; and governance structures linking government, higher education, and industry both within and outside Wales.



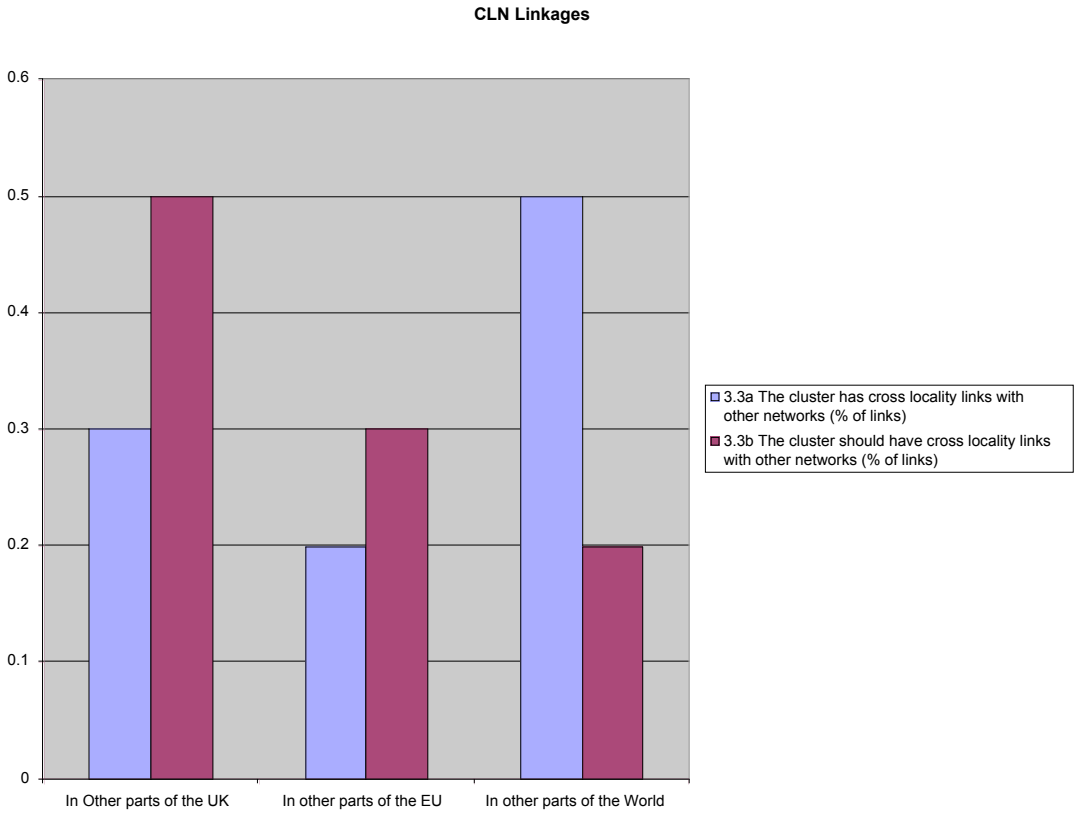
- MRO firm stakeholder decisions, unlike manufacturing, are already spread more evenly among a wider range of firms on a more even footing, reflecting the wider base of companies in this sector. There is still seen to be a need, however, to spread the decision making more widely, and to remove the power of single large firms to determine outcomes.

This highlights a perceived need for a more cooperative, perhaps networked approach, which may be easier to achieve than in manufacturing, given the structure of the sector in Wales.



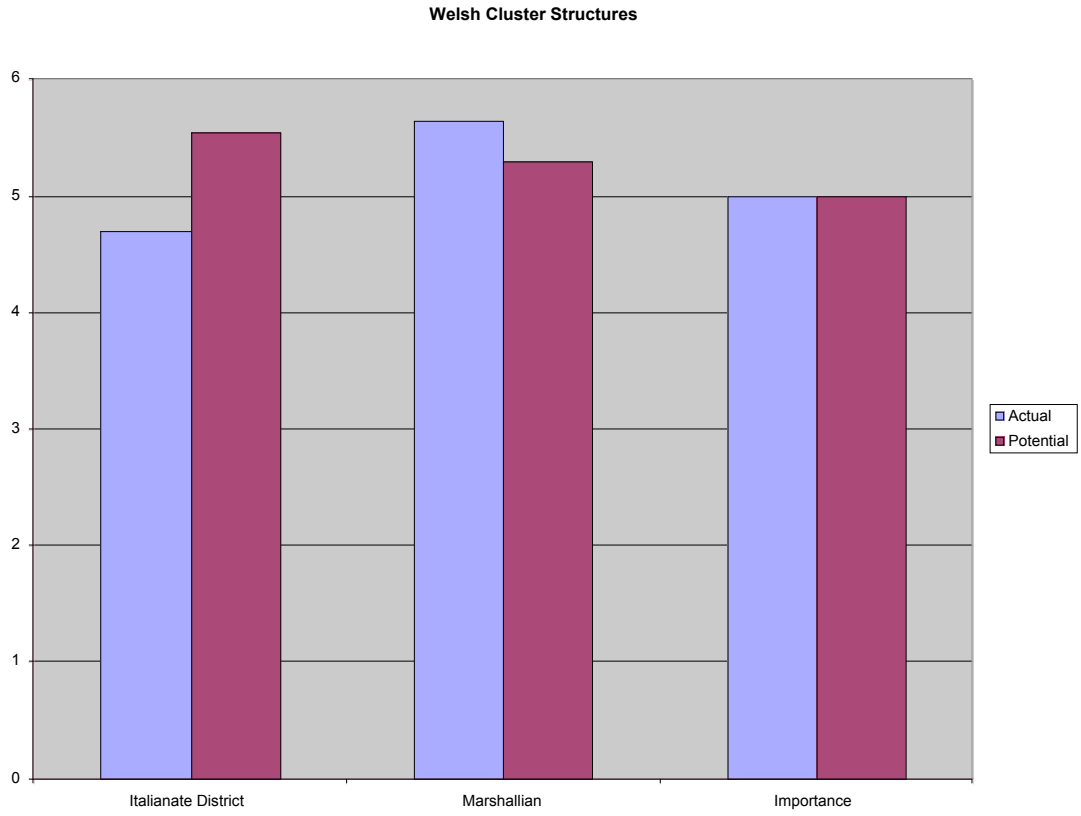
- Perhaps also emphasising the more cooperative nature of existing structures, stakeholder participation is also seen as being at its optimum level, with government at 30 per cent, institutions at 20 per cent and industry at 50 per cent (the levels also perceived as optimum for manufacturing).

This may reflect the general strength highlighted earlier in general linkages between industry and government, and industry and institutions in Wales, though not necessarily for specific activities, such as technological development. Given the issues concerning technological development and networking, however, there is a need to identify the type of cluster/network in operation at present whether and how this would need to adapt, if the required changes are to be facilitated, and how this may differ from manufacturing, given the potentially stronger existing structures for MRO.



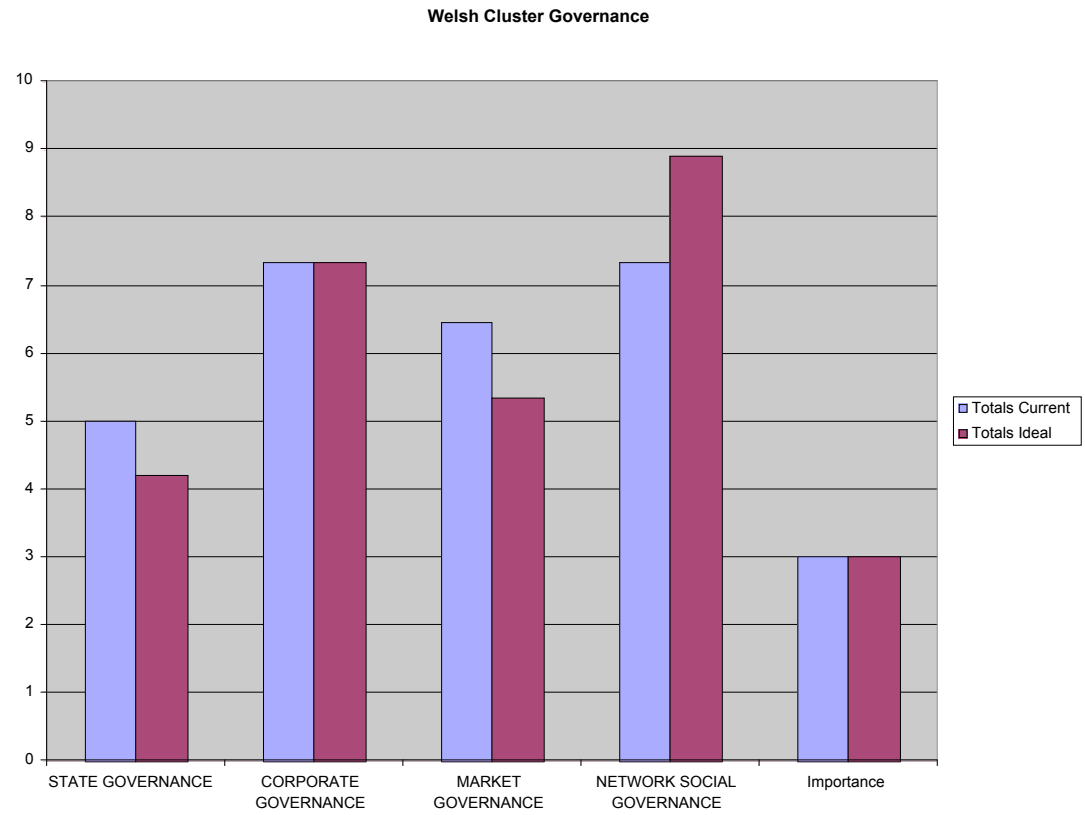
- The need for greater linkages at UK and EU level, at the expense of other parts of the world, reinforces the weakness in this area observed in earlier results on networking for technological purposes.

This mix differs from that for manufacturing, however, where linkages *outside* the UK were seen as being in need of strengthening. The crucial question remains, however, the types of networking and governance that need to be built upon to facilitate these outcomes and whether they differ from those for manufacturing.



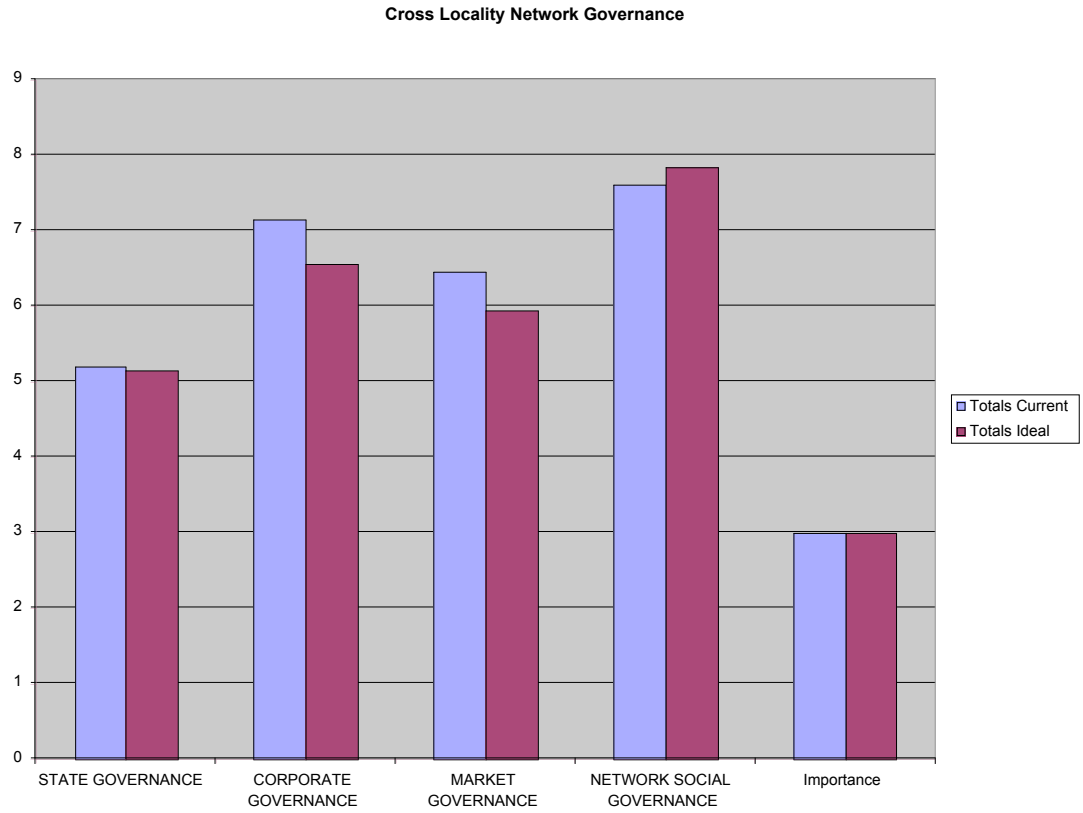
- The cluster structure results suggest that unlike the manufacturing industry's satellite industrial district-type structure, the existing pattern is already more Marshallian, with use of shared resources, such as local training facilities.
- Given the need to develop more local resources and knowledge, however, it is unsurpring that there is perceived to be a need to move closer towards the characteristics of the more cooperative Italianate district, with more interactions and networking between companies; a higher focus on innovation; and creation of more shared infrastructures (particularly for knowledge and technology, based reasons). The chart above also shows, however only a small difference between the Marshallian actual rating (out of the 9 points each of the cluster types is matched against), and the "ideal" Italiante-type district. In addition, the ideal rating has a lower score (out of 9) compared with the actual, and both actual and ideal are rated as of equal importance. This again suggests that a pure cluster is again not seen as the ideal, but rather a "hybrid", based on a stronger role for local networked activities that generate and disseminate knowledge. The pre-existing structures in place also suggest that this more nuanced change may require less of an alteration in governance structures than for manufacturing industry.
- The areas seen as needing strengthening include greater geographical focus for benefits (Marshallian); and stronger focus on trust-based activties, teamwork, longer term network development and more sophisticated learning processes.

Neither of these structures, however, is overwhelmingly strong, (both achieving only just over 5 of the 9 points required for a perfect fit). This again suggests a preference for a hybrid structure, most probably because unlike in a pure Marshallian or Italianate district, there is a sizeable number of relatively large companies rather than a multitude of very small companies. The governance structure will, therefore, also reflect the greater role of corporate as opposed to networked governance structures



- This can be seen, too in the cluster governance arrangements, where the strong existing networking activities (and role of market arrangements), is counterbalanced by an equally strong role for corporate governance arrangements. The greater role for networked activities in the Italianate district-type ideal, highlighted previously, is also reflected in the governance arrangements above, at the expense of market and state governance, rather than corporate governance.
- Specifically, a wider role for corporate governance relative to state governance methods is also stipulated, particularly in arrangements concerning the supply chain, along with a need for faster adjustment, networked arrangements and more non-routine learning.

Again this suggests a non-traditional hybrid, where larger companies are seeking to engage in more networked activities, particularly for reasons linked to technology, but requiring fewer changes than for manufacturing. The story for MRO might, therefore, be a "larger firm Marshallian/Italianate" type district, where, because there are a number of large firms, the corporate hierarchy approach largely takes the place of government hierarchical arrangements. Government might need to take a very much more facilitatory as opposed to directing role, through the network (because these companies can exert greater power than the typical SME within a Marshallian/Italianate district). Although the framework is useful as a basic tool, many potential hybrids also exist, and the additional data gathered on governance arrangements is also, therefore, of importance.



- As for manufacturing, the results for cross locality governance suggest a need to reduce the role of large corporations, but with only a slighty increased network governance approach adopted.
- It also implies a continuing strong (though slightly reduced) role for market governance, and continuing, though again weaker role for government.
- Again, this may be suggestive of a hybrid CLN move towards a more Marshallian/Italianate District type of governance among these larger companies. The stronger role of the market may indicate the need to increase relationships at a more local (i.e. UK) level, where the market may be more appropriate for some governance activities, than it would be for the wider CLNs sought in manufacturing. It may also be indicative of the ability to share resources to a greater extent at a UK level (Marshallian) than could exist at wider geographies.
- The generally higher level of satisfaction with existing arranagements is evidenced by the fact that a greater focus on low cost/moderate value adding activity in the CLN (and less on high-cost/high value added activities), together with a focus on networking and non-routine learning, are the only changes in governance structures seen as necessary. Given that both current and ideal also have the same importance attached, this suggests, too, the need for much smaller changes than seem to be required for manufacturing.

Overall, a more iterative devlopmental role for changes in governance and relationships, building on what already exists to a greater extent appears to be called for.

Interview with Keystone Company Nordam

The company originally located in Wales to enable the Nordam Repair Division based in Tulsa, US to have a European facility. This was to ensure a global presence to meet a growing customer need. At the time there was also financial support from the WDA to assist with building costs through grants. The need for a global presence was the most important reason for the location. In terms of the current location, the reason to stay in Wales is linked to the need to continue to support the growing European customer base. The company recently developed a 40,000 sq ft extension to meet demand, again supported by the WDA grant. In the future, the strategy for the Welsh operation is to continue to provide support to customers. Although costs are high in the UK, support to customers is for product turn time and quality. In terms of government support, there is an issue related to access.

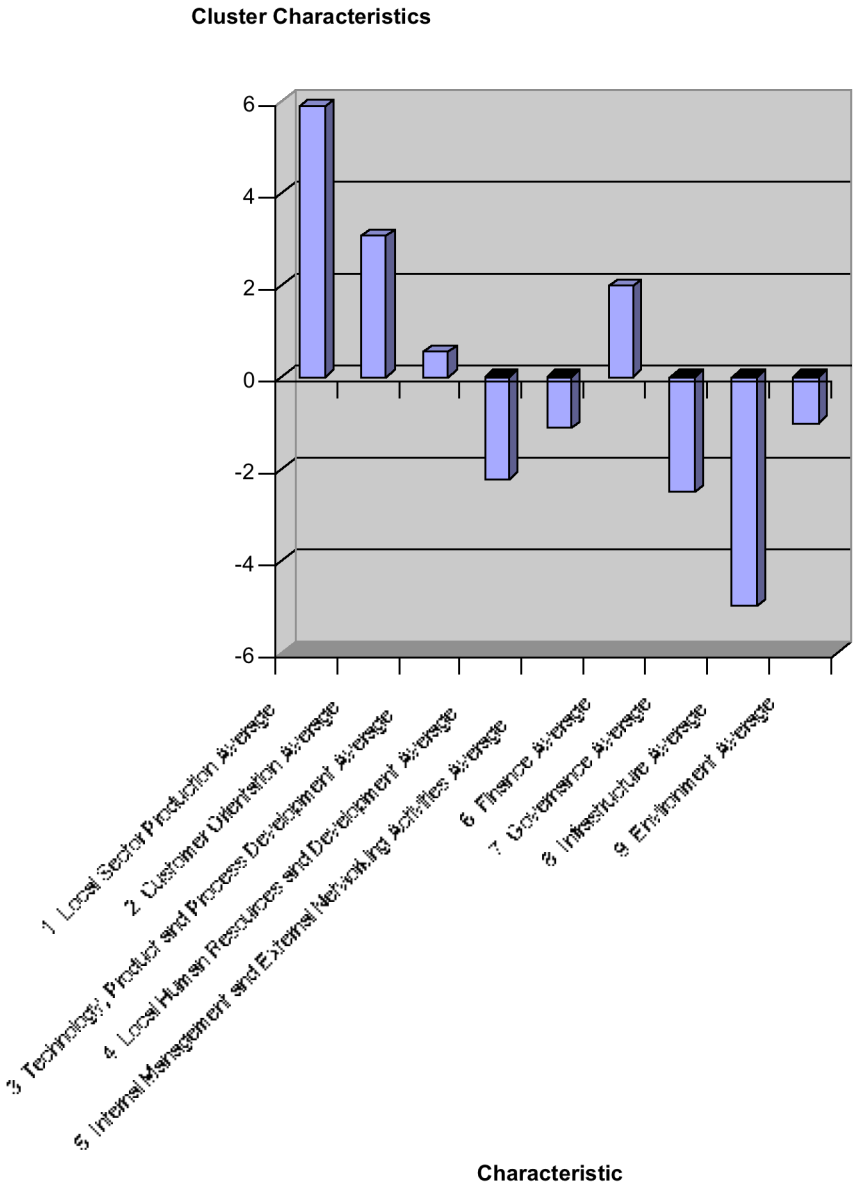
> "Since the WDA became part of the Welsh assembly we have had no contact with government agencies, whereas we used to have regular contact. [It would be useful] if all aerospace industries could have one point of contact to ensure cost effective resourcing and training."

This interview lends support to the case for strengthened corporate governance arrangements, including for government in its dealings with larger companies. This might also indicate a need for government to take more corporate governance approaches to its relationships with business more generally, particularly where industry is asking for more government support and the companies have a degree of power relative to government, such as exists with foreign direct investment (FDI).

Conclusions for Welsh Aerospace MRO

In MRO there is a need to develop stronger internal and external relationships for knowledge creating and disseminating purposes (but at a more UK-level), and improve the interactions between industry and institutions. The opportunity exists to build upon more stable existing structures than exist for manufacturing, with a more nuanced change towards Italianate District type arrangements, while recognising the importance of shared resources, and corprorate governance alongside that of networked governance.

MSQA Results: Aerospace Research Development and Training

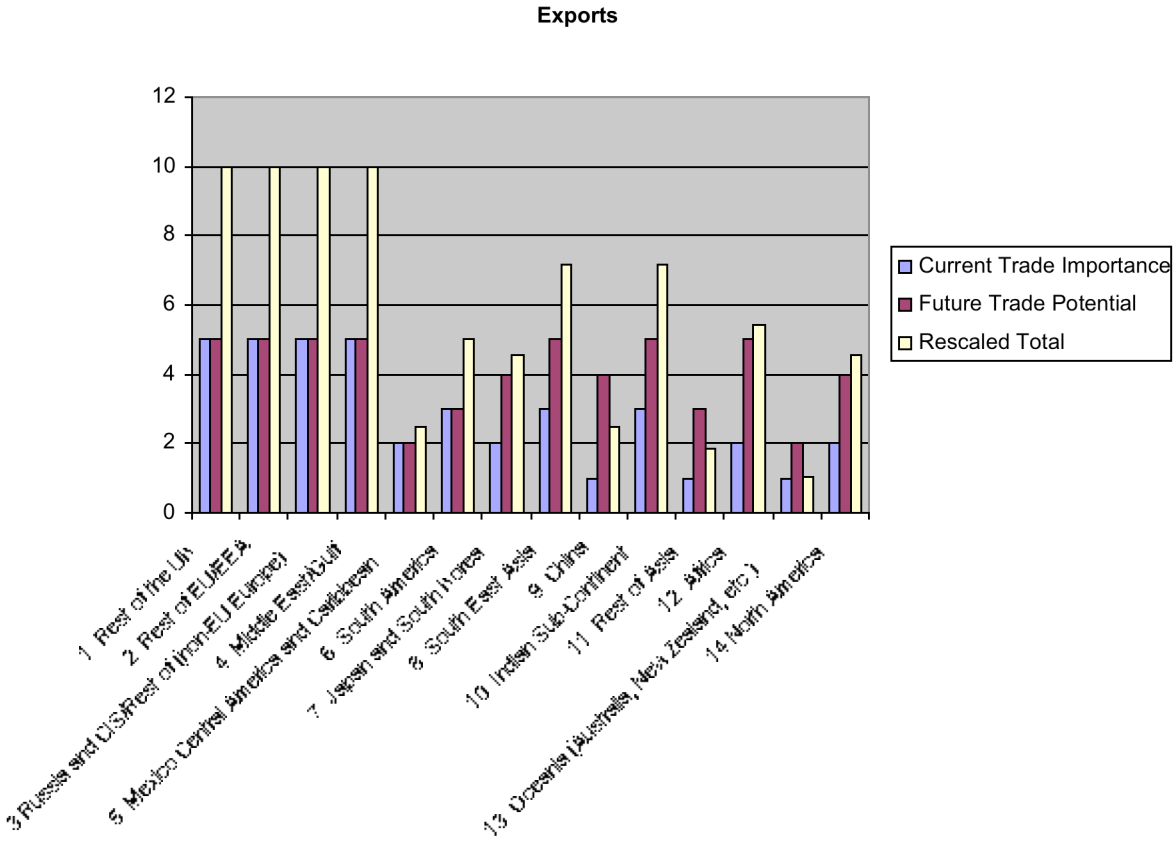


RDT in some ways supports the activities of the other two sectors, as well as being of importance in its own right. It also differs by virtue of a much greater direct government and institutional role. Many of the facilities are owned and run by institutions or government, sometimes working in competititon with private sector actors. There are thus likely to be issues over the appropriate governance type for these quasi-private sector activities and their relationships both with each other and private sector firms.

- The sector can be seen to have some real strengths in terms of local production and customer orientation (particularly in terms of growth potential, "exports", and ability to cope with competition, as well as finance (though in terms of ability to counteract exchange rate fluctuations rather than access to finance).
- In terms of technology, product and process development, strengths in terms of technological collaborations with companies and higher education *outside of Wales* are counteracted by the lack of similar collaborations within Wales, and an absence of technical collaborations at any level.
- Major weaknesses, however, exist at the level of infrastructure (transport and energy costs highlighted as an issue, with buildings also not seen as a strength); governance (due to regulatory and planning restrictions); insufficient networking (both with institutions and also government, though more general

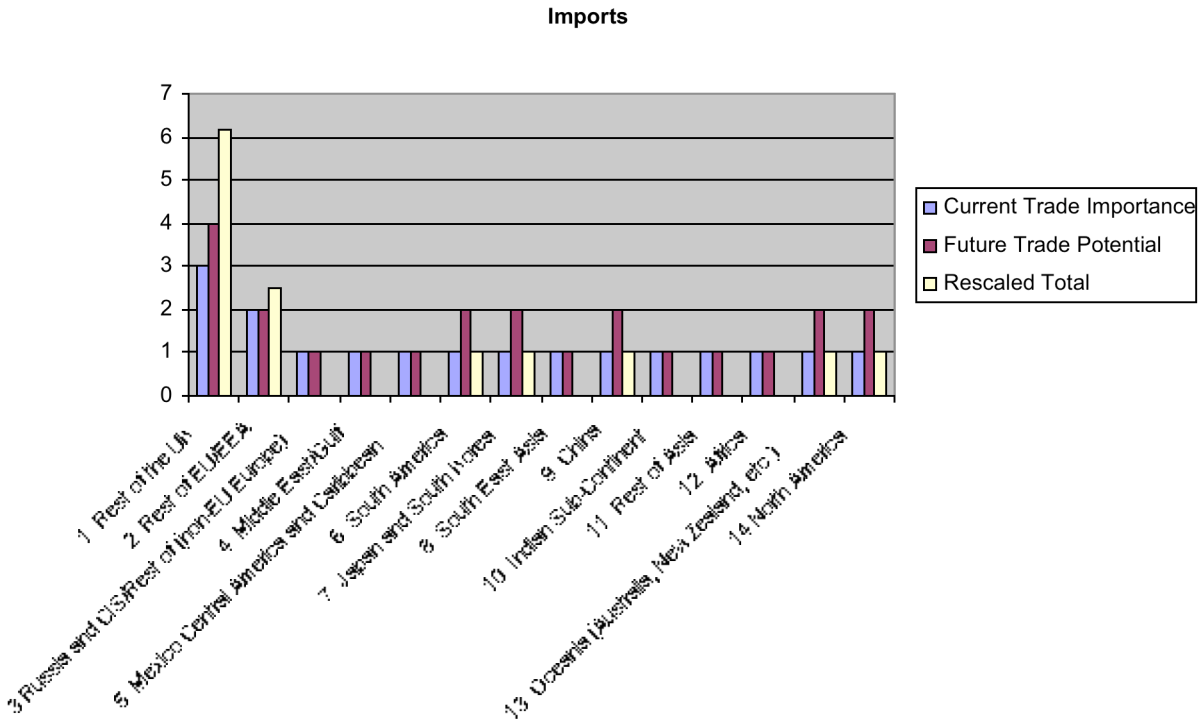
associations were seen as a strength); and also, perhaps most worryingly, human resource development (with clearly perceived weaknesses in training and skills development within the sector, insufficient use of local graduates, and insufficient use of local HE facilities).

This suggests that the potential of RDT in Wales is not being maximised, and that the location of facilities within institutions and the lack of collaboration/networking between them, might be reducing their effectiveness.



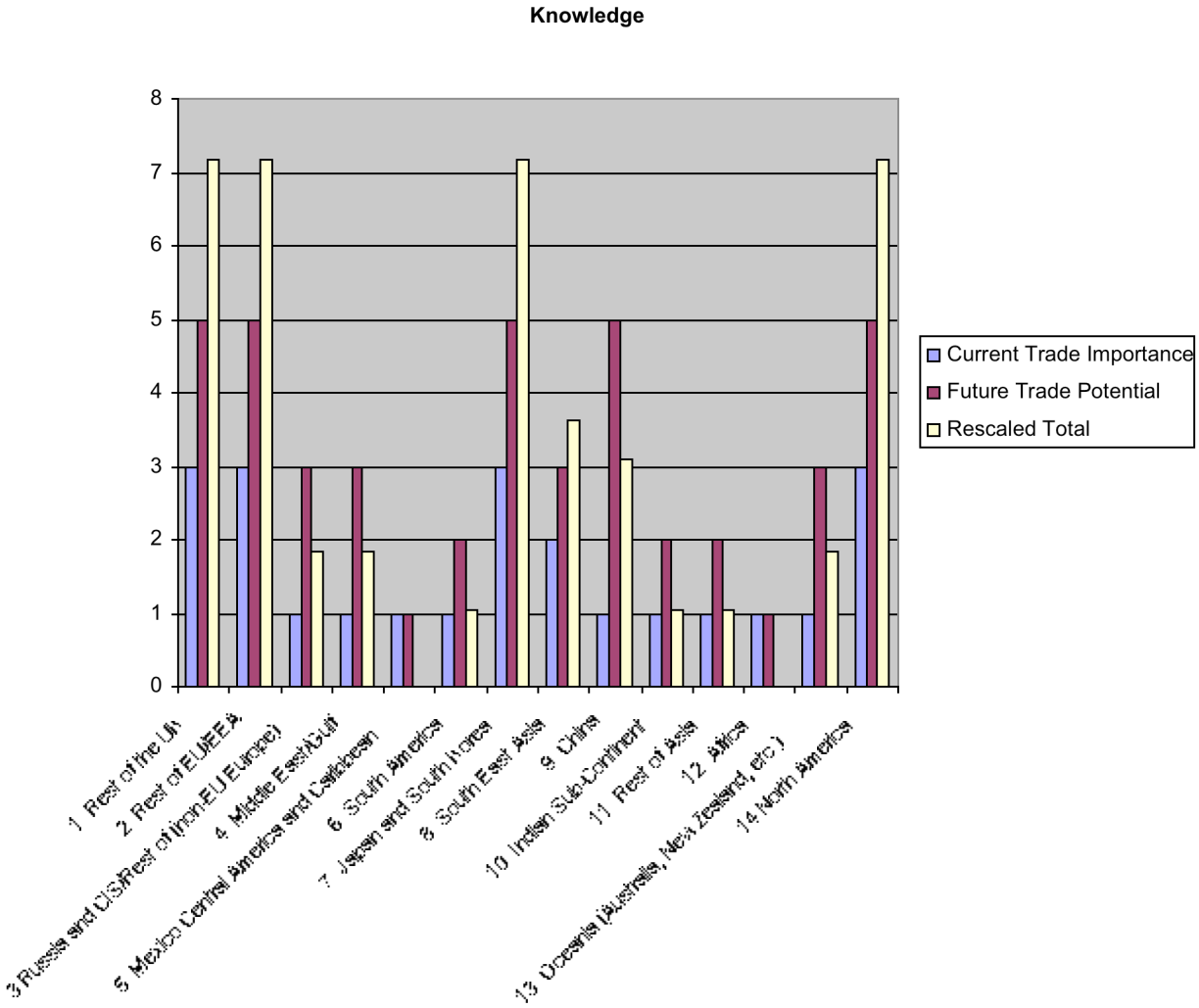
- Because of the ability of RDT to be more globally as opposed to locally or regionally focused, there is a a wider scope for exporting (e.g. training people) to a wider range of markets than highlighted for manufacturing or MRO, particularly in the future. Thus rest of UK, EU, Eastern Europe, Middle East, Asia and Africa all present potentially important future markets.

The potential "location neutrality" of RDT facilities, however, as well as being a strength in not requiring the other parts of the industry to be geographically proximate, may also be a weakness, if the sector does not keep pace with industry developments.



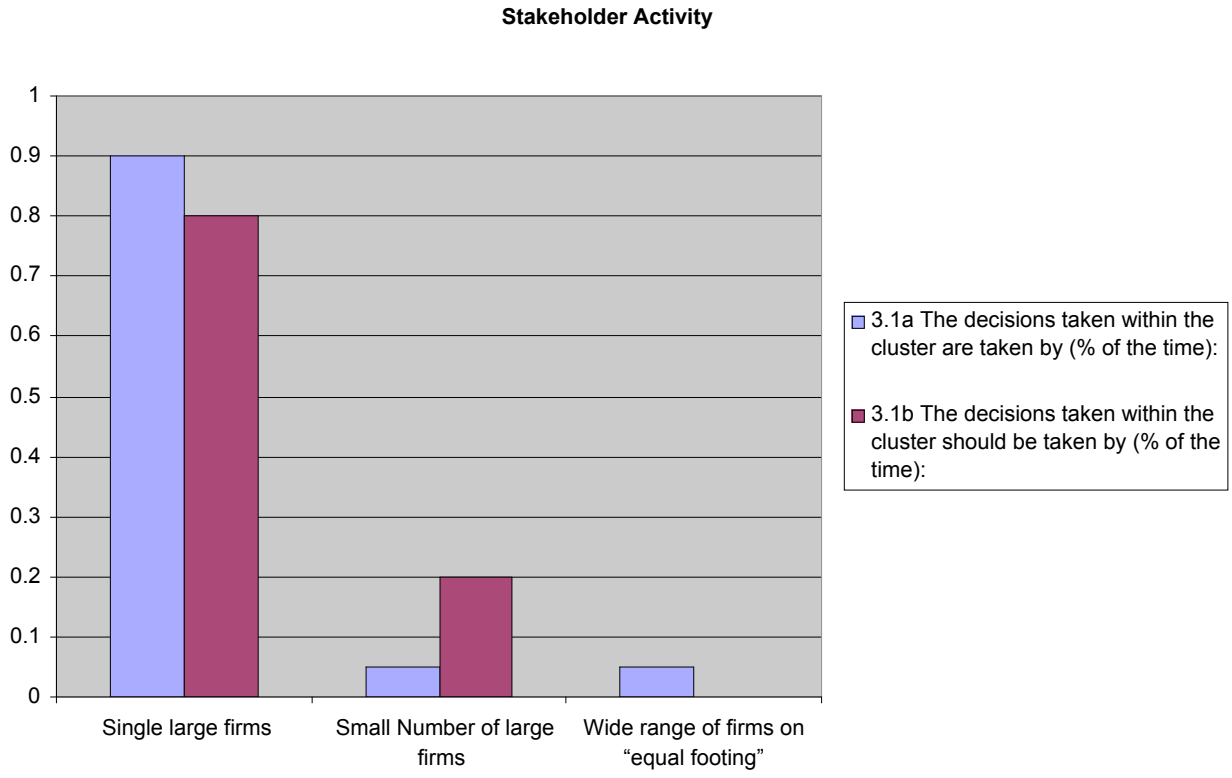
- In terms of imports (i.e. staff) there is, unsurpringly a much tighter geographical focus, with rest of UK seen as of most importance, with areas such as North America, Oceania, China, Japan and South Korea, and South America, seen as almost equally as important as rest of EU.

Concerns might arise over this, if there were a need to import knowledge in the form of personnel able to disseminate RDT in the future.



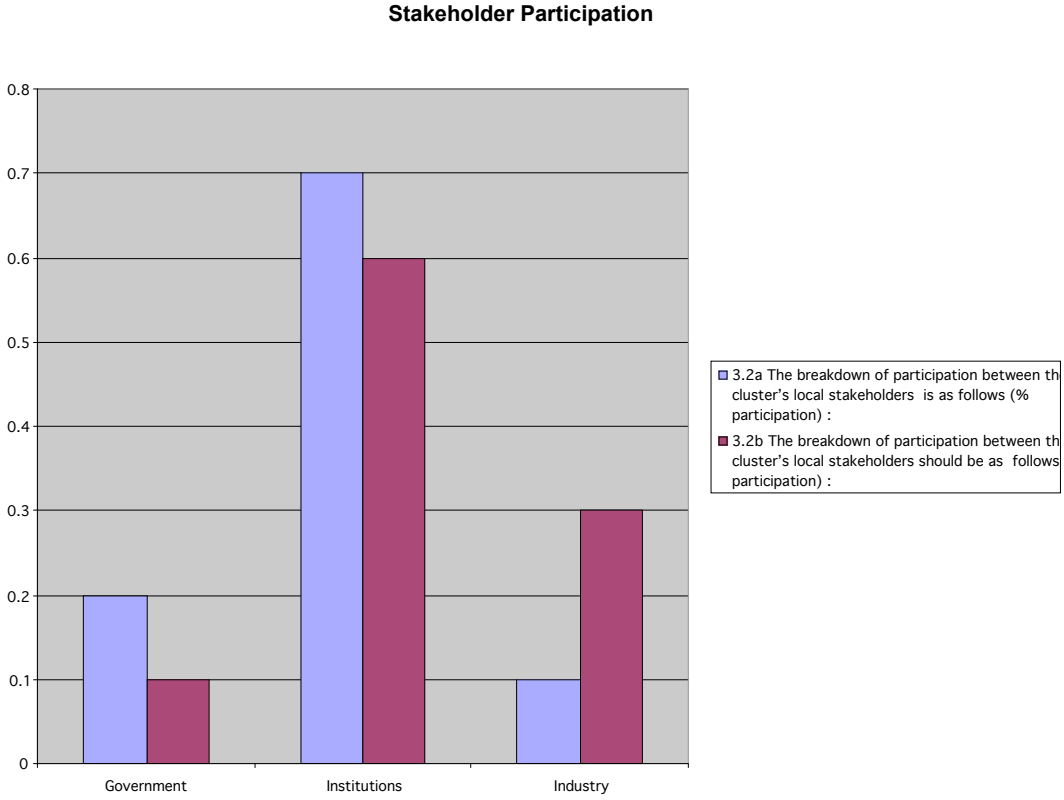
- The importance of such knowledge flows for RDT is highlighted by the figure above, which indicates that key sources of knowledge, particualrly in the future, will be from rest of UK and EU, but also Japan and South Korea, China, and North America.

Appropriate fora must be set up for this knowledge creation and dissemination to take place, as well as appropriate training to allow for dissemination, and networking to facilitate this. As with the other sectors, appropriate structures and networking arrangements must be examined.



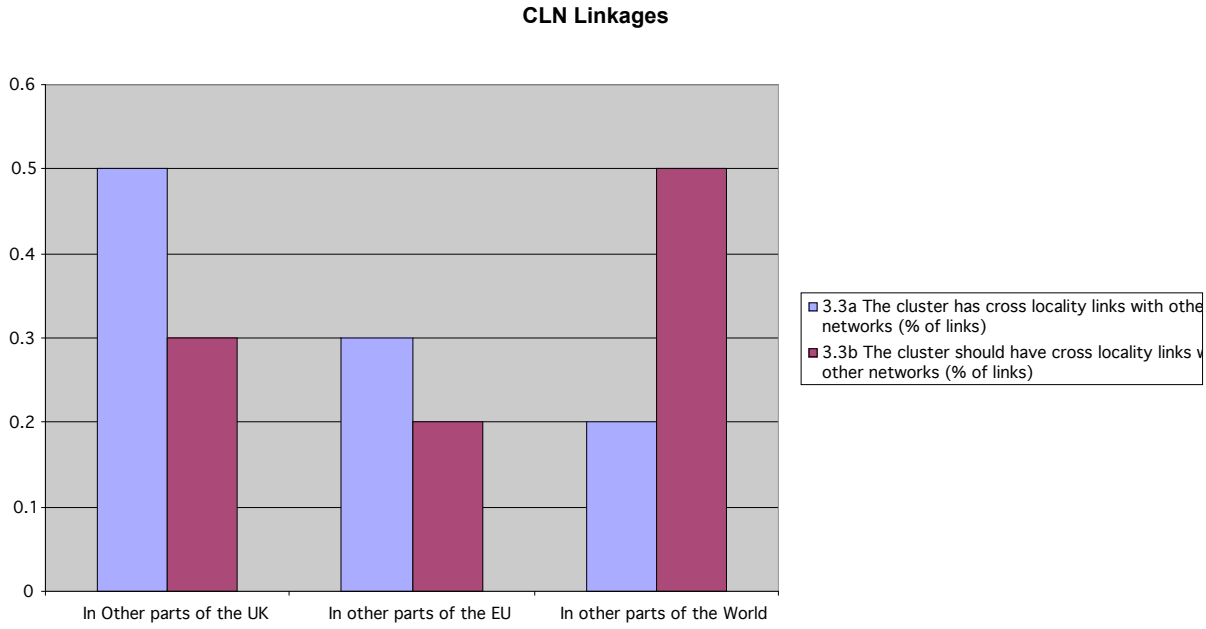
- Unlike the other sectors, RDT decision making seems dominated by single large entities, and seems set to continue to be so, though with an expressed need to widen the spread of decision making within the industry.

This is also suggestive of the structure of the industry, which is again very much more concentrated. This needs to be borne in mind when examining both the clustering and networking at work, and also the governance structures in place.



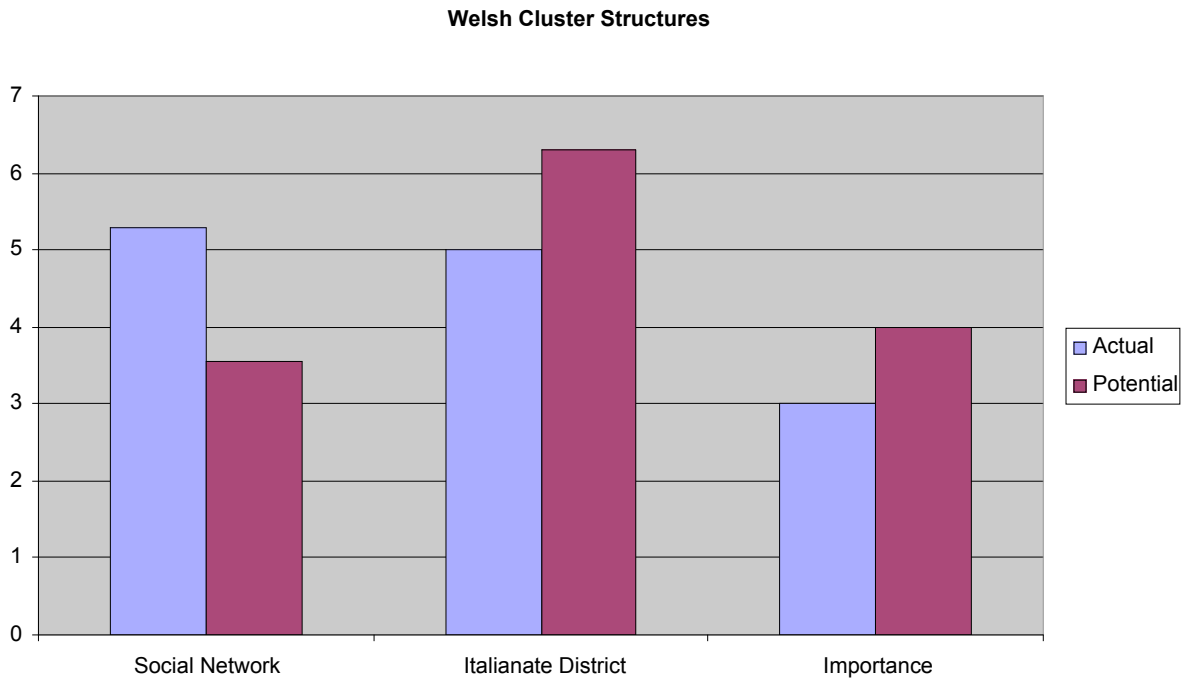
- The differences between RDT and the other sectors can also be seen in relation to stakeholder participation, where the strongest role is played by the institutions that undertake most of these activities, followed by government and then industry. Interestingly, the role of industry is perceived as in need of significant strengthening, at the expense of both government and institutions, suggesting that a more market focused approach to these activities is regarded as desirable, as well as more interaction between industry and institutions.

This supports the results earlier concerning the absence of collaborative working within Wales, and focuses these on institution-industry activities. There is a need, however, to examine how this may fit within network and cluster structures and governance processes.



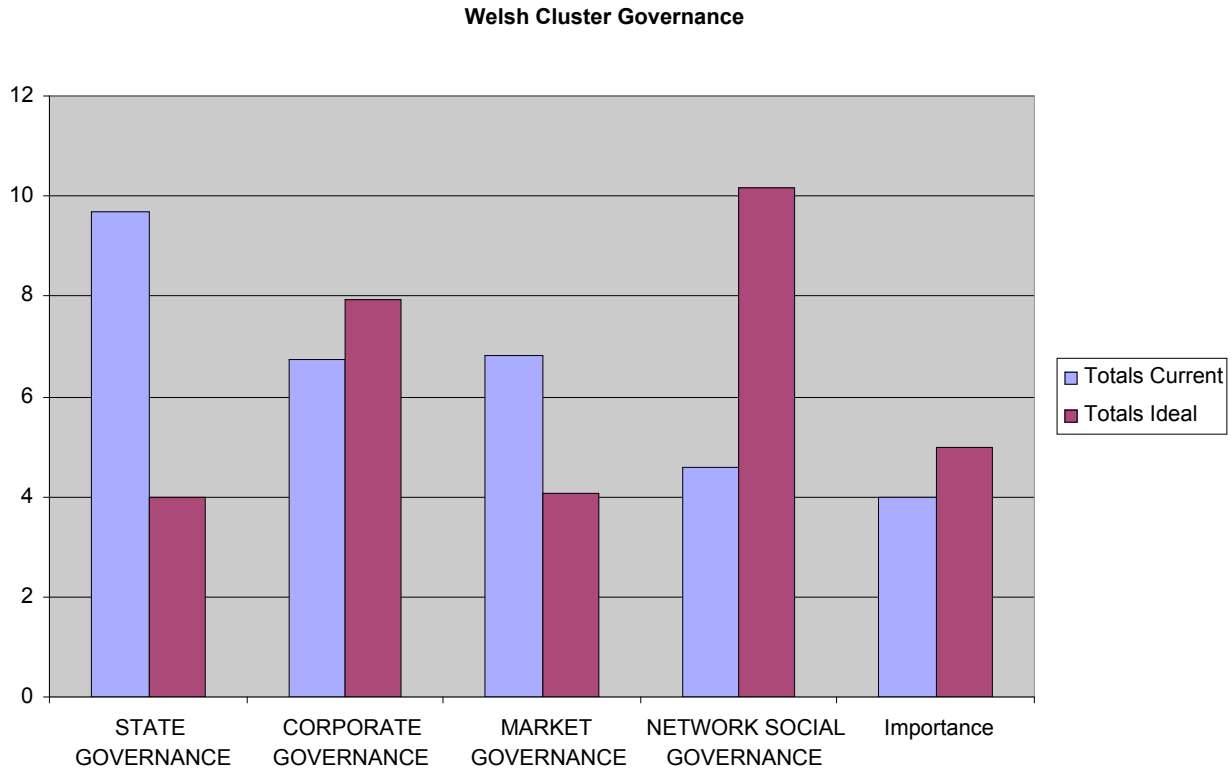
- The perceived need to widen technical colaborations, and access the wider sources of knowledge for RDT in the future lie behind the interest in increased CLNs with the rest of the world, relative to both rest of UK and EU.

The aappropriate governance structures for these processes will, consequently, need to be examined.

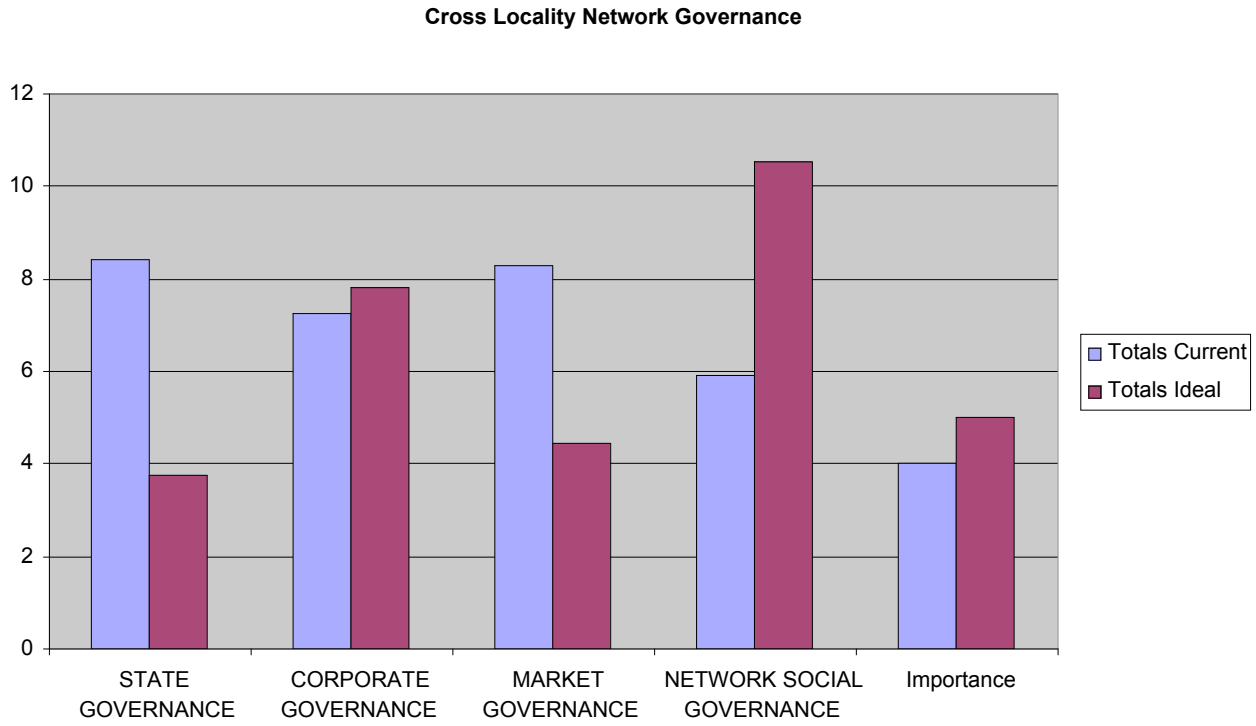


- RDT, more strongly than either manufacturing or MRO, exhibits the need to move towards another cluster type (Italianate district) and away from the existing one (social network). The minimal differences between social network and Italianate disctrict type may suggest, however, that this is more of a nuanced move, with existing Italianate district structures already in place to an extent.
- This illustrates a clear wish, supporting evidence earlier, to formalise networking and collaborative activities to a much greater extent than currently, with more interactions and networking between companies, a higher focus on innovation, creation of more shared infrastructures (particularly for knowledge and technology based reasons). The increased importance attached to the "potential" or "ideal" structures also emphasises the potential importance of this change.
- Specifically, there is seen to be a need for more vertical, formal relationships, but with greater emphasis on trust than (more interactive) teamwork (possibly required because of the stronger need to interact with industry), but on a longer-term network development basis focused on higher levels of learning and greater change.

As with MRO the nature of the industry suggests that this is not a "pure" Italianate district, because of the existence of large institutions and companies likely to give increased weight to corporate and hierarchical governance than in a more traditonal Italianate type district strcuture. The evidence is more suggestive of the need for "Italianate-type" arrangements, rather than a pure cluster of this type.



- This is supported by the governance results. Currently, HEI institutions will have governance more closely aligned to state governance structures, and these dominate (making them inappropriate within a social network setting), with network type structures very low on priorities. The desired hybrid, however, emphasises more networked governance arranagements, but with an increased role for corporate activities, highlighting the increased role for industry (and also perhaps a more corporate type structure for these activities within the institutions themselves).
- This is further demonstrated from an examination of changes highlighted in governance structures. There is seen to be a need for more networked arrangments in terms of a stronger ability to deal with economic turbulence; focus on high cost-high value added activities; growth and spread costs; more trust; social exchange, relational management of networks and focus on social learning; tacit knowledge exchange; and less routine knowledge production. In addition, however, there is also seen to be a need for lower state involvements and higher levels of corporate governance structures, with more use of these in decision-making rather than looser network arrangements, and also less interdependence (at the expense of a mixture of both more dependent and independent relationships).



- The need to widen CLNs (for knowledge-related reasons) can also be seen in the governance structures regarded as of most relevance. The current emphasis on more local UK CLNs can be sen as emphasising the role of government and markets. An increased geographical spread of desired relationships, however, would seem to require more emphasis on networked governance, and also corporate type approaches for the organisations concerned.
- The changes required are similar to those highlighted in the results for Welsh-cluster governance, in that there is seen to be a need for more networked arrangments that will make it easier to deal with economic turbulence; stronger focus on high cost / high value added activities; stronger emphasis on measures to encourage, growth and spread costs; ways to stimulate more trust, social exchange, and relational management of networks; a focus on social learning, and tacit knowledge exchange; and less routine knowledge production. There is also seen to be a need for lower state involvements and higher levels of corporate governance structures instead, with more use of these in decision-making rather than looser network arrangements, and also less interdependence.

This would also seem to emphasise a "hybrid" of the Italianate type approach, where larger organisations are of more importance than in the traditional geographically-bounded italiante district. The distinct nature of this sector also required a wider scope for the keystone organisations, given that there was a mix of institutional and private sector actors, and a more hands-on role for government because of this.

Interviews with Keystone Companies and Organisations in RDT

Two keystone organisations were interviewed in the RDT sector, one from the private sector (training), and one from the public sector (Research and Development). In addition, an interview with one of the key experts was also deemed of importance, because of the linkages between RDT and the other two sectors.

LRTT

The private sector company was LRTT, a joint venture between Lufthansa Technical Training, the technical support arm of Lufthansa, the German airline, and Resource Group, the specialist UK staff training agency. The JV is a European Aviation Safety Agency (EASA) part 147 Approved Basic Training Organisation. Resource Group emerged out of Kelda recruitment, previously a high street recruitment agency, which closed down these operations in favour of a specialised approach, with clients in Wales including aerospace companies, GE and Nordam. The parent group's field of operations covers aircrew, white-collar aero designers, plus aviation operation and maintenance. Resource has a turnover of £30m.

The specialist link with Lufthansa Technical Training arose after initial contract for the supply of Category A individuals. The company was established in 2003 and now has £1.7m turnover and a modest profit. Clients include aircraft manufacturers, and OEMs, international airlines, budget and charter airlines, regional commuter operators, air taxi operators and private individuals. The company offers Part 66 Category A Approved and Modular Courses, Electrical Handskills Training for B1 technicians B1 Conversion courses as well as Technical Translation, Lean techniques and management Training. B2 Approval (Avionics) is currently being sought and is expected during 2007.

Following the creation of a joint venture between the two companies in 2003 to exploit the market for technical training in aircraft maintenance and repair, a search was made for a suitable location in the UK. The most positive response came from the Welsh Development Agency, the company also seeing the much more embryonic state at that time of other Regional Development Agencies in the UK. Research by the company had shown that the business was location neutral, as individuals attending courses are likely to be drawn from across a wide area and will in most cases have to travel to find an appropriate facility in any case.

LRTT's clients are thus individuals seeking training, and companies that have identified training needs for their employees. LRTT business rivals are to be found as far away as Norfolk and Perth, as well as in various further education colleges and universities in different parts of the UK, including Barry College and Bristol College locally. Apart from enthusiastic WDA support, including help in finding suitable premises and financial backing through Regional Selective Assistance, other factors favouring Wales were the presence of a developing aerospace park at St. Athan, near Barry. The site suggested by the WDA at Cwmbran was selected because of its good communications, minutes from the M4, and hence easy access to London, proximity to Cardiff and Bristol airports, and rail services at Newport.

> "This is the best located Objective One area in Britain".

Financial support was particularly important in terms of the initial location decision because, at the time of the start-up, the market for technical training was weak. This was the result of the slump in aviation following the 9/11 terrorist outrages in the US. Companies had cut back on training in response to the drop in passenger numbers and pressures on profits, and were offering few apprenticeships. The legislative landscape, in what is a highly regulated sector, was also uncertain, making it a high-risk time to start the operation. However, when the market environment improved the company was already operating and able to react quickly. Unsurprisingly, therefore, strong government support was of key importance in the initial attraction of the company.

The company remains in Wales partly because the investment already made in terms of equipment, refurbishment, getting a building that can house workshops and class rooms, has been considerable. The building was previously occupied by an engineering training provider and came with power, compressed air, and other facilities already on site. Although most of the company's work is done for client companies and individuals outside Wales, important steps have been taken to integrate into the local economy, including the provision of apprentice training for local people. The company now also has a good understanding of the financial packages available, and has been included in the Welsh Assembly Government's KB4B programme, which works with

companies capable of expanding rapidly.

Another important factor working in favour of continued expansion in Wales is the availability of all-age funding for apprentices. In England funding of £10,000 available for trainees up to the age of 18 is subsequently stepped down, halving for those 18-21. Because age considerations do not apply in Wales, LRTT is able as a result to recruit more mature individuals for training, and these individuals can sometimes be more acceptable to employers and more suitable for sending on courses or attachments outside the country. Thus, in this case, a differential policy is seen as supporting the development of the industry in Wales.

Of the above reasons for remaining, the location is particularly important, though ideally the company would like to be sited on an airfield. (It does have access to facilities at St. Athan but would not wish to move there at the expense of losing easy access to commercial motorway and rail services used by its customers). Training providers located in more distant parts of the UK, such as Perth and Norwich, are seen to be at a disadvantage. The availability of all-age funding for apprentices is also seen as giving Wales a strong competitive advantage and needs to be retained. The lack of good standard budget hotels in Cwmbran to accommodate attendees on course is seen as a problem, however.

> "We could fill a Travelodge on our own if someone would build one"

With regard to the future Welsh operations, there are clear concerns given that the expectation is that heavy maintenance of aircraft will migrate eastwards for cost reasons. Lufthansa, for example, now has two joint ventures in China and Lufthansa Technical Training acquired the technical arm of Philippines Air when it ran into financial difficulties. This operation now handles A340s and A320s. United Airlines of the US is also sending its aircraft to China for maintenance and repair. UK charter carriers are also looking at the Middle East, resulting in an overall reduction in the amount of heavy maintenance taking place in the UK.

Other factors affecting the maintenance sector are the increased reliability of modern aircraft. Lifetime maintenance requirements for a Boeing 777, according to one estimate, would be 63,000 hours – a fifth of that for Boeing 747 Classics. The figure could be lower still for the Boeing 787. Set against this, however, will be the projected growth in air travel and in aircraft utilisation rates. (The worldwide aircraft fleet is expected to grow 4.1 per cent from 2005 to 2015, according to consultancy, Aerostrategy.) The ageing of the workforce in Europe is another problem, partly as a result of the failure to train sufficient apprentices over a number of years.

The RAF, too, has been contracting out maintenance, making greater use of OEM support contracts, as well as reducing the number of squadrons and aircraft. With fewer people joining (and leaving) the RAF, the UK skills pool is being diminished and even reduced demand for aircraft maintenance is not being catered for by the training that is taking place. LRTT has taken trainees from DARA through React Funding and through RAF resettlement funding to try to cater for expected demand. The above factors are expected to continue to create a strong demand for the sort of training provided by LRTT. The company sees its future in offering a more tailored and flexible approach that will give it a competitive edge when bidding against publicly funded colleges and other higher education institutions.

It intends to increase the apprentice training opportunities it offers and to make full use of the KB4B programme to expand its operations. A key objective is to provide apprentice training for the aerospace cluster in Wales, as well as continuing to provide services for MROs across Europe and more widely, as maintenance and repair operations spread to other centres in eastern Europe and Asia. This discussion highlights that there is in reality a clear link between private sector-location and location of manufacturing and MRO activities, emphasising their (at least partial) symbiotic relationship.

One crucial advantage it believes it can offer over college based courses is their greater practical content and hands-on experience of working on engines and airframes. This produces trained individuals who can join companies and immediately make a contribution. Another selling point that the company believes it can use to its advantage is its freedom from the constraints of education timetables, offering an all year round training service. The company is also able to provide training at any location required by its customers and is, for example, currently working extensively in Switzerland with Swiss aviation group, Jet Aviation, in support of parent company Resource Training. The contract will last for a year and also involves training Swiss technicians in Wales. LRTT is also working with Airbus in Erfurt, and in Malta in support of parent company, Lufthansa Technical Training, and in Belgium. This highlights a key problem for institutional providers such as universities, in comparison with private providers, and may emphasise the need to take a more corporate and/or networked approach.

In terms of government support, in addition to all age funding, the company is strongly supportive of the WAG's 14-19 initiative Learning Pathways programme and believes this should be maintained. Colleges are seen as a potential threat to the viability of the business because of their access to government funding for the provision of courses, and the company believes the playing field should be levelled so that competition is fair. Improved road links with St. Athan would help to ease the problems of congestion when travelling from Cwmbran to Barry.

LRTT would also like to see Wales focus exclusively on EASA's own licences rather than their EASA approved UK counterparts and believes this would give Wales an even bigger edge in the provision of training to clients around the world. Continued access to RSA funding is also regarded as vital for extending the range of company activities. In particular, the company argued that there is a need for greater government support for, and recognition of, the role played by independent training providers to enable them to compete effectively with public sector bodies such as colleges and universities. This highlights a key issue in terms of competition versus collaboration between institutions and private sector bodies, as well as a possible "Third" way, where they undertake different activities.

LRTT operates in a highly competitive environment but currently has a strong order book with 45 per cent of this year's capacity sold by January 1. Because of air safety requirements, regulation is intense, with individuals licensed to carry out specific tasks and to work on specific aircraft types. The training provided enables people to obtain or uprate or derestrict their licences and widen the categories of work they can carry out. LRTT describes itself as a sales-orientated organisation. Customers are sought through a direct sales force, through advertisements in aircraft journals such as Flight International and through the company's website. The main business drivers for LRTT are thus currently:

1) Legislation strongly influences the business climate. The timescale for licensing to be harmonised across Europe plus growth in aviation are factors driving the business at present.

2) Technology. LRTT has taken a decision to invest in a composite training facility, jointly with an American company. The company has also extended into light aircraft, many of which already make extensive use of composite materials, thus emphasising this as a key issue)

This interview illustrated the importance of technology, and also key tensions in the compete v. cooperate activities of private versus quasi-public providers. In order to explore these issues in more depth, an interview with an industry expert was carried out, particularly concerning the networking and clustering activities, and issues related to advances in technology and knowledge, and the role of government in these activities.

Expert Interviewee

The expert interviewed argued that attempts had been made over the past three years, to initiate an all Wales FE & HE Education, Training and Academic cluster, "Aerospace Wales Knowledge and Innovation Services" (AWKIS). Whilst all aerospace FE/HE Institutions demonstrated interest i.e. attended a number of meetings etc. lack of funding was perceived as preventing this initiative moving forward. Additionally, training providers have responded to the industry's demand signals, but this has not been supported by industry once considerable investment in resources by the training providers has been made. This is illustrated by the fact that Barry College International Centre for Aerospace Training (ICAT) and the University of Glamorgan have become UK leaders (along with Kingston University) in the training of Licensed Aircraft Maintenance Engineers, recognised by the Civil Aviation Authority (CAA) and yet industry, in this case in the form of the aircraft maintenance organisations, are not willing/prepared to offer the necessary work experience. One reason for this is security (understandable) the other is one of the costs of supervision. This could, in the interviewee's opinion, be easily overcome by a (government–sponsored) industry support grant for every trainee they offer work placement to. There is thus often a perceived lack of coherence between what is reported and what actually the reality is, the emphasis instead being on (government) targets and monitoring of those targets.

In the interviewee's opinion, the training needs to be demand-led by industry, and a "lean" process of education is required (e.g. faster changes to curricula, apprenticeships that take account of this in terms of mechanics, technicians and engineers-initial training followed by refreshers every couple of years)". Instead:

> "Universities are chasing the money, and the government, industry and training providers currently seem to have different interpretations of what is needed in terms of training. There are R&D gaps between universities and colleges**,** leading to a failure to filter the right knowledge down to the training

> of engineers. There is a potential "powerhouse" at Waterton, that needs developing, in order to coordinate activities better."

Indeed, the expert argued that there is a need for something akin to the old Industrial Training Boards. Currently there is joint Government-Industry responsibility, but a lack of consultation. In addition, a problem with devolution is that there can be different strategies at the WAG compared with the UK level (or at the very least delays in implementing essentially the same strategy with a "spin" on it). This indicates a weakness of a "regionally" based strategy, and devolution has caused some issues here (though it also provides potential as well, such as with the training grants).

MEC

In terms of R&D, the Manufacturing Engineering Centre (MEC) is based within a University institution, at Cardiff University. MEC adds to the ability of both manufacturers and R&D personnel who have access to the facilities (i.e. both staff and equipment) to free up their designers to undertake new activities. This means these activities can remain in the UK (i.e. due to resulting cost savings). Having said that, MEC also undertakes work with companies from around the world. What matters now is not location, but quality and expertise. MEC also does some small volume, flexible, low lead-times (e.g. luxury car panels) specialist kit manufacturing that allows no tooling. In terms of why MEC is where it is, Prof Pham is central to this (and also Prof Dimov who came in the early 90s), recruited in 1988 as part of a strategic initiative by the university to raise its research profile in key areas.

The facility remains in Wales because it allows companies not to have to buy this equipment themselves. They could do this, but it's very expensive and if they did have this capability they would probably need to offer it around to other users, because any one company does not need to use it that much, which would be a shift away from their core business. This is not a very likely scenario, so there is not really an issue of companies moving into competition with MEC's activities. Essentially, therefore, it provides an institutional shared resource, in line with the increased emphasis placed on Marshallian type structure for manufacturing. It is possible, however, that other university institutions (e.g. Warwick) may become 'competitors' in the longer term by making the same kind of strategic investments that Cardiff did in the late 80s/early 90s. It would also in theory be possible to the move MEC to a new location, but it is seen as useful to have other ways of doing/thinking about things available- i.e. both within MEC and also the wider university. Again, the people and the projects we have here, e.g. Prof Pham, are the main reasons for staying.

In terms of the future location within Wales, space is certainly an issue at the moment - particularly as new equipment takes up more and more space, and is more complicated to manage i.e. needing a clean environment etc. The other option of course might be a new building with space easy access off the M4. Another possibility is to spin out and grow the commercial side of the centre. Again, however, the lack of any core funding makes it very hard to plan/manage this kind of transition. It is actually difficult under the current regime to be 'strategic' at all. Instead we just have to keep winning the contracts and research projects. The ability to act strategically would make the most significant difference to the future direction of MEC, though there are doubts as to whether things will actually change on this front. This highlights, as before, the excessive emphasis on state (i.e. bureaucratic) governance styles in the sector, when institutional actors such as universities are in competitive markets but are not currently able to act competitively.

In terms of government support in this area, there are very few organisations that can be dedicated totally to aerospace. The interviewee argued that there seemed to be something of a mental blockage in Wales about this, created largely by the WDA, that everything has to fit into a specific 'cluster' or 'sector' i.e. opto/medi/aero/auto etc. Instead, it was argued, that what was needed was developing excellence in the technology/product/application etc itself whatever that may be, with the various uses/markets derived from this. MEC does not receive any government/core funding – it is all won on a competitive basis – around one third commercial sources, and two thirds research projects. This, of course, raises wider questions in term of short termism and inability to plan strategically.

> "This takes time and money because you have to deal with the 'so what?' factor. Even if someone is aware of what we are doing, you still need someone to go out, meet them, explain what the technology can do for them etc. The biggest single impact would be the ability to run this kind of advisory/technical sales/marketing type team here… ultimately leading to actual manufacture of new products here in Wales. We have the expertise and the external contacts to do this, but it's a chicken and egg situation – i.e. you need the cash up front to be able to do this - project funding issue again. As described above -

> we could make all the companies active in aerospace in Wales aware of what we do… I'm pretty sure half of them (especially the smaller ones) have never heard of us, so what chance have they got at them moment of accessing this expertise? I find it crazy that we spend millions on these state of the art facilities, and then effectively keep it a secret!

MEC would also like to have open house e.g. once a month, for small groups e.g. 5/6 at a time, to showcase equipment, answer specific questions on potential uses, and have one to one follow-up sessions, and then follow these up etc. Again, however, additional resources are required to undertake this, and a general wish was expressed concerning non-project funding policy that would enable more strategic activities for MEC's dealings with aerospace, but also for other industries.

Conclusions for Research Development and Training

The evidence highlights clear issues here, both in terms of the need for more formal (Italianate-type) networking and collaboration, but also for a more commercially-focused approach from institutions, and possibly government policy to facilitate this, at both Welsh and also UK levels. There seems to be a need, therefore, for restructuring the nature of the organisations themselves, as well as their relationships with each other, other sectors of the industry, and government.

5. CONCLUSIONS AND RECOMMENDATIONS

Locational decisions dating back to the second world war and a more recent policy of providing support for inward investment aimed at creating new employment opportunities have, together with other historic factors, endowed Wales with a surprisingly large aerospace industry. Indeed, with the decline of other former mainstays of the Welsh economy, aerospace is now one of the country's principal technological, export, and employment assets, worth an estimated £2bn a year to the economy (WAG, 2006).

Yet, this strong and important sector has developed more as a result of unrelated decisions by the main participants than as a result of an overall strategy designed to create a coherent aerospace industry in Wales, well integrated into the world aerospace business. Indeed, in many respects the industry, with its concentrations of manufacturing in North Wales and MRO (and manufacturing) in South Wales, operates as separate constituent parts of other aerospace clusters in neighbouring regions of England and further afield.

Our report looks in detail at the size, output and general characteristics of the three main elements within the Welsh aerospace sector – manufacturing, MRO and RDT - and seeks to show how these individual aggregations work in relation to other private and public sector partners including government and higher education institutions both within Wales and beyond. It seeks to show the extent to which each of these elements can be characterised as a cluster; to which of eight cluster patterns (or various hybrids) identified in recent academic studies they mostly closely correspond; and the direction of travel now needed if the industry in Wales is to progress to the type of structure that will give it the best chance of thriving.

The results highlight several important points concerning the methodology adopted: -

- Clear differences exist between the three sub-sectors of the aerospace industry, and that there is merit in the approach adopted, particularly when there are difficulties in generating official statistics (e.g. from NOMIS and input-output tables) about such sub-sectors.
- Although the framework is useful as a basic tool, potential hybrids can and do exist in addition to the eight basic types highlighted by Clifton et al (2005).
- The additional data gathered on governance arrangements is also of importance, in terms of identifying an additional number of areas where changes may be required and thus policy can be focused (in addition to those highlighted by the basic cluster mapping tool from Clifton et al (2005)).
- There is clear merit in the additional evidence gathered from the keystone companies, in assisting evaluation of the prospects of the industry, where a small number of companies may dominate an industry in a particular region.

There is, therefore, a clearly defined set of issues which the industry will need to deal with urgently, if it is to succeeed in this increasingly competitive environment.

The detailed findings from the individual sectors can be summarised as follows.

- **Aircraft manufacture** is the core strength of the industry in Wales and mainly takes place in the north east. The ratio of design-build as opposed to build-to-print skills and knowledge appears to be higher in South Wales, however, where the industry is also more diverse and fragmented and less vulnerable to single threats.
- Industry responses suggest that in manufacturing current strengths in production, consumer orientation, and environmental impacts are counterbalanced by perceived weaknesses in technology, networking, finance and governance that could impair the future success of the industry, if not addressed.
- Knowledge links need to be developed with developing new markets in Asia and elsewhere which are likely to be two way trade partners of growing importance in future.
- Governance arrangements are in need of widening to enable a broader range of firms to participate in decision-making. A rebalancing that would enable educational institutions to take a stronger role at the expense of Government is also desirable. Stronger linkages are needed, too, with the rest of the EU and other parts of the world, relative to the UK.
- The Welsh manufacturing cluster currently exhibits the characteristics of the relatively simple satellite industrial district, with a small number of large firms relying on external regions for its knowledge base and majority of firms focusing on individual survival. It would ideally move towards becoming a more sophisticated Marshallian / Italianate -type hybrid, enjoying shared used of common resources, particularly

those arising out of higher education. (See Table 1, for definitions of cluster types described in this summary.)

- Overall, the industry should seek to develop internal and external relationships and networks as part of an ongoing process that will allow manufacturing to reduce its role as a satellite of other regions' aerospace industries and play a fuller role in the development of the industry in Wales.
- A continued supply of skilled labour at all levels is also perceived by Airbus as the most important factor in ensuring re-investment at its Welsh site. Financial support from Government in UK, while small in relation to the total investment amounts required, needs to be maintained as a demonstration to partner governments of British commitment.
- **Maintenance repair and overhaul (MRO)** is concentrated in South Wales where it has located to take advantage of local availability of a skilled aerospace workforce. As competition for work intensifies from new suppliers in Asia and elsewhere (particularly for long-haul and older aircraft maintenance), the sector is likely to have to focus more on high value, sophisticated tasks. There will be a need therefore, to constantly review whether the requisite skills, knowledge and relationships are being developed to facilitate this technologically-based focus.
- Perceived strengths exist in customer orientation and environmental impacts appear to be more than outweighed by weaknesses in technology, product and process development, (reflecting less than satisfactory R&D and technical capacity), inadequate relationships between companies and institutions both within and outside Wales; in finance; and in networking (because of a lack of autonomy in key functions). These issues could impact the future of the sector, if not addressed.
- Although stakeholder decisions are perceived to be spread evenly among a wide range of firms reflecting the wider base of companies in this sector than in manufacturing, there is still seen to be a need to spread decision-making more widely and to limit the power of single large firms to determine outcomes. The extent of participation within the sector by industry, government and institutions is seen, however, as being at near optimal levels.
- Unlike manufacturing, the maintenance and repair sector's cluster structure already has significant Marshallian characteristics, with a modest preference being expressed for a move towards the more co-operative Italianate district structure, enabling more interactions and greater networking between companies for knowledge creating and disseminating purposes.
- In governance a preference is expressed for greater network social governance within the Welsh cluster (reflecting the greater role of networked activities in the Italianate-type district ideal) and in cross locality network governance only for a reduced role for the large corporations. A weaker role is aspired to for state and market governance.
- Issues of access to Welsh development officials since the incorporation of the Welsh Development Agency into the Welsh Assembly government in May 2006 were also raised by company officials from one of the keystone companies interviewed for the report.
- **Research, development and training** is concentrated mainly in South Wales, with R &D facilities including the engineering departments at Cardiff and Swansea universities, both of which also engage in composites research. Training is provided by several higher education institutions and by private sector providers and is characterised by a much greater perceived direct government and institutional involvement than the other two sectors, creating issues over the most appropriate governance type.
- The sector has perceived strengths in terms of local production and customer orientation, the latter offering good growth potential through its ability to generate "exports" and to cope with competition. Strengths in technology-related fields and collaboration with companies and higher education institutions outside Wales are counteracted, however, by the lack of similar collaborations in Wales.
- Major perceived weaknesses exist in infrastructure, particularly transport and energy costs and buildings; in governance; networking; and perhaps most worryingly of all human resource development where there are perceived weaknesses in training and skills development, and insufficient use of local graduates. The potential of RDT in Wales may not accordingly be being maximised.
- Key sources of knowledge for the future will be Japan, South Korea, China and North America as well as the UK and rest of EU, and appropriate for a for this knowledge creation and training to allow for dissemination as well as networking facilities need to be set up.
- Research development and training needs to a greater extent than the other two sectors to move towards a different cluster type, in this case Italianate district and away from its present social network type. This arises from a clear wish to formalise networking and collaborative activities to a much greater extent than is currently the case. There is also a perceived need for more formal vertical relationships.
- Good transport links in South East Wales, financial support and business advice, and distinctive Welsh industrial policies were quoted by one interviewee for establishing and staying in Wales. Competition between state-supported higher education institutions and private sector training providers was raised, however, as an issue, pointing to the need to plan more effective collaboration or differentiation of activities.

A cause for concern expressed by another interviewee was the reluctance of the industry to support increased training capacity moves made by the higher education sector by failing to offer work experience places to trainees. Government funding is seen as offering a potential solution to this problem.

- University research needs a broader canvas than aerospace alone enabling excellence to be developed across a number of user markets in technology/product development/applications. There was insufficient recognition of this in Government thinking, another interviewee believed, with centres being asked to fit neatly into a particular designated cluster.
- A lack of core funding meant all projects had to be won on a competitive basis, making it difficult to move beyond short-termism and to plan strategically.

It is clear from the above that the aerospace industry in Wales is now in many ways at a cross roads. Although the UK has a strong technological base in aircraft manufacture and maintenance, the industry, like other less technically advanced counterparts, is now highly mobile internationally and strong competition from lower cost countries can be expected over time to impact and, indeed, is already doing so. Challenges are also emerging from the development of new materials, such as composites, which threaten to devalue the existing metal expertise of many existing Welsh aerospace companies, including Airbus.

Ongoing strong and focused Government support at a UK level for UK science and engineering thus appears to be important to meet the efforts being made by the emerging Asian economies to establish themselves as centres of manufacturing excellence. While efforts are being made by the Government, industry, academic and other partners to ensure the UK remains abreast of new technologies through the National Aerospace Technology Strategy, it is vital that Wales fully participates in these changes and that Welsh manufacturing operations are enabled to use the new technologies.

Continued financial support also appears to be vital for the launch of major new airframe products, not as much for market failure-based reasons, but rather to demonstrate continued UK commitment to the future of the sector, particularly in the light of the ownership changes that have seen the withdrawal of BAe Systems from the Airbus consortium. The concerns of other manufacturers on related issues such as human resources, transport infrastructure, and regulation among others will also need to be heeded.

Competition for MRO operations, particularly for olong-haul aircraft is emerging from low cost countries such a China, where investment in facilities and the provision of skilled personnel has been gathering pace. The sector's ability to compete will depend heavily on technological innovation, a move towards higher added-value activities and a continuing supply of skilled labour.

Wales's established position as an important participant in the international aerospace manufacturing and MRO sector, and its RDT sub-sector, represents a strong platform on which to build the future success of the industry. As our report demonstrates, however, the structures within the industry are not as favourable as they might be and there is an urgent need for the three sectors of the industry to move towards the kind of institutional arrangements that will most likely guarantee its ability to continue to grow and prosper.

Much of the initiative for achieving these changes will need of necessity to come from within the industry in its broadest sense. There will, however, be a role for the Welsh Assembly Government and its agencies, and we strongly recommend that further work to implement appropriate cluster strengthening along the lines indicated in the responses to this report now takes place.

6. REFERENCES

Asheim, B. and Gertler, M. (2005) The Geography of Innovation: Regional Innovation Systems, in: J Fagerberg, D C. Mowery & R.R. Nelson (eds), *The Oxford Handbook of Innovation*, Oxford: Oxford University Press, 291-317.

Borys, B. and D. Jemison (1989) Hybrid Arrangements as Strategic Alliances: Theoretical Issues in Organizational Combinations, *Academy of Management Review,* **14** (2): 234-249.

Boschma, R.A. (2005) Proximity and Innovation: A critical assessment, *Regional Studies,* **39** (1): 61-74.

Bristol Evening Post (28 February 2007) '750 jobs to go at Airbus'

Campbell, R. (2006) 'Airbus UK Procurement - Looking Forward', Weston-Super-Mare: West of England Aerospace Forum (WEAF): paper for WEAF 2006 annual conference *Delivering Customer Satisfaction,* 8 February

Clifton, N. David, R. and Pickernell, D. (2005) *Auditing Welsh Industry: A clusters based approach,* Cardiff: Welsh Assembly Government.

Cooke, P. (1998). Introduction: Origins of the concept. In H.J. Braczyk, P. Cooke & M. Heidenreich (Eds.), *Regional Innovation Systems – The Role of Governance in a Globalized World*. London: UCL.

Cooke, P. (2003). The Regional Innovation System in Wales: Evolution or Eclipse in Cooke, P, Heidenreich, M. & Braczyk, H. (eds) (2003) *Regional Innovation Systems (2nd Edition*), London, Routledge.

Cooke, P. Clifton N. and Oleaga, M. (2005) Social capital, firm embeddedness and regional development, *Regional Studies*, **39** (8): 1065–1077.

Cooke, P and De Laurentis, C. (2006) Cooke, P., De Laurentis, C., Tödtling, F., Trippl, M. *Regional Knowledge Economies: Markets, Innovation and Clusters*, (Cheltenham: Edward Elgar).

Cooke, P. and Ehret, O.M. (forthcoming) 'Procurement Decisions in the Welsh Aerospace Industry: Knowledge and Skills as Key Determinants,

Department of Trade and Industry [DTI] (2001) Business Clusters in the UK: A First Assessment, DTI / Trends Research, London.

Department of Trade and Industry [DTI] (2003) *An Independent Report on the Future of the UK Aerospace Industry. Aerospace Innovation and Growth Team,* no place: DTI

Dhanaraj, C., and Parkhe, A., (2006) Orchestrating Innovation Networks, *Academy of Management Review* **31** (3), 659-669

Dowdy, J. (2006) 'UK Aerospace Supply Chain Review,' London: Society of British Aerospace Companies (SBAC): paper for SBAC 2006 annual conference *21st Century Supply Chains,* 1 March

Ehret, O.M. and Cooke, P. (forthcoming a) 'Conceptualising Aerospace Outsourcing: Airbus UK and the Lean Supply Approach,' in (book)

Ehret, O.M. and Cooke, P. (forthcoming b) 'Proximities in the Welsh Aerospace Industry,' in *International Journal of Technology Management*

Evans P. (1995) *Embedded Autonomy: States and Industrial Transformation* (Princeton: Princeton University Press).

Feldman, M.P. (1994) *The Geography of Innovation* (Kluwer, Dordrecht).

Flight International (17 July 2006) 'Concorde to carbon fibres'

Flight International [FI] (20 June 2006) 'Rise of a dragon'

Florida, R. (1996) Regional Creative Destruction: production Organization, Globalization, and the Economic Transformation of the Midwest, *Economic Geography,* Vol. 72 No 3, pp. 314-334.

Floyd S.W. Woolridge W. (1999) Knowledge creation and social networks in corporate entrepreneurship: The renewal of organizational capability, *Entrepreneurship theory and practice,* **23** (3): 123-143.

Frenz, M., and Oughton, M., (2006) Innovation in the UK Regions and Devolved Administrations: A Review of the Literature: Final Report for the Department of Trade and Industry and the Office of the Deputy

Prime Minister, DTI, London

Grabher G. (1993) ed. *The Embedded Firm: On the Socio-Economics of Inter-Firm Networks* (London: Routledge).

Granovetter M. (1985) Economic action and social structure: the problem of embeddedness, *American Journal of Sociology*, **91**: 481-510.

Granovetter M. (1992) Problems of explanation in economic sociology, in N. Nohria and R. Eccles eds. *Networks and Organizations: Structure, Form and Action* (Boston: Harvard Business School Press).

Griffiths, A. & Zammuto, R. F. (2005); Institutional Governance Systems and Variations in National Competitive Advantage: An Integrative Framework, *Academy of Management Review,* 30:4 823-842.

Hayward, K. (2005) *UK Aerospace: Position & Prospects, Rhoose*: lecture organised by Royal Aeronautical Society, 13 October

Hickie, D. (2006) 'Knowledge and Competitiveness in the Aerospace Industry: The §Cases of Toulouse, Seattle and North-west England,' in *European Planning Studies***, 14** (5), 697-716

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

Howells, J. (2002) Tacit Knowledge, Innovation and Economic Geography, *Urban Studies***, 39**(5-6): 871-884.

Jaffe, A.B. Trajtenberg, M. and Henderson, R. (1993) Geographic localization and knowledge spillovers as evidenced by patent citation, *Quarterly Journal of Economics,* **108**: 577-598.

Jamal, Z. (2004) Microsoft partnership implemented, *United Nations Development Program, Regional Bureau for Arab States, Regional Programme Division Newsletter*, Issue 3.

Keast, R. and Brown, K. (2002) The Government Service Delivery Network: A Case Study of the Push and Pull of Central Government Coordination*, Public Management Review*, **4.**

Keast, R. and Hampson, K. (2005) Innovation Networks in the Construction Arena: The Strategic Management of Mixed Enterprises*,* paper presented in Panel Track: Governance and Management of Hybrid Organisations, *9th International Research Symposium on Public Management* 6-8 April, Milan.

Keast, R. M.P. Mandell, and K. Brown (2005) "Governance Arrangements and Network Management: The Impact on Hybrid Networks", paper presented to the Ninth International Research Symposium on Public Management, Milan, 6-8 April.

Leonard, D., and Sensiper, S. (1998) The role of tacit knowledge in group innovation, *California Management Review*, **40** (3): 112-132.

Leydesdorff, L. (2000) The Triple Helix: An Evolutionary Model of Innovation, *Research Policy,* **29** (2), 243-255.

Lundvall, B-A. (1992) *National Systems of Innovation*: *Towards a Theory of Innovation and Interactive Learning* London: Pinter.

Mair, A. (2001) *North West England Aerospace Cluster: Cluster Mapping Project: Final Report to North West Development Agency [and] North West Aerospace Alliance,* no place: UK Research Partnership

Menard, C. (2002) *The Economics of Hybrid Organizations* (Presidential Address ISNIE 2002, MIT September 29, Available at www.isnie.org).

Niosi, J. and Zhegu, M. (2005) 'Aerospace Clusters: Local or Global Knowledge Spillovers?' in *Industry and Innovation,* **12** (1), pp. 5-29

Nonaka I. (1994) A dynamic theory of organizational knowledge creation, *Organization Science,* **5** (1): 14-37.

Oliver, R. L. and Anderson, E. (1994) An empirical test of the consequences of behaviour- and outcome-based sales control systems, *Journal of Marketing,* **58**: 53–67.

Pagell, M and Krause, D.R. (2005) Determining When Multiple Respondents Are Needed In Supply Chain Management Research: The Case Of Purchasing And Operations, Academy of Management Conference Proceedings, Honolulu, August 5-10: B1-B5

Patton, M. Q. (1990). *Qualitative evaluation and research methods* (2nd ed.). Newbury Park, CA: Sage Publications

Penrose E. (1959) *The Theory of the Growth of the Firm* **(**Oxford: Oxford University Press).

Peterson, J. (2004) Policy Networks, in Wiener, A. and Diez, T. eds *European Integration Theory*, (Oxford University Press: Oxford) 117-135.

Pickernell, D. Rowe, P.A. Christie, M.J. Clifton, N. and David R. (2005) Cluster development and benchmarking -A recent Welsh approach, CRIC Cluster Conference, Ballarat, Victoria, Australia, 30 June–1 July.

Pickernell, D., Packham. G., Miller, C., Thomas, B., and Keast, R. (2006) University Challenge? Innovation Policy and SMEs in Welsh Economic Development Policy: Towards a New Framework, 51st International Council for Small Business Conference, Melbourne 18-21 June.

Polyani, H. (1962) Tacit Knowledge, *Review of Modern Physics*, **34**: 601-616.

Polanyi M. (1966) *The Tacit Dimension* (Doubleday: New York NY).

Putnam R. (2000) *Bowling Alone: The Collapse and Revival of American Community* (New York: Simon and Schuster).

Reed, F.M. and Walsh, K. (2002) 'Enhancing Technological Capability Through Supplier Development: A Study of the U.K. Aerospace Industry,' in *IEEE Transactions on Engineering Management,* 49 (3), 231-242

Rhodes, R.A.W. (1997) From marketisation to diplomacy: It's the mix that matters, *Public Policy and Administration,* **12**: 31-50.

Roberts, B., and Stimson, R.J. (1998) Multi-sectoral qualitative analysis: a tool for assessing the competitiveness of regions and formulating strategies for economic development, *Annals of Regional Science,* **32**, pp. 469-494.

Rowe, P.A. and Christie, M.J. (2006) in press Sharing of tacit knowledge within top management teams in civic entrepreneurship. In R. Harrison and C. Leitch eds. *Entrepreneurial Learning: Conceptual Frameworks and Applications.*

Rowe, P.A. (2004) Leadership and Learning in Executive Teams, unpublished PhD Thesis, UQ Business School, The University of Queensland, Australia.

Rowe, P.A. (2002) Behaviour-based control: developing a behaviour modell framework for organizational learning, Australian and New Zealand Academy of Management Conference, Beechworth, December.

Schaeffer, P. and Loveridge, S. (2002) Towards and understanding of types of public private cooperation, *Public Performance and Management Review*, **26** (2): 169-189.

Schuller T., Baron S. and Field J. (2000) Social Capital: a review and critique, in S. Baron, J. Field and T. Sschuller (eds.) *Social Capital: critical perspectives* (Oxford: Oxford University Press).

Schwatrz, R.G. and Teach, R.D. (2000) Research Note: Entrepreneurship Research: An Empirical Perspective, *Entrepreneurship Theory and Practice,* **24 (3): 77**-81

Smith, D.J. and Tranfield, D. (2005) 'Talented suppliers? Strategic change and innovation in the UK aerospace industry,' in *R&D Management,* **35**, (1), 37-49.

Smith, D., and Ibrahim, G., (2006) Cluster Dynamics: Corporate Strategy, Industry Evolution and Technology Trajectories – A Case Study of the East Midlands Aerospace Cluster, *Local Economy***, 21(**4), 362-377.

Society of British Aerospace Companies [SBAC] (2005) *UK aerospace industry survey,* London: SBAC

Swan, J., H. Scarbrough, and M. Robertson (2003) The construction of 'communities of practice' in the management of innovation. *Management Learning*, **33** (4), 477-496.

Teece D. and Pisano G. (1994) The dynamic capabilities of firms: an introduction, *Industrial and Corporate Change*, **3**, 537-556 (reprinted in G. Dosi, D. Teece and J. Chytry eds. 1998 *Technology, Organization and Competitiveness***,** Oxford, OUP).

Van Dijk, M.P., and Sverrisson, A. (2003) Enterprise Clusters in Developing Countries: Mechanisms of Transition and Stagnation, *Entrepreneurship and Regional Development,* **15** (July-September): 183-206.

Weick, K.E., (1990) Organizational culture as a source of high reliability. Calif. Manage. Rev. 29 (2), 112–127

Welsh Assembly Government (2006) Aerospace and Defence Strategic Plan (Final Draft), April 2006, Cardiff, WAG.

Welsh Economy Research Unit (2002) Welsh Growth Sector Analysis 2002, Cardiff, Welsh Economy Research Unit.

Welsh Economy Research Unit (2004) Welsh Economy Input-Output Tables for 2000, Cardiff, Welsh Economy Research Unit.

Woolcock, M. (1998) Social capital and economic development: towards a theoretical synthesis and policy framework, *Theory and Society*, **27**: 151-208.

Appendix 1: MSQA Letter and Questionnaires.

Dear Colleague,

The Institute of Welsh Affairs (IWA), Centre for Advanced Studies (CAS) and Welsh Enterprise Institute (WEI) have been asked by the Welsh Assembly Government to further develop a methodology for analysing the characteristics of industry sectors and clusters in the Welsh economy. We would therefore very much welcome your involvement in this research project. The aerospace industry cluster has been identified as a sector of particular interest, split into:-

- Manufacturing
- Maintenance, Repair and Overhaul
- Research, Development, and Training

Expert opinion regarding the development potential of sectors and industries, such as yours, will form an important input to economic development policy in the future, to reinforce more traditional official statistical analysis etc. We have identified you as an expert, and are hoping you would be prepared to undertake a short questionnaire-based interview (face-to-face or telephone).). In brief this would involve your views concerning your aerospace sub-sector with regard to the following: -

- Activities, Capacities, Risks and Relationships
- Current and Future Trade and Knowledge interactions

We should emphasise that we are primarily concerned with a Welsh industry based viewpoint. A summary of the results of the completed research exercise would then be forwarded on to you. Please do not hesitate to contact us if you have any queries regarding the project or the questionnaire.

Nick Clifton : 02920 876064 (e-mail: cliftonn1@cardiff.ac.uk)

Oliver Ehret : 02920 876064 (e-mail: ehretom@cardiff.ac.uk)

David Pickernell : 01443 483759 (e-mail : dgpicker@glam.ac.uk).

Rhys David: 02920 202666606 (e-mail: rhysdavid@iwa.org.uk)

With many thanks for your time,

Yours sincerely

Dr N.C. Clifton Senior Research Associate (CAS)	R David Development Director (IWA)	Dr. D. Pickernell Reader (WEI)	Dr. O. Ehret Research Associate (CAS)

QUESTIONNAIRE 1: INFORMATION SHEET

Guidance Notes for Completion

This survey is intended to elicit your views on the nature and development of your selected sector within the aerospace industry. Where possible we have also sent additional summary information related to the industry/cluster to illustrate the area of the economy we are referring to. Please answer the questions to the best of your knowledge and ability. If you feel you are unable to answer a particular question, we will insert a dash (-) in the relevant box. However, we are interested in your impressions, even when not necessarily based on concrete data. This exercise is meant to complement economic data sources, and to enable examinations of industries and sectors not easily identifiable in standard statistics.

Part A: Industry Activities, Capacities, Risks and Relationships

This section is looking to generate a picture of the industry's activities, capacity, and the risks facing it, in terms of characteristics such as production, market orientation, technology, human resources, internal management and networking, financial issues, governance, infrastructure and environment. There are a number of statements made about each of these characteristics and we would like you to grade, first their accuracy, and then the importance of the issue to the industry sector.

For each statement, please fill out the left hand (***accuracy***) box with a number from one to five depending upon how far you believe the relevant statement is accurate, from 1 for strongly disagree with the statement to 5 for strongly agree with the statement. For example, if you strongly agree with the statement that business start-up rates in the industry are high in Wales, then the respondent would put a 5 in the right hand box. Conversely, if you strongly disagree with this statement then the respondent would put a 1 in the right hand box. If you believe any statement is not at all appropriate to the industry concerned, and thus its accuracy cannot be commented upon, please write N/A in the relevant left hand box.

Each right hand box attempts to ascertain the ***importance*** of the particular characteristic to future *industry development, from 1 to 5, where 1 = irrelevant to the industry, to 5 where it is very important.* For example, if you believe that business start-up rates in the industry being high in Wales is *very important* to the industry sector's development in Wales, then the respondent would put a 5 in the right hand box. Conversely, if this factor is *irrelevant* then the respondent would put a 1 in the right hand box.

Part B: Current and Future Trade and Knowledge

Here we are seeking to ascertain the likely importance of different regions (including rest of UK) as export markets for Welsh goods or services, sources of imports (of materials and services), and also of knowledge.

For the export related question, for each region the left hand box indicates the ***current*** importance of the region as an export market to the industry in Wales, with 5 indicating "very important" and 1 indicating "not important" at all. The right hand box indicates the ***future potential*** of the region as an export market to Welsh industry, again 5 indicating "very high" future potential and 1 "irrelevant".

For the import-related question, for each region the left hand box indicates the ***current*** importance of the region as a source of imports to the industry in Wales, with 5 indicating "very important" and 1 indicating "not important" at all. The right hand box indicates the ***future potential*** of the region as a source of imports to Welsh industry, again 5 indicating "very high" future potential and 1 "irrelevant".
For the knowledge-related question, for each region the left hand box indicates the ***current*** importance of the region as a source of knowledge to the industry in Wales, with 5 indicating "very important" and 1 indicating "not important" at all. The right hand box indicates the ***future potential*** of the region as a source of knowledge Welsh industry, again 5 indicating "very high" future potential and 1 indicating "irrelevant".

A: Industry Sector | **Activity, Capacity, Risks and Relationships**

We are interested in your views on whether the following statements are an **accurate** representation of the sector in question.

Please rank as follows in the left hand box:

5=strongly agree; 4=agree; 3= neither; 2= disagree; 1=strongly disagree

We would also like to know whether this particular aspect is of importance to the development and success of the sector. Please tell us your views on the **importance** of the attribute in question to the sector;

5=very important; 4=important; 3=of some importance; 2=of little importance; 1=irrelevant

All questions refer to the industry sector in Wales, except where explicitly stated

Industry- Specific Activity

1. Local Sector Production	**ACCURATE (Scale 1-5)**	**IMPORTANT (Scale 1-5)**
1.1 The industry has high gross value added compared to other industries in Wales		
1.2 The industry has high wage levels relative to the Welsh average (£????)		
1.3 Business start-up rates in the industry/cluster are high in Wales		
1. 4 Relative to rest of UK, the industry has a concentration within Wales		
1.5 The industry/cluster's Welsh supply chains are strong and efficient		
1.6The industry /cluster, through its local purchasing links, supports significant activity elsewhere in Wales?		
1.7The industry /cluster, through its local purchasing links, supports significant activity elsewhere in Wales *in related industries*?		
1.8 The industry has strong, efficient purchasing links with rest of UK?		
1.9 The industry has strong, efficient purchasing links with the rest of the World?		
1.10 The industry has secure purchasing links with the rest of the world?		
1.11 The industry is not overly dependent on monopoly suppliers for its inputs?		

2. Customer Orientation	**ACCURATE (Scale 1-5)**	**IMPORTANT (Scale 1-5)**
2.1 Output in the industry has grown strongly in the last five years?		
2.2 The industry is expected to grow strongly in the next decade?		
2.3 Industry development is not over dependent on the Welsh market for its output?		
2.4 The industry sells a significant amount of final output to other parts of the United Kingdom?		
2.5 The industry is a strong overseas exporter compared to other Welsh industry (5 per cent of Gross Value added***)***		
2.6 Industry development is not over dependent on a small number of geographical markets?		
2.7 Industry development is not over-dependent on politically unstable overseas markets		
2.8 Industry development is unlikely to be unduly hampered by changes in international trade conditions		
2.9 The industry in Wales can cope with internationally based cost competition		
2.10The industry in Wales can cope with internationally based quality competition		
2.11 The industry in Wales has a strong record of customer satisfaction		

Activity Potentially Linked to External Institutions (e.g. Universities)

3. Technology, Product and Process Development	**ACCURATE (Scale 1-5)**	**IMPORTANT (Scale 1-5)**
3.1 The industry in Wales has the ability to capitalise on new technologies as they arise		
3.2 The industry/cluster in Wales has a significant R&D spend compared to other Welsh industry		
3.3 The industry/cluster in Wales spends a significant amount on R&D compared to the industry globally		
3.4 The industry/cluster in Wales has appropriate technical expertise at all Levels		
3.5 The industry/cluster in Wales enjoys high levels of technological collaboration between companies within Wales		
3.6 The industry/cluster in Wales enjoys high levels of technological collaboration with companies in other parts of the UK		
3.7 The industry/cluster in Wales enjoys high levels of technological collaboration with companies in other parts of the world		
3.8 The industry/cluster has significant technical collaborations with the Higher Education sector in Wales		
3.9 The industry/cluster has significant technical collaborations with the Higher Education sector in rest of UK		
3.10 The industry/cluster has significant technical collaborations with the Higher Education sector in the rest of the world		
3.11Research and development of the industry creates technical or productive spillovers into other Welsh industries.		

4. Local Human Resources and Development	**ACCURATE (Scale 1-5)**	**IMPORTANT (Scale 1-5)**
4.1 Local Training resources within the industry are adequate for its current needs		
4.2 It is easy to recruit suitably trained and qualified people in Wales in a reasonable timescale		
4.3 The local industry generally invests in skills and training for its employees (e.g. high adherence to Investors in People)		
4.4. The industry features a well diversified range of occupations and activities, ranging from entrants to senior managers		
4.5 The industry makes extensive and appropriate use of local (i.e. Welsh) university graduates and their educational capital on suitable career paths		
4.6 The industry makes extensive and appropriate use of local (i.e. Welsh) FE and HE education and training facilities and courses		
4.7 The industry makes extensive and appropriate use of non-local (i.e. UK or overseas) university graduates and their educational capital on suitable career paths		
4.8 The industry is characterised by very good local industrial relations and practices		

5. Internal Management and External Networking Activities	**ACCURATE (Scale 1-5)**	**IMPORTANT (Scale 1-5)**
5.1 The industry at the local level has a strong independent Marketing function		
5.2 The industry at the local level has a strong independent finance function		
5.3 The industry at the local level has a strong independent R&D Function		
5.4 The industry features a strong network of formal and informal associations ***within*** Wales		
5.5 The industry features a strong network of formal and informal Associations ***outside*** Wales		
5.6 The industry within Wales features a strong network of formal/informal ties with local (i.e. Welsh) Government		
5.7 The industry within Wales features a strong network of formal/informal ties with local institutions (e.g. universities).		
5.8 The industry in Wales uses extensive and varied IT resources in its management and networking activities		

Issues Potentially Linked to Government

6. Financial Issues	**ACCURATE (Scale 1-5)**	**IMPORTANT (Scale 1-5)**
6.1 The Industry is easily able to access finance for investment from commercial sources		
6.2 The Industry can easily avail themselves of financial resources from non-commercial (e.g. government) sources		
6.3 The industry is easily able to cope with the impact of fluctuations in international exchange rates on inputs		
6.4 The industry is easily able to cope with the impact of fluctuations in international exchange rates on outputs		

7. Governance	**ACCURATE (Scale 1-5)**	**IMPORTANT (Scale 1-5)**
7.1 The Industry suffers few undue regulatory constraints at a UK level which hinder growth		
7.2 The Industry in Wales is characterised by high levels of autonomy in decision-making		
7.3 General public sector business support for the Industry locally is strong and appropriate		
7.4 The future development of the Industry in Wales is unlikely to be unduly affected by planning restrictions		

8. Infrastructure	**ACCURATE (Scale 1-5)**	**IMPORTANT (Scale 1-5)**
8.1 Transport facilities (roads & services etc.) are adequate in the region for the Industry		
8.2 Other physical facilities are adequate in Wales for this Industry (e.g. buildings, specialised physical resources etc.)		
8.3 The Telecoms and IT infrastructure regionally is adequate for Industry needs currently and will not hinder growth in the immediate future		
8.4 Energy costs for the Industry in Wales will not hinder growth in the immediate future		

9. Environment	**ACCURATE (Scale 1-5)**	**IMPORTANT (Scale 1-5)**
9.1 Environmental and waste management facilities for the Industry locally are adequate		
9.2 The Industry/cluster in Wales produces relatively small amounts of greenhouse gases		
9.3 The Industry creates no water-borne emissions in Wales		
9.4 The Industry is associated with relatively small environmental effects Generally		
9.5 Planning restrictions on this Industry are imposed for identifiable social or environmental reasons		

Please turn to next page

B: Current and Future Trade and Knowledge

In the left hand box, please rank the **current** importance of the stated region to the industry/cluster. **Please rank the current importance of each market as follows :**

5=very important; 4=important; 3=of some importance; 2=of little importance; 1=irrelevant

Please also assess, in the right hand box, the **future potential** of the stated region to the sector in Wales. Please rank this potential as follows;

5=very high; 4=high; 3=medium; 2=low; 1=little or no potential

1: As a market for finished goods and services

Region	CURRENT (EXPORT) TRADE IMPORTANCE (Scale 1-5)	FUTURE (EXPORT) TRADE POTENTIAL (Scale 1-5)
1. Rest of UK		
2. Rest of EU/EEA		
3. Russia and CIS/Rest of (non-EU Europe)		
4. Middle East/Gulf		
5. Mexico Central America and Caribbean		
6. South America		
7. Japan and Korea		
8. South East Asia		
9. China		
10. Indian Sub-Continent		
11. Rest of Asia		
12. Africa		
13. Oceania (Australia, New Zealand, etc.)		
14. North America		

2: As a Source of Inputs of goods and services

Region	CURRENT (IMPORT) TRADE IMPORTANCE (Scale 1-5)	FUTURE (IMPORT) TRADE POTENTIAL (Scale 1-5)
1. Rest of UK		
2. Rest of EU/EEA		
3. Russia and CIS/Rest of (non-EU Europe)		
4. Middle East/Gulf		
5. Mexico Central America and Caribbean		
6. South America		
7. Japan and Korea		
8. South East Asia		
9. China		
10. Indian Sub-Continent		
11. Rest of Asia		
12. Africa		
13. Oceania (Australia, New Zealand, etc.)		
14. North America		

3: As a source of Knowledge

Region	CURRENT IMPORTANCE (Scale 1-5)	FUTURE POTENTIAL (Scale 1-5)
1. Rest of UK		
2. Rest of EU/EEA		
3. Russia and CIS/Rest of (non-EU Europe)		
4. Middle East/Gulf		
5. Mexico Central America and Caribbean		
6. South America		
7. Japan and Korea		
8. South East Asia		
9. China		
10. Indian Sub-Continent		
11. Rest of Asia		
12. Africa		
13. Oceania (Australia, New Zealand, etc.)		
14. North America		

Final question for part B: Are there other comments you would like to make?

Dear Colleague,

The Institute of Welsh Affairs (IWA), Centre for Advanced Studies (CAS) and Welsh Enterprise Institute (WEI) have been asked by the Welsh Assembly Government to further develop a methodology for analysing the characteristics of industry sectors and clusters in the Welsh economy. We would therefore very much welcome your involvement in this research project. The aerospace industry cluster has been identified as a sector of particular interest, split into:-

- Manufacturing
- Maintenance, Repair and Overhaul
- Research, Development, and Training

Expert opinion regarding the development potential of sectors and industries, such as yours, will form an important input to economic development policy in the future, to reinforce more traditional official statistical analysis etc. We have identified you as an expert, and are hoping you would be prepared to undertake a short questionnaire-based interview (face-to-face or telephone). In brief this would involve your views concerning your aerospace sub-sector with regard to the following: -

- Current Welsh Cluster/Network structures and process and Future Potential
- Current Welsh Cluster/Network Governance and Management and Future Potential
- Current Cross Locality Network (i.e. Welsh sector links with other parts of the UK and the rest of the World) Governance and Management and Future Potential

Our definition of a cluster/network covers a number of types of arrangements, utilising the definition that a cluster/network consists of industries linked through vertical (buyer/ supplier) or horizontal (common customers, technology, channels) relationships. These relationships may be linked through transactions (supply chains), geographical closeness (highlighted by location quotients) or relationships (both formal and informal).

We should emphasise that we are primarily concerned with a Welsh industry based viewpoint. A summary of the results of the completed research exercise would then be forwarded on to you. Please do not hesitate to contact us if you have any queries regarding the project or the questionnaire.

Nick Clifton : 02920 876064 (e-mail: cliftonn1@cardiff.ac.uk)

Oliver Ehret : 02920 876064 (e-mail: ehretom@cardiff.ac.uk)

David Pickernell : 01443 483759 (e-mail : dgpicker@glam.ac.uk).

Rhys David: 02920 202666606 (e-mail: rhysdavid@iwa.org.uk)

With many thanks for your time,

Yours sincerely

Dr N.C. Clifton Senior Research Associate (CAS)	R David Development Director (IWA)	Dr. D. Pickernell Reader (WEI)	Dr. O. Ehret Research Associate (CAS)

For interviewer

Part A: Wales-based Current Cluster/Network structures and process and Future Potential

1 Structures

The first set of questions examines the cluster structures in existence ***(asked under the two scenarios of current reality and ideal situation)***

For question 1.1 the **horizontal** box relates to where the networks are internal to the firms only, or if they are across the industry cluster at the same point in the production process, or if they exist across industries at the same point in the production process. Please tick the **vertical** box if the relationships are external to the firm and within the industry at different points in the production chain (e.g. supply chains).

For question 1.2 please **formal** relates to where the relationships are based around transactions, and **informal to when** they are based on relationships.

For question 1.3 **transactions** relates to when the cluster's advantages derive from having close supply chains, **geographical concentration** where the advantages occur from the firms being close together (and therefore able to share labour markets, resources etc.), and **relationships** if the advantages come from firms being able to create relationships between one another.

For each of these questions the right hand box indicates how important the stated structure is to the cluster, from **5 if "very important"**, to **1 if "irrelevant".**

2 Processes

The second set of questions look at processes at work within the cluster ***(asked under the two scenarios of current reality and ideal situation).***

Q 2.1 relates to the focus or reason for the clustering/networking activity – i.e. **reducing costs, sharing knowledge, or a combination of both (indicated by percentages in each box)**.

2.2 individual **survival** refers to where survival of the individual firms is the primary goal within the industry, **collective survival** if the networks survival is the primary goal of companies, **and wider survival** if the focus is on the regional economy as a whole.

For question 2.3 the conduct of the firms is **control and transactions** if the cluster's networks operate via transactional supply chain based exchanges, collective action if the cluster operates through joint activities, and collaborative learning if the cluster's networks operates primarily through the learning facilitated by the relationships created between the companies

For question 2.4 the basis of the network is **transactions** if the network is based on transactions (e.g. through supply chains), **trust** if this is the basis of any networks created (whether transactions take place or not), and **teamwork** if active collaboration between participants is the basis of the cluster.

Question 2.5 looks at the type of management of the cluster/network (related to how long it has been in existence). S**hort term network connection** relates to **creating** the network. **Network survival** relates to sustaining a cluster network in the medium term, and **network development** should be ticked if management is focused on building and growing the cluster and network in the longer term.

2.6 examines the learning occurring in the cluster. **Doing things better** relates to incremental (mainly cost-based) improvements, **Doing things differently relates to improvements via process innovation knowledge , and different things** relates more to product innovation knowledge

For each of these questions the right hand box indicates how important the stated process is to the cluster, from **5 if "very important"**, to **1 if "irrelevant".**

3. Current Stakeholders/Participants

Question 3.1 refers to who takes decisions within the cluster (per cent of time) from single large (dominant) firms, a small number of the large firms, to a wider range of firms from across the industry

Question 3.2 relates to stakeholder participation within the cluster, (again on a per cent basis), from between government, institutions (such as universities), and the industry itself.

Question 3.3 relates to the degree of cross-locality networking taking place (per cent of total links outside Wales, from between other parts of the UK, other parts of the EU, to other parts of the world

4. Overall importance

This relates to the overall importance of the cluster/network structures, processes, and stakeholder/participant activities and links, to the industry, under two scenarios. How important these are currently, and how important would they be if changed to the ideal situation.

Part B: Wales-based Current Cluster/Network Governance and Management and Future Potential

In these questions we are seeking to ascertain the *current reality* of the **Welsh cluster's** governance and management processes, *in comparison* with the way in which the industry/cluster *should ideally* be managed. These are again indicated by ticking the relevant *left hand box if only one applies,* or, if necessary, i*ndicating a relevant percentage* i*f more than one box applies* (with the total to add up to 100 per cent). Again the right hand (Importance) box indicates the importance of this process to the industry. Again there is also a final question in part B where the overall importance of the current processes are compared with the importance of those processes should they be changed to the "***ideal"*** structures and processes.

1. Structural Elements
Question 1 refers to the role of government (options are outlined in detail on the questionnaire schedule) in the industry's governance in Wales

Question 2 refers to big business (corporate) involvement (low-high) in the industry's governance in Wales

Question 3 refers to the structure of the industry's value chain (supply chain) in Wales (integrated or fragmented)

Question 4 refers to the role of government in this value chain issue (should they be involved or not)

Question 5 refers to how the industry's activities are coordinated (by the **state**, **large** corporations, pure **market** forces, or **collaboratio**n between the stakeholders)

Questions 6 refers to the industry in terms of cost and value added (these are the two things referred to in the possible answers high cost/high value added, low cost/ moderate value added, low cost/low value added and moderate cost/high value added)

2 Fora
This refers to how cluster/network activities are organised in terms of institutional arrangements.

3. Returns
3.1 This refers to the conditions under which the cluster/network functions best.
3.2 refers to the speed at which the cluster/network adjusts to changing market conditions

4. Participant Goals
4.1. refers to how costs of adjustment are spread around the cluster/network (and what the focus of the adjustment is) – from sharing the existing "pie" with all, to forcing weakest members of cluster/network to bear costs of adaptation, to "growing the pie for all".

5. Participant Conduct (basis of it)

5.1 looks at orientation of influence. Dependent Management relies on top-down command and control methods, strict chain of command based on a reliance on decision-making elites with a dependent chain of interaction in primarily vertically oriented activities. Independent management relies on arms-length market-related transactions, with firm focus on establishing strategic linkages to secure optimal outcomes while retaining an autonomous stance. Interdependent orientation relies more on horizontal, networked relationships.
5.2 looks at the nature of the relationships, the choices being between those based on authority, to those based on exchange, to those based on social relationships

6. Participant Basis
6.1 Looks at how the cluster/network activities are integrated, from **rules**, to **transaction**s, to **trust**.

7. Network System management
7.1 looks at the focus of management of the cluster/network, **administration, contracts, or relationships**

7.2. looks at the key management tasks of management of the cluster/network – from **"bureaucratic"** activities, to **"market-type"** activities, to **"relationship-building**" activities.

8. Learning
8.1 Looks at the rate of innovation and who it benefits

8.2 Looks at the conduit through which learning occurs **(via transactions or social (relational) processes).**
8.3 looks at the focus of the learning itself, from **routine** activities, to more questioning of these norms and **non-routine** activities.
8.4 looks at how tacit knowledge (knowledge that people carry in their minds and is, therefore, difficult to access, but considered valuable because it provides context for people, places, ideas, and experiences, and usually requires high trust to be passed around), is dealt with (i.e. **not shared** or **shared**)

9. Overall importance

This relates to the overall importance of the management and governance activities, under two scenarios. How important these are currently, and how important would they be if changed to the ideal situation.

C: Current Cross Locality Network Governance and Management and Future Potential

In these questions we are seeking to ascertain the ***current reality*** of the Welsh industry's governance and management processes in its **Cross Locality (i.e. non-Welsh) Networks** with **other parts** of the industry in the UK/worldwide. These are again indicated by ticking the relevant ***left hand box if only one applies,*** or, if necessary, ***indicating a relevant percentage*** if ***more than one box applies*** (with the total to add up to 100 per cent)**.** Again the right hand (**Importance)** box indicates the importance of this process to the industry. Again there is also a final question in part C where the overall importance of the current processes are compared with the importance of those processes should they be changed to the "***ideal"*** structures and processes.

1. Structural Elements
Question 1 refers to the role of government (options are outlined in detail on the questionnaire schedule) in the Cross Locality Network

Question 2 refers to big business (corporate) involvement (low-high) in the Cross Locality Network governance

Question 3 refers to the structure of the industry's value chain (supply chain) in the cross locality network (integrated or fragmented)

Question 4 refers to the role of government in this Cross Locality Network value chain issue (should they be involved or not)

Question 5 refers to how the industry's cross locality network activities are coordinated (by the **state**, **large** corporations, pure **market** forces, or **collaboratio**n between the stakeholders)

Questions 6 refers to the cross locality network in terms of cost and value added (these are the two things referred to in the possible answers high cost/high value added, low cost/ moderate value added, low cost/low value added and moderate cost/high value added)

2 Fora
This refers to how cross locality network cluster/network activities are organised in terms of institutional arrangements.

3. Returns
3.1 This refers to the conditions under which the cross locality network cluster/network functions best.
3.2 refers to the speed at which the cross locality network cluster/network adjusts to changing market conditions

4. Participant Goals
4.1. refers to how costs of adjustment are spread around the cross locality network cluster/network (and what the focus of the adjustment is) – from sharing the existing "pie" with all, to forcing weakest members of cluster/network to bear costs of adaptation, to "growing the pie for all".

5. Participant Conduct (basis of it)

5.1 looks at cross locality network **orientation of influence. Dependent** Management relies on top-down command and control methods, strict chain of command based on a reliance on decision-making elites with a dependent chain of interaction in primarily vertically oriented activities. Independent management relies on arms-length market-related transactions, with firm focus on establishing strategic linkages to secure optimal outcomes while retaining an autonomous stance. Interdependent orientation relies more on horizontal, networked relationships.
5.2 looks at the nature of the cross locality network relationships, the choices being between those based on authority, to those based on exchange, to those based on social relationships

6. Participant Basis
6.1 Looks at how the cross locality network cluster/network activities are integrated, from **rules**, to **transaction**s, to **trust**.

7. Network System management
7.1 looks at the focus of management of the cross locality network cluster/network, **administration, contracts, or relationships**

7.2. looks at the key management tasks of management of the cross locality network cluster/network – from **"bureaucratic"** activities, to **"market-type"** activities, to **"relationship-building**" activities.

8. Learning

8.1 Looks at the rate of innovation and who it benefits in the cross locality network

8.2 Looks at the conduit through which learning occurs **(via transactions or social (relational) processes). In the** cross locality network

8.3 looks at the focus of the learning itself, from **routine** activities, to more questioning of these norms and **non-routine** activities in the cross locality network

8.4 looks at how tacit knowledge (knowledge that people carry in their minds and is, therefore, difficult to access, but considered valuable because it provides context for people, places, ideas, and experiences, and usually requires high trust to be passed around), is dealt with (i.e. **not shared** or **shared**) in the cross locality network.

9. Overall importance

This relates to the overall importance of the management and governance activities, under two scenarios. How important these are currently, and how important would they be if changed to the ideal situation.

QUESTIONNAIRE 2: INFORMATION SHEET

Part A: Current Cluster/Network structures and process and Future Potential

We are seeking to ascertain the ***current reality*** of cluster structures, processes and participants in existence and also the processes at work, and to compare these to the way in which the industry/cluster ***should*** be structured in terms of its processes, and its participants.

These are indicated by ticking the relevant ***left hand box if only one applies***, or ***indicating a relevant percentage*** if ***more than one box applies*** (with the total to add up to 100 per cent)**.** e.g. If the clusters networks are all vertical then the vertical box can just be ticked. If they are 70 per cent vertical and 30 per cent horizontal then this can be indicated by writing the relevant percentage in the relevant box.

The right hand (**Importance)** box indicates the importance of the structure or process to the industry. e.g. If in question 1.2 relationships are "of some importance to the industry" then a "3" should be put in the right hand box next to the relationships question. There is also a final question in part A, where the overall importance of the current structures and processes are compared with the importance of those structures and processes should they be changed to the "***ideal"*** structures and processes.

Part B: Current Cluster/Network Governance and Management and Future Potential

In these questions we are seeking to ascertain the ***current reality*** of the Welsh cluster's governance and management processes, ***in comparison*** with the way in which the industry/cluster ***should ideally*** be managed.

These are again indicated by ticking the relevant ***left hand box if only one applies,*** or i***ndicating a relevant percentage*** i***f more than one box applies*** (with the total to add up to 100 per cent)**.**

Again the right hand (**Importance)** box indicates the importance of this process to the industry. Again there is also a final question in part B where the overall importance of the current processes are compared with the importance of those processes should they be changed to the "***ideal"*** structures and processes.

Part C Current Cross Locality Network Governance and Management and Future Potential

In these questions we are seeking to ascertain the ***current reality*** of the Welsh industry's governance and management processes in its **Cross Locality (i.e. non-Welsh) Networks** with other parts of the industry in the UK/worldwide.

These are again indicated by ticking the relevant ***left hand box if only one applies,*** or ***indicating a relevant percentage*** if ***more than one box applies*** (with the total to add up to 100 per cent)**.**

Again the right hand (**Importance)** box indicates the importance of this process to the industry. Again there is also a final question in part C where the overall importance of the current processes are compared with the importance of those processes should they be changed to the "***ideal"*** structures and processes.

A : Current Cluster/Network structures and processes and Future Potential

In these three questions we are seeking to ascertain the ***current reality*** of the cluster structures in existence and the processes at work**, in comparison** with the way in which the industry/cluster ***should ideally*** be structured and its processes work. These are indicated by ticking the relevant ***left hand box if only one applies, or indicating a relevant percentage if more than one box applies*** (with the total to add up to 100 per cent)***.)***.

The **right hand box** indicates **the Importance** of the factor to the industry/cluster, where;

5=very important; 4=important; 3=of some importance; 2=of little importance; 1=irrelevant

1. Structures	**Please tick if one box applies Relevant boxes if more than one Horizontal**		**or per cent in box applies Vertical**	**Importance (1-5)**
1.1a The cluster's networks are mainly				
1.1b The cluster's networks **should** be Mainly				
	Formal		**Informal**	
1.2a The cluster's relationships are best characterised as				
1.2b The cluster's relationships **should** be characterised as				
	Transactions	**Geographical concentration**	**Relationships**	
1.3a The advantages of the cluster in Wales are derived through				
1.3b The advantages of the cluster in Wales **should** be derived through				
2. Processes		**per cent in each box**		
	Reducing Costs		**Sharing Knowledge**	
2.1a The focus of the cluster in Wales is on				
2.1b The focus of the cluster in Wales **should** be on				
	Individual Survival of the firm	**Collective Survival of the network cluster**	**Wider survival of the regional economy**	
2.2a The goals of the companies from being in the cluster are mainly				
2.2b The goals of the companies from being in the cluster **should** be mainly				
	Control and Transactions	**Collective Action**	**Collaborative Learning**	
2.3a The conduct of the companies is based on				
2.3b The conduct of the companies **should** be based on				
	Transactions based	**Trust-based**	**Teamwork based**	
2.4a The cluster's network is				
2.4b The cluster's network **should** be				
	Short-term network connection	**Medium term network survival**	**Long term network development**	
2.5a Management of the cluster is based on				
2.5b Management of the cluster **should** be based on				
	Doing things better	**Doing things differently**	**Doing different things**	
2.6a The learning that takes place in the cluster is best described as				
2.6b The learning that takes place in the cluster **should** be aimed at				

3. Current Stakeholders/Participants

	Please tick if Relevant boxes Single large firms	one box applies if more than one Small Number of large firms	or per cent in box applies Wide range of firms on "equal footing"	
3.1a The decisions taken within the cluster are taken by (per cent of the time):				
3.1b The decisions taken within the cluster **should be taken** by (per cent of the time):				
	Government	**Institutions**	**Industry**	
3.2a The breakdown of participation between the cluster's local stakeholders is as follows (per cent participation) :				
3.2b The breakdown of participation between the cluster's local stakeholders **should be as** follows (per cent participation) :				
	In Other parts of the UK	**In other parts of the EU**	**In other parts of the World**	
3.3a The cluster has cross locality links with other networks (per cent of links)				
3.3b The cluster **should have** cross locality links with other networks (per cent of links)				

4. Overall Importance

		Current structures and processes:	
		Ideal structures and processes:	

B: Current Cluster/Network Governance and Management and Future Potential

In these questions we are seeking to ascertain the current reality of the Welsh cluster's governance and management processes, in comparison with the way in which the industry/cluster should ideally be managed. These are indicated by ticking the relevant ***left hand box if only one applies, or indicating a relevant percentage if more than one box applies*** (with the total to add up to 100 per cent).. The right hand box indicates the Importance of the factor to the industry/cluster, where; 5=very important; 4=important; 3=of some importance; 2=of little importance; 1=irrelevant

	Please tick if	one box applies more than one	or per cent in box applies	relevant boxes if	Importance (1-5)
1. Structural Elements					
	High corporatist style (bringing key economic players together to negotiate outcomes)	**Low-intervenes to address competitive imbalance**	**Low-minimal tariffs/trade agreements**	**Low-intervenes to facilitate only transformational capabilities**	
1.1aWhat is the state's involvement in industry governance?					
1.1bWhat **should be** the state 's involvement in industry governance?					
	Low	**High**			
1.2a What is corporate involvement in industry governance?					
1.2b What **should be** corporate involvement in industry governance					
	Fragmented			**Integrated**	
1.3a What is the structure of the value chain					
1.3b What **should be** the structure of the value chain					
	High			**Low**	
1.4a What is the state's involvement in the value chain					
1.4b What **should be** the state's involvement in the value chain					
	The State	**Corporations through managerial hierarchies**	**Market forces**	**Collaboration**	
1.5a Who has the main role in coordination of economic activities and decision making					
1.5b Who **should have** the main role in coordination of economic activities and decision making					
	High/ High	**Low/ Moderate**	**Low/Low**	**High/High**	
1.6a What is the competitive orientation in terms of cost/ value added					
1.6b What **should be** he competitive orientation in terms of cost/ value added					
		(per cent in each box- ad up to 100 per cent)			
2. Fora	**Committees, working parties, interdepartmental committees**	**Committees, working parties, interdepartmental committees, Business associations, corporate boards**	**Business associations, corporate boards**	**Network Arrangements, informal collaborations, social charters and compacts and roundtables**	
2.1a. What are the institutional arrangements in place for the cluster					
2.1b. What **should be the** institutional arrangements in place for the cluster					

3. Returns	Please tick if **Long-term growth which fosters identity during tough economic times**	one box applies more than one **Rapid Industry Growth**	or per cent in box applies **Economic stability or growth that encourages industry expansion**	relevant boxes if **Equally well under stability, growth or economic turbulence**	**Importance (1-5)**
3.1a What are the economic conditions in which the cluster functions best?					
3.1b What **should be** the economic conditions in which the cluster functions best?					
	Slow			**Fast**	
3.2a What is the speed of adjustment to industry changes					
3.2b What **should be** the speed of adjustment to industry changes					
4. Participant Goals	**Costs of adaptation distributed across industry. Focus on "sharing the pie"**	**Weakest members of value chain bear the costs of industry adaptation**	**Weakest members of value chain bear the costs of industry adaptation**	**Costs of adaptation are distributed across industry participants, focus on "growing the pie"**	
4.1a How are the costs of adjustment spread across the cluster/industry					
4.1b How **should** the costs of adjustment be spread across the cluster/industry					
5. Participant Conduct	**Dependent**		**Independent**	**Interdependent**	
5.1a What is the orientation of influence?					
5.1b What **should be** the orientation of influence					
	Authority		**Exchange**	**Social/Exchange**	
5.2a What is the nature of the relationships					
5.2b What **should be** the nature of the relationships					
6. Participant basis	**Centralised and legitimate authority, rules regulations procedures and legislation**		**Formalised legal contractual arrangements, Arms length transactions bargaining**	**Interpersonal trust, mutuality and reciprocity**	
6.1a What are the key integration mechanisms in the cluster/industry					
6.1b What **should be** the key integration mechanisms in the cluster/industry					
7. Network Systems Management	**Administrative management**		**Contractual management**	**Relational Management**	
7.1a What is the focus of management regarding the cluster					
7.1b What **should be** the focus of management regarding the cluster					
	Top-down command and control, planning, organising staffing, directing, coordinating, reporting, budgeting		**Arms-length transactions, negotiated interactions, performance specifications, bargained outcomes**	**Activating, mobilising, framing and synthesising activities**	
7.2 What are the key managements strategies and core tasks regarding the cluster					
7.2b What **should be** the key managements strategies and core tasks regarding the cluster					

8 Learning	**Please tick if** **Slow- but industry enhancing**	**one box applies more than one** **Fast-but firm specific**	**or per cent in box applies** **Slow-but firm specific**	**relevant boxes if** **Facts-oriented towards development of future oriented industry capabilities**	**Importance (1-5)**
8.1 What is the rate of innovation through the industry cluster's activities					
8.1b What **should be** the rate of innovation through the industry cluster's activities					
	Transactional Processes			**Social Processes**	
8.2a What is the conduit for innovative learning within the cluster					
8.2b What **should be** the conduit for innovative learning within the cluster					
	Focus on Routinisation, adhering to norms, conventional management practices			**Focus on episodes of non-routine activity, questioning of norms**	
8.3a What is the learning focus within the cluster?					
8.3b What **should be** the learning focus within the cluster					
	Not much sharing of tacit knowledge			**High sharing of tacit knowledge**	
8.4a How does the cluster deal with tacit knowledge?					
8.4b How **should** the cluster deal with tacit knowledge					
9. Overall Importance				**Current Processes:**	
				Ideal Processes:	

C: Current Cross Locality Network Governance and Management and Future Potential

In these questions we are seeking to ascertain the current reality of Cross Locality Network governance and management processes that the Welsh industry is involved in, in comparison with the way in which the cross locality network should ideally be managed. These are indicated by ticking the relevant ***left hand box if only one applies, or indicating a relevant percentage if more than one box applies*** (with the total to add up to 100 per cent)**.**
The right hand box indicates the Importance of the factor to the cross locality network, where;
5=very important; 4=important; 3=of some importance; 2=of little importance; 1=irrelevant

CROSS LOCALITY NETWORK	**Please tick if**	**one box applies more than one**	**or per cent in box applies**	**relevant boxes if**	**Importance (1-5)**
1. Structural Elements	**High corporatist style (bringing key economic players together to negotiate outcomes)**	**Low-intervenes to address competitive imbalance**	**Low-minimal tariffs/trade agreements**	**Low-intervenes to facilitate only transformational capabilities**	
1.1aWhat is state 's involvement in CLN governance?					
1.1bWhat **should be** the state 's involvement in CLN governance?					
	Low	**High**			
1.2a What is corporate involvement in CLN governance?					
1.2b What **should be** corporate involvement in CLN governance					
	Fragmented			**Integrated**	
1.3a What is the structure of the value chain					
1.3b What **should be** the structure of the value chain					
	High			**Low**	
1.4a What is the state's involvement in the value chain					
1.4b What **should be** the state's involvement in the value chain					
	The State	**Corporations through managerial hierarchies**	**Market forces**	**Collaboration**	
1.5a Who has the main role in coordination of economic activities and decision making					
1.5b Who **should have** the main role in coordination of economic activities and decision making					
	High/ High	**Low/ Moderate**	**Low/Low**	High/High	
1.6a What is the competitive orientation in terms of cost/ value added					
1.6b What **should be** he competitive orientation in terms of cost/ value added					
2. Fora	**Committees, working parties, interdepartmental committees**	**Committees, working parties, interdepartmental committees, Business associations, corporate boards**	**Business associations, corporate boards**	**Network Arrangements, informal collaborations, social charters and compacts and roundtables**	
2.1a. What are the institutional arrangements in place for the CLN					
2.1b. What **should be the** institutional arrangements in place for the CLN					

	Please tick if	one box applies more than one	or per cent in box applies	relevant boxes if	Importance (1-5)
3. Returns	**Long-term growth which fosters identity during tough economic times**	**Rapid Industry Growth**	**Economic stability or growth that encourages industry expansion**	**Equally well under stability, growth or economic turbulence**	
3.1a What are the economic conditions in which the CLN functions best?					
3.1b What **should be** the economic conditions in which the CLN functions best?					
	Slow			**Fast**	
3.2a What is the speed of adjustment to CLN changes					
3.2b What **should be** the speed of adjustment to CLN changes					
4. Participant Goals	**Costs of adaptation distributed across industry. Focus on "sharing the pie"**	**Weakest members of value chain bear the costs of industry adaptation**	**Weakest members of value chain bear the costs of industry adaptation**	**Costs of adaptation are distributed across industry participants, focus on "growing the pie"**	
4.1a How are the costs of adjustment spread across the CLN					
4.1b How **should** the costs of adjustment be spread across the CLN					
5. Participant Conduct	**Dependent**		**Independent**	**Interdependent**	
5.1a What is the orientation of influence?					
5.1b What **should be** the orientation of influence					
	Authority		**Exchange**	**Social/Exchange**	
5.2a What is the nature of the relationships					
5.2b What **should be** the nature of the relationships					
6. Participant basis	**Centralised and legitimate authority, rules regulations procedures and legislation**		**Formalised legal contractual arrangements, Arms length transactions bargaining**	**Interpersonal trust, mutuality and reciprocity**	
6.1a What are the key integration mechanisms in the CLN					
6.1b What **should be** the key integration mechanisms in the CLN					
7. Network Systems Management	**Administrative management**		**Contractual management**	**Relational Management**	
7.1a What is the focus of management regarding the CLN					
7.1b What **should be** the focus of management regarding the CLN					
	Top-down command and control, planning, organising staffing, directing, coordinating, reporting, budgeting		**Arms-length transactions, negotiated interactions, performance specifications, bargained outcomes**	**Activating, mobilising, framing and synthesising activities**	
7.2 What are the key managements strategies and core tasks regarding the CLN					
7.2b What **should be** the key managements strategies and core tasks regarding the CLN					

	Please tick if	one box applies more than one	or per cent in box applies	relevant boxes if	Importance (1-5)
8 Learning	**Slow- but industry enhancing**	**Fast-but firm specific**	**Slow-but firm specific**	**Facts-oriented towards development of future oriented industry capabilities**	
8.1 What is the rate of innovation through the CLN's activities					
8.1b What **should be** the rate of innovation through the CLN's activities					
	Transactional Processes			**Social Processes**	
8.2a What is the conduit for innovative learning within the CLN					
8.2b What **should be** the conduit for innovative learning within the CLN					
	Focus on Routinisation, adhering to norms, conventional management practices			**Focus on episodes of non-routine activity, questioning of norms**	
8.3a What is the learning focus within the CLN?					
8.3b What **should be** the learning focus within the CLN					
	Not much sharing of tacit knowledge			**High sharing of tacit knowledge**	
8.4a How does the CLN deal with tacit knowledge?					
8.4b How **should** the CLN deal with tacit knowledge					
9. Overall Importance				**Current Processes:**	
				Ideal Processes:	

Appendix 2: Keystone Company Interviews

Dear Colleague,

The Institute of Welsh Affairs (IWA), Centre for Advanced Studies (CAS) and Welsh Enterprise Institute (WEI) have been asked by the Welsh Assembly Government to further develop a methodology for analysing the characteristics of industry sectors and clusters in the Welsh economy. We would therefore very much welcome your involvement in this research project. The aerospace industry cluster has been identified as a sector of particular interest, split into:-

- Manufacturing (– i.e. focus on this area for final stage analysis?)
- Maintenance, Repair and Overhaul (geographic focus i.e. Cardiff International Airport)
- Research, Development, and Training (Barry, Cardiff, Swansea, NEWI)

The research process is seeking to interview a small number of key companies in each of the selected industry sub-sectors to comment on the following: -

- Why the company/organisation established its current operations in Wales in the first place?
- Why the company/organisation currently remains in its operations in Wales?
- What the likely future strategy of the company/organisation is likely to be with respect to its Welsh operations
- What government /industry/university-related policies would be of assistance in facilitating the company's continued location in Wales?

We have identified your company/organisation as a key to the Welsh industry, and are hoping you would be prepared to undertake a short interview (face-to-face or telephone) based on the above questions. We should emphasise that we are primarily concerned with a Welsh industry based viewpoint. A summary of the results of the completed research exercise would then be forwarded on to you. Please do not hesitate to contact us if you have any queries regarding the project or the questionnaire.

Nick Clifton : 02920 876064 (e-mail: cliftonn1@cardiff.ac.uk)

Oliver Ehret : 02920 876064 (e-mail: ehretom@cardiff.ac.uk)

David Pickernell : 01443 483759 (e-mail : dgpicker@glam.ac.uk).

Rhys David: 02920 202666606 (e-mail: rhysdavid@iwa.org.uk)

With many thanks for your time,

Yours sincerely

Dr N.C. Clifton Senior Research Associate (CAS)	R David Development Director (IWA)	Dr. D. Pickernell Reader (WEI)	Dr. O. Ehret Research Associate (CAS)

Guidance Notes for Completion

This interview is intended to elicit your company/organisation's views, as a key to the Welsh industry, in terms of the following four basic questions: -

- Why the company/organisation established its current operations in Wales in the first place.
- Why the company/organisation currently remains in its operations in Wales
- What the likely future strategy of the company/organisation is likely to be with respect to its Welsh operations
- What government/industry/university-related policies would be of assistance in facilitating the company's continued location in Wales

If you feel you are unable to answer a particular question, we will insert a dash (-) in the relevant section. However, we are interested in your impressions, even when not necessarily based on concrete data. This exercise is meant to complement economic data sources, and to enable examinations of industries not easily identifiable in standard statistics.

Interview Schedule with Keystone Companies/Organisations

Based on your company/organisation's views

Name of Company_____

Name/Position of Interviewee_____

Q1a: Why did your company/organisation establish its current operations in Wales in the first place?

Q1b: Of the above, which are the most important reasons?

Q2a. Why does your company/organisation currently remain in its operations in Wales?

Q2b) Of the above, which are the most important reasons?

Q3a What do you think is likely to be future strategy of the company/organisation with respect to its Welsh operations?

Q3b Of the above, what are likely to be the most important?

Q4a What government /industry/university-related policies would be of assistance in facilitating your continued location in Wales?

Q4b) Of the above, which are the most important reasons?

Q5. Are there any questions which you believe to be of importance and which we have not asked? If so, please elaborate