CLUSTER POLICIES AND CLUSTER STRATEGIES: LESSONS FROM THE ISRN NATIONAL STUDY

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Introduction

The goal of cluster development remains an elusive target for many local economic development agencies. The fascination with industrial clusters arises out of the perceived relation between clustering and enhanced competitiveness and innovation performance. The literature suggests that the sources of competitiveness do not lie solely within the individual firm, but also in the firm's local environment. These environments consist of clusters of firms engaged in traded and untraded relationships with each other, with suppliers of specialized services and knowledge inputs and infrastructure, and with governments and consumers. The cluster approach is a 'systems' approach to understanding economic behaviour. To understand clusters as systems, we have to understand their internal workings — their components, their structures, their processes and routines, and their development pathways. Geographical proximity yields a variety of benefits costs through these localization and urbanization economic effects (Porter 1998).

A key challenge for policymakers at the local and regional level — is how to generate cluster–based development. The cluster literature has been preoccupied to a large extent with identifying the key factors that contribute to the origins and growth of clusters. Although the presence of such critical factors is sometimes taken as a causal explanation for the development of the clusters, as well as a guide for policy makers, it does neither very effectively. An adequate account of the factors that contribute to the genesis and development of industrial clusters must differentiate between those factors that are a function of broader economic processes and those which are the outcome of explicit policies. Furthermore, it must also differentiate between those policies that create the underlying conditions that are conducive to the emergence and growth of clusters, in contrast to those that sustain and promote the development of clusters once they have emerged.

The following paper draws upon the results of a comprehensive national study of industrial clusters in Canada by members of the Innovation Systems Research Network (Holbrook and Wolfe 2005) to analyze both categories of policies. The ISRN cluster study involved an extensive examination of twenty-six case studies across the country (Wolfe 2003; Wolfe and Gertler 2004; Wolfe and Lucas 2004; Wolfe and Lucas 2005).[1] The goal of the research project was to determine the prevalence and success of local industrial clusters in Canada's diverse regional economies, and to analyze how the formation and growth of these clusters contributes to local economic growth and innovative capacity. We now possess detailed case studies for these clusters by industry and by region, as well as analyses of existing

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[1] A comprehensive bibliography of publications resulting from the ISRN national cluster study can be found online at: www.utoronto.ca/isrn/cluster_initiative/biblio.html.

innovation surveys and the creation of a comprehensive database of statistical indicators. The findings differentiate between those factors that contributed to the initial development of the clusters, as opposed to those that were important for their subsequent growth and vitality. A central conclusion of the research is the necessity of distinguishing between those policies which can create the initial conditions conducive to cluster development and the trigger events that sparked the actual emergence of the cluster. While it is virtually a commonplace to state that governments cannot create clusters by fiat or direct policy intervention, our account of the evolutionary character of cluster development suggests that government policies play a critical role at many different stages of cluster formation and growth.

The qualitative and quantitative results of the ISRN cluster study provide a rich tapestry from which to draw conclusions about the appropriate range of policies to generate and support the development of industrial clusters. Many of the leading industrial countries, as well as a large number of regional and local governments, in Europe, North America and Japan have adopted cluster strategies, both as a means of focusing existing government policies, as well as to provide additional support for the expansion of clusters. A recent report from Oxford Research AS in Norway documents the incredibly wide range of cluster policies adopted in the past decade by thirty one European countries (Oxford Research AS 2008). However, there is a wide range of policies that are considered to contribute to cluster development and little consensus on exactly what constitutes 'cluster policies'.

The TCI *Cluster Policies Whitebook* notes that cluster policies can cut across a wide range of existing policy areas: industry policy, science and technology policy, competition policy, education and labour policy and social policy. It identifies cluster initiatives as "systematic efforts aimed at influencing and creating clusters", while cluster policies are defined as activities "pursued by public actors for the purpose of increasing socio–economic benefits through the creation or further development of clusters" (Andersson, Serger, Sorvik, et al. 2004, 52–53). At the same time, a recent OECD report on *Competitive Regional Clusters* notes that policies to support regional specialization and clustering lie at the intersection of several different policy families, which include regional policy, science and technology policy and industrial/enterprise policy. The programs and instruments employed across this wide range of policy areas that support cluster development are those designed to foster improved linkages among firms and research institutes. In general, policies to support clusters are often targeted at more than one policy objective and these objectives may change over time (OECD 2007, 40–41). Cluster policies do not constitute a new policy area per se, but rather represent a new approach to synthesizing a range of policy instruments that cut across the fields mentioned above. The purpose of cluster policies is to use these existing instruments in a more focused and coordinated

way and facilitate coordination, dialogue and interaction among the constituent elements – especially firms – that comprise the cluster (Nauwelaers 2003). This paper presents an overview of effective cluster policies based on insights derived from the ISRN study, as well as the analysis of relevant programs.

Key Findings from ISRN Research

A considerable amount of research has focused on the key factors that give rise to clusters in specific locales; but these analyses include both public and private factors, which does not offer an helpful basis for determining the most effective public policies. Similarly, there is a certain lack of clarity around the relative importance of chance events, or serendipity, in the emergence of clusters, as opposed to rational or intentional policy design. The ISRN case studies provide important insights into this relationship and its implications for policy design. They also underline the sectoral specificity of industrial clusters – far too much of the literature generalizes from a few case studies in selected sectors. Detailed comparison of the clusters in the ISRN study underlines the necessity of understanding how the sectorally specific characteristics of individual clusters affect the appropriateness of individual policy instruments. Clusters in different sectors also draw upon different knowledge bases which influence both the innovation process within those clusters and the underlying relationship between the cluster and the research infrastructure which supports it. Finally, the ISRN case studies accentuate the centrality of a strong, dynamic talent base, or 'thick' labour market for the success of most clusters. The ability to draw upon a plentiful supply of skilled labour with the skills required by cluster firms is often the most critical factor that attracts them to, and anchors them in, a specific geographic location.

Factors that Contribute to Cluster Development

Much of the cluster literature is overly preoccupied with identifying lists of factors that contribute to the origins and growth of clusters. The presence of a number of these factors is usually credited as the reason for the emergence and development of successful clusters. The success of a number of clusters has been directly attributed to the role played by leading research institutions, such as Stanford in Silicon Valley or MIT in Route 128. Clusters may also emerge out of the central role played by a core or leading firm. The location of a dynamic lead firm with strong linkages to the global economy, such as Hewlett Packard in Silicon Valley or Nortel Networks in Kanata, can serve both as a demonstration effect for other firms in the cluster, as well as a continuous source of spin–offs, feeding the process of new firm formation. However, the mere identification of a list of key factors reveals little about the underlying dynamics that

contributed to the growth of the cluster, and thus does not always provide an effective guide to policy development.

This analysis of the key factors that underlie the presence of clusters is also borne out in a related corpus of policy related work done in Canada and the US. Research undertaken for the National Research Council situates the process of industrial clustering within the systems of innovation approach (Nordicity Group 1996). Based on this analysis, the NRC identifies a set of eight factors that contribute to cluster development, including: the presence of local champions with greater vision than single firm success; the existence of a strong S&T knowledge infrastructure – which includes research universities, government laboratories, cooperative research centres; source of motivated learners and technology, knowledge and skills; the presence of at least one exporting firm, with some global reach; involvement by local networking facilitators who promote the growth of relationships within the cluster; involved, knowledgeable local sources of innovation financing; sustained, aligned development strategies by local institutions and governments; and a supportive business climate, and policy conditions favourable for innovators. While all of these factors may play a role in the cluster development, it is critical to understand the underlying dynamics by which that contribution is made and the relative importance of them in seeding the cluster process. The results of the ISRN research can provide some valuable insights in this respect.

Path Dependence -- Cluster Origins

Central to the question of cluster policy is the role of path dependencies created by small, initial – often chance – events, as opposed to that played by deliberate actions of both private actors and public sector agencies. The concept of path dependency as developed in evolutionary economics sets out to explore how structured patterns of development – across both space and time – can result from seemingly chance or contingent occurrences. The concept was first used to explain why certain technologies prevail over a variety of alternatives in periods of rapid innovation when the marketplace is characterized by the emergence of a number of competing designs. Paul David defines a path-dependent sequence of economic changes as one in which important influences upon the eventual outcome can be exerted by temporally remote events, including those dominated by chance elements, rather than systematic forces. He suggests that in a dynamic process, positive feedbacks are generated by strong technical complementarities on the supply side of markets, and/or the interdependence of customer preferences operating on the demand side. He insists that this does not mean that the eventual outcomes are inevitable; rather,

contingent events play a significant role in constraining the economic and political choices available (David 1997, 17).

The concepts of path dependence and increasing returns have obvious relevance for understanding the historical paths taken by regional clusters. Once a region establishes the basis for its success in an interrelated set of production activities, its chances for continued growth are reinforced by the initial advantage it has gained. The geography of industrial location is replete with examples of individual regions establishing their preeminence in emerging industries – Detroit in automobiles (Klepper 2007), Hollywood in motion pictures (Scott 2006) or Silicon Valley in computers and semiconductors (Sturgeon 2000; Moore and Davis 2004). The challenge lies in determining which aspects of a developmental path or trajectory can be attributed to underlying factors or preconditions of the region, and which are the result of chance or contingent events. Once a regional cluster establishes itself as an early success in a particular set of production activities, its chances for continued growth tend to be high. While this may be reducible to the success of dominant 'lead' firms in the region or, as Klepper argues, to the spinoff of new firms by disaffected employees, the key aspect of the process involves the manner in which the conducive terrain of a particular location establishes a competitive advantage in the new industry, which is then reinforced by a series of contingent events. By the same token, ailing places may also face great challenges in improving their fortunes, for the same reason. Once a path-dependent trajectory of decline becomes established, institutional and cultural lock-in will make deviation from this path a serious challenge for its existing firms and clusters.

The literature on cluster development has tended to focus on the importance of factor endowments in explaining regional concentrations of industry. It builds on Marshall's original thinking on the nature of agglomeration economies (1927) to specify the types of supply side externalities that generate increasing localized returns (Krugman 1991). For his part, Michael Porter is explicit on the factors that contribute to cluster formation and the constraints on the role that public policy can play. He traces the roots of cluster emergence in a particular location to the relevant components of his 'diamond' model of competitive dynamics (Porter 1990; Porter 1998). Although he affords all four corners of the diamond equal weight as factors contributing to the seeding of clusters, he clearly privileges the role of factor input conditions. The most important factors that serve as attractors to firm location in a region or stimulate the formation of startup companies is the availability of a strong pool of factor inputs, such as specialized skills and talent, specific areas of expertise in the research infrastructure, an attractive physical location, and especially supportive infrastructure (1998, 237). While he eschews the language of path dependence and increasing returns, he does suggest that chance events intervene in the birth or genesis of a cluster – especially, those that cannot be fully explained by local circumstances in

the sense that the companies could have been located anywhere. The chance relocation of William Shockley from Bell Labs to the west coast had totally unforeseen consequences for the future location of the semiconductor industry, just as in Canada, the forced divestiture of Northern Electric by Western Electric in the 1950s was crucial for the future development of the telecommunications and fiber optics cluster in Kanata. However, Porter then goes on to apparently contradict himself by asserting that "chance, however, often has locational antecedents, making its role less than it first appears" (1998, 238). Citing the case of Medtronic in Minneapolis, he maintains that its emergence in the region "was inextricably entwined with the area's local university and medical institutions" (1998, 239).

The key lesson here is that the path dependencies for cluster creation are highly variable, and that the chance events that provide the trigger for cluster formation can come from many sources. There is a certain element of serendipity in many of the cases that comprise the ISRN study – wireless technologies in Calgary, software in Waterloo and ICT in Ottawa – but in virtually all of them 'chance had its locational antecedents'. Once a cluster emerges through this combination of local antecedents, chance events and entrepreneurial initiative, the effects of increasing returns and positive feedback work to reinforce its existing advantages. Yet Porter seems to downplay the importance of local antecedents in seeding clusters where no significant advantages previously exist. The most appropriate policy he suggests should be to build on existing or emerging fields that have already passed a market test (Porter 1998, 240). Despite his reservations, the preceding discussion points in the direction of a critical lesson for policy analysis – public policies should be designed with an appropriate balance between those that help establish the local antecedents for clusters in specific regions and those that support the continued growth and development of the clusters once they have emerged (Wolfe and Gertler 2006).

Clusters as a Sectoral Phenomenon

Another key finding that emerges from the ISRN case studies is the extent to which the cluster/sector distinction that is often made in the literature has masked one of the most significant dimensions of the cluster. Michael Porter, among others, argues that clusters are distinct from traditional industrial sectors in that cluster boundaries should include all industries and institutions within a region with strong linkages, whether these are vertical, horizontal and institutional and regardless of pre-defined sectoral boundaries. He maintains that clusters normally include a combination of end-product, machinery, materials and service industries, which are usually classified separately in standard industrial classification systems. "Clusters,

then, represent a distinct way of organizing economic data and viewing the economy" (Porter 1998, 204). While the ISRN research adopted this perspective at the outset, cross-cluster analysis of the twenty-six case studies highlighted the extent to which the character of individual clusters is strong influenced by the nature of the particular sectors in which they are based. This finding has critical implications for the formulation of cluster policies, as policies which may be appropriate or valuable for clusters with one set of sectoral dynamics, may be inappropriate for clusters in a another sector.

The results of the ISRN case studies were analyzed to highlight some of the most significant cross-sectoral variations that appeared. The key insight derived from this analysis was the point that the key components that root an individual cluster in a specific geographic location is highly variable. For some it may be the underlying nature of the labour market, for another, the vitality and strength of the research infrastructure upon which it draws, for a third, the nature of linkages in the supply chain which is the driving factor that determines the competitiveness of firms co-located in the cluster, and for a fourth, it may be the bridging elements of local civic capital that strengthens the linkages between a cluster of local firms and their supportive infrastructure of local institutions in the regional economy. The significance of this sectoral specificity of individual cluster was made emphatically in a recent paper on the Southern Ontario automotive clusters by Tod Rutherford and John Holmes, who argue that the predominant conception of cluster dynamics tends "to downplay the industry specific nature of cluster development both within high technology and more traditionally based clusters." They stress the role played by different forms of knowledge and industrial restructuring in mature clusters and the impact of asymmetric power relations between firms, especially in those clusters that have become more tightly integrated into the supply chains of global production networks (Holmes and Rutherford 2007). In these cases, which also apply to other metal and machining clusters in the ISRN study, the 'pipeline' dimension becomes a tightly linked set of asymmetric relationships among original equipment manufacturers and their Tier I and Tier 2 suppliers.

Differentiated Knowledge Base of Clusters

As the preceding discussion indicates, clusters can also be differentiated in terms the critical source of knowledge they draw upon. It is useful therefore to have a clearer understanding of how these forms of knowledge vary between industries. The significance of the science base and its links to industry are vitally important in pharmaceuticals or nuclear physics. Pavitt (1984), Malerba (2005) and others have argued that knowledge bases tend to vary systematically by industry — and so too does the nature of the innovation process. Recent analyses of the

geography of knowledge flows — within and between local clusters — have begun to identify distinctive patterns by sector. These analyses have found the distinction between 'analytical' and 'synthetic' knowledge bases (Laestadius 1998) to be helpful in this regard (Asheim and Gertler 2005). A *synthetic* knowledge base is typical of industrial settings where innovation takes place mainly through the application or novel combinations of existing knowledge. Innovation in such industries is driven by the need to solve specific problems arising in the interaction with clients and suppliers. Classic examples come from sectors within advanced industrial engineering (such as the development of specialized machinery). In these sectors, research plays a secondary role to product development. When it occurs, it tends to take the form of applied research, but the dominant type of innovative activity is incremental product or process development to solve technological or production problems presented by customers. Relevant knowledge is generated through an inductive process of testing, experimentation, and simulation. While there may be a partial element of codified knowledge embodied in the incremental products developed, tacit knowledge tends to be more important, since shop floor or office experience, on–the–job training, and learning by doing, using and interacting are crucial to knowledge generation.

In contrast, in those sectors where scientific knowledge is highly important, and where knowledge creation is normally based on formal models, codified science and rational processes, an *analytical* knowledge base prevails. Obvious examples of such industries are found in the biotechnology and information and communications technology sectors. Here, the core activity that underpins the development of new products and processes is systematically organized research and development, both inside the individual firm and through collaboration with universities and other research organizations. The inputs to this type of knowledge base are more often codified (or readily codifiable) than in the case of synthetic knowledge, although this does not mean that tacit knowledge is unimportant. As Asheim and Gertler (2005) note, the predominance of codification is due to several factors:

> knowledge inputs are often based on reviews of existing studies, knowledge generation is based on the application of widely shared and understood scientific principles and methods, knowledge processes are more formally organised (e.g. in R&D departments) and outcomes tend to be documented in reports, electronic files or patent descriptions.

However, just as most innovation processes employ both tacit and codified forms of knowledge, so too do many industrial sectors draw upon *both* synthetic and analytical forms of knowledge. Thus, individual industries fall along a continuum from purely analytical to synthetic knowledge bases, with many occupying an intermediate position along this continuum.

In our analysis of the ISRN study results, we developed a matrix of clusters differentiated by the nature of their knowledge base and the relative importance of the global/local dimensions of knowledge flows within those cases (Gertler and Wolfe 2006). Several insights emerge from the distribution of clusters within the matrix. First, while there is a tendency for synthetic–knowledge industries to source their knowledge locally, this is not universally true. In the case of the Ontario steel cluster, leading firms, such as Dofasco in Hamilton, are embedded in both local and international knowledge networks (Warrian and Mulhern 2005). Similarly, knowledge flows in synthetically oriented sectors like aerospace that increasingly involve the integration of complex technology subsystems draw upon a global network of system integrators to assemble the final product. According to Niosi and Zhegu:

> Four characteristics appear when these knowledge flows are examined. First, they are mostly international. Second, they are mostly constituted of explicit and codified knowledge. Third, they involve several independent companies. And finally, they are closely tied to markets for parts, components and subassemblies (2005, 22).

Second, while cases such as agricultural biotech in Saskatoon support the predicted correspondence between analytical knowledge and global sourcing, other analytical–knowledge cases such as biotech in Montreal, Toronto, and Vancouver, or telecom equipment and photonics in Ottawa depend on a mix of strong local and global knowledge sources and flows. Third, hybrid sectors show no clear tendency toward one scale or the other. Cases such as Toronto's medical technologies industry — for which analytical knowledge is a strong complement to synthetic forms of knowledge — show strong dependence on local knowledge sources. Food and wine clusters in Toronto, Niagara and Okanagan rely significantly on both scales of knowledge flow, while Montreal aerospace draws only limited unique knowledge from purely local sources. While these results defy easy generalization, they illustrate the critical importance of developing cluster policies that reflect the nature of the knowledge flows within the sector involved and tailor the policies appropriately.

The Role of Talent in Cluster Development

One of the most consistent findings from the ISRN research is the centrality of skilled labour as the single most important local asset. If there is one type of input that is overwhelmingly local, it is highly skilled labour. A consistent finding across virtually all of the case studies is that the depth and breadth of the local labour market is the key ingredient defining a cluster's ability to support knowledge-intensive production. This factor endowment is created and maintained by the attraction and retention of highly educated, potentially mobile workers who are drawn to

thick and deep opportunity-rich local labour markets. Recognition of the contribution that this element makes to cluster development "stresses the centrality of local labour market processes to the innovative capacity, competitiveness and indeed existence of clusters. It is the dynamism of the local labour market that ... account(s) for the associated clusters' dynamism" (Malmberg and Power 2006, 60). It is also the factor that is most amenable to public policy influence. Post–secondary educational institutions play a central role in the development of a local talent pool. According to Gertler and Vinodrai, universities act as anchors of creativity in producing, attracting and retaining highly skilled talent, while they simultaneously create an open and tolerant attitude in the communities in which they are located. This in turn reinforces the conditions needed to attract and retain talent in the local community (2005; Florida 1999). In our case study of the Waterloo ICT cluster, the University of Waterloo provides a particularly salient example of the impact of post-secondary institutions on the local labour pool: the founders of many firms that populate the cluster are graduates of the university and most local firms overwhelmingly cite the presence of a strong local labour pool as a key factor in explaining their presence in the region (Bramwell and Wolfe 2008).

Research Infrastructure and Talent Creation

In much of the cluster literature, the presence of research intensive institutions is depicted as a critical factor in seeding the growth and development of the cluster; the generation of a strong pool of highly skilled talent and the presence of a 'thick' labour market are portrayed as a positive, but secondary consequence of the investment in building dynamic research capabilities. The results of the ISRN case studies suggest that the line of causality may point in the other direction. In relatively few of our cases, outside of those which rely most strong on a synthetic knowledge base, such as the biotechnology clusters, does the cluster owe is emergence and present strength to direct spinoffs of new firms or the licensing of technology from research-intensive institutions. In the Waterloo, Ontario case, the mobilization by local business leaders to secure a charter for a new university, financed with federal and provincial funding, and their foresightedness in structuring a curriculum around math, sciences and engineering and creating a pioneering program of co-operative education, laid the groundwork for the future emergence of a strong information technology cluster. In this case, it was the specific pattern of interaction of dynamic, visionary leaders at the community level with the increase in combined federal and provincial funding for post-secondary education that strengthened the local antecedents essential for the emergence of the information technology cluster. In the case of Ottawa, the Canadian capital, the dense concentration of federal government laboratories in telecommunications served

as the magnet that drew Northern Electric's primary research facility to the region (Wolfe forthcoming).

The ISRN findings underline the fact that direct seeding of the cluster by postsecondary institutions is the exception, rather than the rule. The case studies suggest that the presence of universities and research institutes act primarily as attractors of inward investments by leading anchor firms interested in tapping into the knowledge base of the local community, or its local buzz, and as providers of the talent pool that firms in the cluster draw upon, rather than as direct initiators of cluster development. In this respect, universities also act as part of the network linking actors in the local cluster to the global pipelines that are essential to the knowledge flows in the cluster. Successful research universities also attract leading scientists, further reinforcing their linkages to external knowledge flows through the extensive network of contacts they bring to their new location. Drawing upon a subset of the ISRN case studies, Doutriaux found no direct causal relationship between the presence of a university and local high technology development in eleven high technology clusters (2003). His observation is confirmed in a broad cross-section of the case studies which found that universities often act as catalysts for cluster development by training local talent and contributing to the local knowledge base, but were rarely the key drivers of cluster formation in themselves. Similar to the case of Stanford University in Silicon Valley (Lécuyer 2005; Moore and Davis 2004), many of the leading research-intensive universities in Canada have proven themselves highly effective at responding to 'market' signals and expanding their research and teaching activities in fields that are most heavily in demand with local industry (Wolfe forthcoming).

This means that the role of public policy in stimulating economic development through direct support for research-intensive universities is critical, if not always in terms of the popularly conceived linear relationship. On balance the public interventions which have the most enduring effect in sustaining the process of local economic development are those that strengthen the research infrastructure of region or locality and contribute to the expansion of its talent base of skilled knowledge workers.

Policy Implications and Policy Directions

The unpredictable nature of path dependencies and the role of chance events in cluster creation constrain, but do not eliminate, the role for public policies. The critical insight of the evolutionary approach to the study of clusters is that multiple locational outcomes are possible in the early stage of cluster formation. This potential makes it difficult for regional policy makers to target the development of specific clusters (Lambooy and Boschma 2001). Conversely, the importance of local antecedents for cluster development means that policy, across multiple levels

of governance, can contribute to the accumulation of key assets in a specific location. Frequently, public sector agencies are critical in establishing the local antecedents that define this context. Public sector involvement can affect cluster trajectories in a variety of ways; one of the most effective ways of seeding cluster development is through investment in building the research infrastructure and educated labour base in a region. While far from sufficient in itself, the establishment of a strong local talent pool of highly skilled and knowledgeable workers feeds the growth of local firms in the cluster as increasing returns begin to take hold, and attracts outside firms to invest in the cluster to gain access to the underlying talent pool. While the ultimate impact of these policy interventions cannot be fully anticipated at the outset, over the long-term, those policy interventions that strengthen the research and institutional infrastructure of a region or locality have the greatest potential to act as attractors for a cluster of firms (Wolfe and Gertler 2006).

A critical insight from the ISRN studies is that different cluster policies are appropriate at different stages of the cluster life cycle — there may be one set of environmental conditions that support the creation of a cluster, while a different set of conditions may be required for the ongoing development of a cluster and the competitive advantages the cluster confers upon its constituent enterprises. The project identified a life cycle model of cluster development and transformation that includes the following stages:

- Latent – the presence of a strong research infrastructure or the growth of a thick labour market endowed with specific skill sets creates the preconditions for cluster formation. The region has a number of firms and other actors that begin to cooperate around a core activity and realize common opportunities through their linkages.

- Developing – an outbreak of entrepreneurial activity often as spin-offs from the lead or anchor firm or from public research institutes, stimulates the development of the cluster. As new actors in the same or related activities emerge or are attracted to the region, stronger linkages develop among the key players in the cluster. Formal or informal institutes for collaboration may appear, as may a label and common promotional activities for the region.

- Established – a certain critical mass of firms and supporting institutions is established. Relations both within and outside of the cluster are strengthened. There is a self-sustaining dynamic of new firm creation through start-ups, joint ventures, and spin-offs.

- Transformational – clusters change with their markets, technologies, and processes. In order to survive, the cluster must avoid stagnation and decay. Transformation may be through changes in the products and methods, or into new clusters focused on other

activities (Wolfe, Davis, and Lucas 2005) adapted from (Andersson, Serger, Sorvik, et al. 2004).

Policy interventions are important at every stage of the cluster life cycle, even the later ones, and may be especially critical at the transformational stage when the cluster is facing novel and unprecedented challenges. The essential point for policy is that the form of intervention will vary over the different stages of the cluster life cycle; laying the conditions for the emergence of a latent cluster requires a very different set of policy responses than supporting the growth of an emerging one or facilitating the revitalization of a cluster in the transformational stage (den Hertog, Bergman, and Charles 2001).

This paper divides the appropriate policies into two broad categories. The first category consists of general policies designed to foster the initial conditions that create the conditions for latent clusters to develop and ensure an adequate supply of the factor endowments critical for cluster emergence. The public policies that supply these factors are often generic policies primarily designed to achieve some other public policy goal — such as the provision of support for fundamental research and applied technology development. The second category of policies includes those targeted at providing supports for the continued growth of clusters once they have emerged. Public sector agencies with cluster mandates must clearly refine their role in individual clusters to accommodate the specific developmental stage of each one. However, these strategies must also take account of the underlying technology and knowledge base of the cluster, its geographical location within the country and the nature of the global/local as well as inter-firm dynamics within the cluster.

Policies to Create the Initial Conditions for Cluster Development

Public policies that create a strong knowledge base in the regional economy and contribute to the creation of a well educated workforce establish the local antecedents that can support the emergence of clusters. While clusters are overwhelmingly a local and regional phenomenon, in most industrial countries the policies that contribute most directly to seeding the condition in which they can emerge lie within the jurisdiction of federal or provincial governments. The recent OECD report on national policy approaches to cluster strategy notes the increasing focus on building strategic research capacity in selected regions as the basis for promoting clusters: Finland's Centres of Expertise program, the Norwegian Centres of Expertise, Canada's National Research Council cluster initiatives, the French Pôles de compétitivité program, the German BioRegio program, the Japanese Knowledge Clusters and a variety of state programs across the U.S. are just several illustrations of this point (OECD 2007, 43–51).

A broad cross-section of the cases included in the ISRN national study underline the important roles played by different scales of political jurisdiction in the genesis of clusters. Canadian cases where the activity of one or both senior levels of government was instrumental in establishing the local antecedents for cluster emergence include: National Research Council Institutes in Montreal's biotech cluster (Niosi and Bas 2000; Niosi and Bas 2003) and the Saskatoon canola cluster (Ryan and Phillips 2003); the instrumental role of provincial policy in upgrading the Ontario wine cluster (Mytelka and Goertzen 2007), the initiative of two provincial corporations in Alberta in laying the groundwork for the formation of the Calgary wireless cluster (Langford, Wood, and Ross 2003); provincial funding with federal transfer dollars for the establishment of a new university in Waterloo with a strong focus on math, computer science and engineering (Nelles, Bramwell, and Wolfe 2005); the presence of the federal Communications Research Centre and several NRC Institutes in Ottawa as a key attractor for the establishment of Bell Northern Research on the western outskirts of the city (Chamberlin and de la Mothe 2003); and the offshoots of a federal centre of excellence at Laval University as the basis for the development of the photonics cluster in Québec City (Kéroack, Ouimet, and Landry 2004) provide just a few examples that support this point.

Policies that have a positive effect on cluster development are not always intentional ones. In a telling account, George Squires, VP of Research at TRLabs, described the tale of 'two cities – two disasters' in describing the role that failed public investments in two companies — Microsystems International Ltd in Ottawa and NovAtel in Calgary — played in seeding the respective clusters. In each case substantial public funds were invested in companies that ultimately were sold off at a substantial discount to private firms. In both cases, however, the failed enterprises proved to be highly successful breeding grounds for the next generation of entrepreneurs in the individual clusters. According to Squires, more than 100 companies in the Ottawa cluster were born out of MIL's failure, while Nortel went on to invest billions in semiconductor research through the 1990s. In Calgary, the Alberta government was reported to have lost $500 million in the failed venture, the pieces of which were eventually sold off to Nortel, and several other companies. However, virtually every key interviewee in the Calgary cluster referred to their previous training at NovAtel U. — the lesson here being that policy inadvertence can also be a key ingredient in cluster success and that policies which contribute to the development of a deep pool of highly skilled talent are ultimately the ones with the greatest long–term potential for cluster promotion (Squires 1997; Mallet 2002; Harrison, Cooper, and Mason 2004; Langford, Wood, and Ross 2003).

Cluster Development and Policy Coordination

Many of the public policies that are most effective at seeding the growth of clusters are frequently designed with some other goal or objective in mind. Public policies that build a strong knowledge base in the regional economy, and contribute to the creation of a well educated workforce, rank among the most effective in establishing the local antecedents that can support the emergence of clusters. While a strong research infrastructure and a thick labour market are distinctly local phenomena, they are not exclusively the result of local, or even state and provincial government policies; the presence of the national or federal level of government lurks in the background. The most effective of these polices are financed by senior levels of government; and rarely do these levels have the goal of cluster promotion uppermost in their minds.

The case of Silicon Valley provides the clearest illustration of the way in which the different levels of government impact the development of local clusters. Silicon Valley exists within the distinctive features of the US system of innovation – with its unique system of laws, regulations and conventions governing the operation of capital markets, forms of corporate governance, research and development and other relevant factors. A number of these features are critical to Silicon Valley's growth and development. The federal government played a central role as the initial customer for many of the early products of the cluster. Government funding for innovative research projects, and to create the backbone for the first computer networks through the Department of Defense's Advanced Research Projects Agency, combined with high levels of demand for semiconductors through the defense and space programs, provided the spark that stimulated the growth of the spin off firms that began to proliferate in the Valley in the 1960s and 1970s (National Research Council 1999; Leslie 2000; OECD 2007, 119). Once the cluster began to emerge in the 1960s and 1970s, subsequent changes in capital gains tax rates and the tax treatment of stock options, as well as the rules governing investments in venture capital by pension funds, stimulated the growth of the venture capital industry, a critical factor for the development of the ICT cluster (Kenney and Florida 2000, 114).

However, cluster policies can serve as a highly effective means of focusing the impact of a wide range of other policy instruments to ensure they achieve maximum impact and benefit in promoting the development of networks of local firms (Rosenfeld 2002a; Rosenfeld 2002b). This perspective suggests that local governments can achieve a better understanding of their economies through an analysis of their clusters. Cluster analysis can help regional and local governments be more strategic, systematic and effective in their expenditure of limited public resources. It can allow governments to target prospective investments in a way that strengthens clusters in both mature and emerging industries. The development of effective cluster strategies

includes a number of essential elements: actions for identifying the key clusters, mapping the systematic relationships within them and benchmarking their performance against competitors; working with cluster associations to respond to industry needs and improve inter–firm collaboration; reorganizing the delivery of information and services to strengthen and promote the relationships identified by cluster analysis by disseminating information about available government services through the clusters, establishing one stop points of entry for cluster members, and creating cluster teams to focus on solutions that cut across departmental and agency boundaries; and finally use clusters as the focus for upgrading labour skills and qualifications to create the thick labour markets that strengthen the competitive base of firms in the cluster and attract new ones to it (Rosenfeld 2002b).

In order to accomplish this goal, governments need to ensure an appropriate degree of coordination between policies designed with other policy objectives in mind and the goal of cluster development. For most other clusters aspiring to emulate the success of Silicon Valley, relying on the inadvertent effects of federal government policy is unlikely to have the same impact (Bresnahan, Gambardella, and Saxenian 2001). A key challenge for economic development policy is to ensure a better degree of integration and coordination of available policy instruments across all levels of government. As much of the preceding analysis argues, the cluster focus provides an effective mechanism for achieving this at the level of the local and regional economy. It also requires a greater degree of coordination between all three levels of government and their respective economic development agencies.

The recent OECD report on national policy approaches to cluster development notes that national governments of federal countries have limited options in promoting policy coherence across multiple levels of government. They lack the authority to dictate policy goals to subnational governments, although direct funding can be used to induce those governments to adopt a desired course of policy action. With respect to cluster development, however, the report identifies the lack of policy coordination as leading to three types of 'missed opportunities'. The first arises from federal or provincial funding for research centers or centre of excellence programs. Most OECD countries have introduced such programs in parallel with other cluster policies, although there is little or no direct linkage between the two program initiatives. These policies typically develop from a research policy focus based in ministries of higher education with responsibility for university funding. The centers funded under these initiatives serve to support the development of regional specialization, but without formulating direct linkages to cluster policies and strategies, regions and urban areas are less effective at capturing the benefits of that research.

The second missed opportunity arises from the lack of integration of science and industrial parks with cluster programs. Programs to promote science and industrial parks often originate at the local level and are therefore not explicitly aligned with cluster policies and programs originating at the national or provincial level. The third missed opportunity arises from the lack of coordination of regional with national innovation systems that leaves the regional systems isolated from the greater resources available under the national programs. This is more likely to occur when the program supporting regional innovation is developed outside of the national science and technology policy fields (OECD 2007, 122). A coordinated approach to cluster development at the regional and local level requires integrated to policy planning at the 'governance' level, across existing program boundaries, as well as levels of government, leading to a more effective degree of 'policy alignment'.

Multilevel Governance and Cluster Policies

As the preceding analysis argues, however, these key policies are rarely designed and implemented with an explicit goal of cluster creation in mind. It requires a greater degree of coordination between the senior levels of government with responsibility for research and education policy and local and regional development agencies with cluster responsibilities to ensure the cluster benefits are realized. Thus clusters can be seen as being nested within, and impacted by, other spatial scales of analysis, including regional and national innovation systems, each of which adds an important dimension to the process of knowledge creation and diffusion that occurs within the cluster. For instance the national innovation system plays a preponderant role in establishing the broad framework for research and innovation policies, in providing a national system of public laboratories and research organizations, and in setting the rules of operation for the financial system that determine the availability of different sources of financing and time horizons for new and established firms (Wolfe and Gertler 2004).

In many jurisdictions the concept of multilevel governance has been adopted to help achieve the desired degree of cross-jurisdictional coordination (Wolfe and Creutzberg 2003). Many existing research and innovation programs with greater potential have been implemented in a traditional fashion, administered by individual departments or agencies with little attention paid to the broader implications of the program for cluster development in the local or regional innovation system. The use of clusters as a focusing device can provide a means of achieving a better degree of policy integration to ensure the maximum economic benefit is achieved from these critical investments.

Research Infrastructure and Cluster Development

In the Canadian cases considered above, the role of the federal and provincial governments in building the local research infrastructure and building up the resources of highly skilled labour was equally critical. The strength and vitality of universities remains essential for growth in the knowledge–based economy. Universities perform vital functions both as generators of new knowledge through their leading-edge research activities and as trainers of highly qualified labour. As most research universities will attest, the two functions are integrally linked and when they are most effective, they contribute strongly to regional economic growth and development. As such, they provide the essential infrastructure from which clusters can develop. Universities play a critical role in building local clusters in a number of different ways. Strong research intensive universities feed the growth of clusters by expanding the local knowledge base and providing a steady stream of talent to feed supports the growth of firms in the cluster. They also play a key role in attracting and retaining leading edge researchers which, in turn, can serve as a magnet for investments by leading or anchor firms, drawing them into the cluster to gain more effective access to the knowledge base and *local buzz*. In some instances, successful research efforts can expand the cluster by spinning off research results into new products and firms, but it is a mistake to view this as the only role they play. Recent policy initiatives which aim to elevate the commercialization of technology to equal status with research and teaching as mandates of the university fundamentally miss this point. Universities also play a critical role in facilitating the process of incremental innovation by linking academic knowledge capabilities to technical personnel in local firms involved in the critical task of product development; this is done through a variety of means — informal contacts between faculty and firm researchers, formal consulting arrangements, joint industry–university research projects and the transfer of university graduates into local firms. Universities also constitute a vital part of the local 'economic community' by building the region's social capital and taking a leadership role in activities designed to enhance the region's absorptive capacity (Bramwell and Wolfe forthcoming; SSTI 2006).

Continued public support for both the teaching and research mandates of the university are essential if they are to succeed in these roles and contribute to the growth of their local and regional economies. These points were strongly emphasized in a recent report prepared for the Ontario government,

> Basic university research advances fundamental understanding and provides a substantial rate of economic return through the preparation of a highly skilled workforce, contributing to the foundation of many new technologies, attracting long-term foreign (and domestic) investment, supporting new company development and entrepreneurial companies and participating in global networks. Government funding is the primary

support for virtually all investment in truly frontier university research (Munroe–Blum 1999, 14).

One illustration of this dilemma is the Canada Foundation for Innovation, which makes major infrastructural investments in expanding the research capacity of post-secondary institutions and research hospitals across the country, but rarely attempts to integrate these important new facilities into the existing or emerging industrial structure or local clusters of those regions receiving the new investment. Virtually every university in Canada has been required to draft strategic research plans as a criterion for receiving federal and often matching provincial grants through the CFI program, as well as the Canada Research Chairs Program. In only a few isolated instances where individual universities have taken the initiative have these plans been drafted through a process of consultation with local and regional development officials or with an eye to the potential contribution that these critical research investments can make to building cluster capacity. The failure to do so constitutes a classic case of a 'missed opportunity' in the sense described by the OECD report discussed above.

Policies to Promote Cluster Growth and Development

Once the initial conditions for a cluster have been laid, and a group of interrelated firms begins to emerge in a specific locale, policies to support its further growth must be consistent with its specific stage of development in terms of the cluster life cycle. Policies to support cluster development should include three distinct types: one to involve key actors in the process of cluster development, second, to facilitate the development of collective services to support cluster firms, and third, to engender more effective use of localized research and development infrastructure, as well as specialized local training programs and institutes. Many policy measures to promote cluster development target increased interaction and dialogue among cluster–based firms and supporting public sector actors as a principal goal. However, the elaboration of each of these types of cluster policies should also take account of the specific needs of the individual clusters involved (OECD 2007, 92; Andersson, Serger, Sorvik, et al. 2004, 53–54).

The formation of cluster–based organizations often represents a crucial step that provides the basis for implementing a number of the policies outlined above. Feldman, Francis and Bercovitz posit the existence of a three stage model of cluster development, comparable to the first three stages of the ISRN model (Feldman, Francis, and Bercovitz 2005). The first stage constitutes the latency phase in which a strong base of labour skills or human capital, or a significant research infrastructure, is created in a region. In the second stage, the cluster evolves

as entrepreneurs establish their own networks and build the institutional structures that constitute the industrial system or supply architecture of a region described above. This point was strongly reinforced in the recent report prepared for the National Governors Association and the Council on Competitiveness in the U.S.,

> The prime movers of cluster growth are entrepreneurs. As clusters form, entrepreneurial firms provide information about new opportunities, become role models for yet more startups, and generate spillover knowledge about technologies, markets and customers, all of which help reduce the risks of starting a new business (Rosenfeld 2007, 6).

As clusters take form, local entrepreneurs also begin to setup the support organizations needed to sustain their own activities and encourage new entrepreneurs to enter the market. The emergence of cluster support organizations at this stage of development is much more varied and is often tailored to meet the needs of the specific region in which the cluster is located. The final stage occurs when there is a fully functioning entrepreneurial environment where the success of the initial startups creates additional possibilities for new ones, as well as spin-offs.

Throughout the ISRN case studies, the emergence of cluster–specific support organizations, as well as region–wide civic associations, provided a crucial institutional means for the delivery of programs and services to cluster members, as well as for the implementation of cluster strategies and policies (Wolfe and Nelles 2008). The cluster literature suggests that the benefits of clustering are linked to advantages that firms derive from proximity to other firms in related and supporting industries, as well as to the benefits from having privileged access to extra–economic resources related close to the cluster. Closely related to these resources are the presence of an institutionally 'thick' set of local actors who provide dynamic leadership to promote the interests of the cluster – both in terms of facilitating the kinds of networking and inter-firm linkages that accelerate the flow of knowledge among cluster-based firms, as well as promoting the policy interests of the cluster to all relevant levels of government. As Malmberg and Maskell point out, "(t)here is . . . a fundamental interdependence between the economic structure and the institutions of the cluster." (Malmberg and Maskell 2002, 441).

The Role of Civic Associations in Cluster Strategy
The formation of local cluster associations constitutes an important stage in the evolution of the cluster, signifying that it has reached a self–sustaining level of development. However, their emergence cannot be taken for granted, nor should it be assumed that they do not encounter numerous obstacles once they have emerged. However, many cluster strategies make the

formation of cluster support organizations a centre piece of their strategy, and in situations where they have formed independently, government policies also target support for the association as a crucial piece of the overall strategy. The ISRN case studies suggest that the most successful clusters have profited from the development of strong social networks at the community level and the emergence of dedicated, community–based organizations. Once established, local cluster, or even more broadly based civic, associations can provide a convenient institutional basis for delivering cluster support programs and helping overcome coordination problems in the delivery of national and regional programs of benefit to local clusters. These entities link leaders in the individual clusters to a broader cross–section of community leaders involved in the process of local economic development. They are supported by new institutions of civic governance that identify problems impeding the growth of the cluster and help mobilize support across the community for proposed solutions. We found some evidence to suggest that size is a critical variable in the success of civic engagement, with some of the larger, urban centres encountering greater difficulty in achieving effective degrees of mobilization.

The concept of *civic* capital is a critical element that local institutions and local actors bring to the process of cluster development. Civic capital consists of interpersonal networks and solidarity within a community based on a shared identity, expectations or goals and *tied to a specific region or locality*. It is comprised of formal or informal networks between individual community members, between communities, or between community and the state (Wolfe and Nelles 2008). Civic capital recognizes the role played by local leaders, or civic entrepreneurs, in intensifying and formalizing collaborative networks within and between communities. Civic entrepreneurs can bond members of a community to coalesce and formalize coalitions based on shared identities and interests. However, their most important role is in *bridging* the gap between communities and between the local governments and community actors. Civic entrepreneurs understand the importance of collaboration; they bring business, the community and government together to set and achieve long–term development goals. They can emerge from any sector of society — business, government, education and community organizations — but share similar characteristics of visionary leadership, charismatic personalities, interest in building the economic region, and commitment to collaborative solutions. Civic entrepreneurs help to build and intensify civic capital by "creating opportunities for people to work together on specific projects to advance their economic community" (Henton, Melville, and Walesh 1997, 31).

The analysis of the case studies reveals the presence of a large number of local institutions and local actors that help build civic capital in the cluster and the local economy.

There is broad set of institutions and actors that contribute; key among them are local trade or industry associations and community-based advocacy groups. Many of the most successful clusters among the case studies have developed highly effective local associations that promote interaction and networking among the various members of the cluster, as well as advocating for local, regional and even national, policy innovations that work to the benefit of cluster members.

The variety of local actors involved in the individual clusters is also strongly influenced by the particular trajectory of development — or path dependence — of the individual case study. Many of the current clusters have either emerged in the past two to three decades, particularly those in the biotech, information technology, new media, and even the wine clusters, or have experienced significant growth and transformation in the same period, such as those in more established industrial sectors, like auto parts and tool, die and mold makers. In almost all of the cases examined, the key local institutions and actors have grown up and developed during this same period as part of the development and transformation of the cluster itself. In some instances, the emergence of the key local actors was a contributing factor in the development of the cluster, while in others, local institutions and organizations emerged as a reflection of the growing significance of the cluster within the local economy. The wide variation observed in the number and type of local actors serves as a reminder that there is no single template for effective models of cluster development; clusters which flourish often do so by building on both the strengths of the local economic base and drawing upon the talents and resources of key local actors to promote their further growth.

The associations active in the various clusters in the national study were quite varied in their origins. In the instance of the successful high technology cluster association in the Ottawa region, OCRI (Ottawa Centre for Research and Innovation), several local educational institutions came together in the early 1980s to create a network to link post-secondary research institutions with some of the prominent federal government laboratories in the national capital region. This important regional network resulted from emerged the efforts of several civic entrepreneurs, among them OCRI's founding president. Along with partners from the private sector, he was instrumental in expanding the associational base of the region through founding and leading several related groups (i.e. the Ottawa Community Network, OCRInet and the Optical Processing and Computing Consortium of Canada). Over the next two decades, OCRI evolved into a highly effective networking association that hosts more than seven hundred events a year and is widely hailed as one of the most effective of its kind in the country. It plays an active role in providing a wide range of services for firms in the ICT cluster and has even taken over key marketing and investment attraction functions previously performed by the municipal government in Ottawa (Mallet 2002; Chamberlin and de la Mothe 2003).

In the case of the somewhat smaller, but quite dynamic software and information technology cluster in Waterloo, Ontario, the community–based high technology association was initiated by the founders of some of the leading companies in the region. After meeting on a relatively informal basis for a number of years, they decided to create a more formal organization, dubbed Communitech, and in the early 1990s recruited many of the other emerging high technology companies in the region to join. Communitech works in association with the economic development offices in the different communities that make up the regional cluster and in conjunction with local companies. It runs an array of programs similar to those sponsored by OCRI in Ottawa, including Peer to Peer groups, a mentoring program, advocacy activities on behalf of the high tech cluster, seminars and events and the Business Accelerator Program which has assisted over 120 entrepreneurs since early in 2000 and helped to raise $65 million in capital. As in the case of OCRI in Ottawa, the creation of Communitech in Waterloo symbolized an approach to regional governance that transcends traditional jurisdictional boundaries and attempts to establish new policy networks between the community and the provincial and national levels of government. The association has contributed to the creation of a 'buzz' about the technology potential of the region and attracted interest from as far afield as Silicon Valley.

In situations where these cluster support organizations may have failed to emerge or encountered impediments to their effective operation, a number of important strategies have been suggested to build cluster identity and intensify the degree of interaction between actors, both firms and supporting organizations within the local cluster. Foremost among these actions is the establishment of 'sites' or platforms to encourage dialogue among key cluster actors. In the more formalized schemes developed in some European and American jurisdictions this can involve the use of 'cluster brokers' to act as facilitators in opening up avenues of dialogue and fostering greater interaction. In many instances, there is often a failure on the part of cluster members to recognize the extent to which there is a critical concentration of interrelated firms in the local economy that comprise an effective cluster (Robinson 2005). In this instance, undertaking a cluster audit can help identify the relevant range of firms and their specific technical areas of competence. Often the results of the audit itself can serve as a useful tool for making cluster firms aware of potential suppliers and partners within their own local economy. The cluster audit can also include, or be followed by, a cluster benchmarking exercise, which affords cluster members a view of their relative state of development in relation to comparable clusters in competitor jurisdictions. The results of both the cluster audits and cluster benchmarking exercises can also be used as a device to bring cluster actors together and help to establish a platform for enhanced cluster dialogue. Various strategies can also be adopted by local authorities, frequently with support from regional and national governments, to create greater

external awareness of the cluster and its dynamic capabilities. There is no simple or easy way to accomplish these goals and they require frequent refinement to help build the desired degree of cluster interaction (Andersson, Serger, Sorvik, et al. 2004, 96; Rosenfeld 2007; Rosenfeld 2002a).

The Role of Strategic Foresight in Cluster Development Strategy

Local high technology associations, such as OCRI in Ottawa or Communitech in Waterloo, or broader based organizations, such as The Ottawa Partnership or the Prosperity Council in Waterloo, can also play a central role in formulating innovation–based economic strategies. One set of techniques developed and applied at the local and regional level in Europe and North America involves a process of strategic planning or regional foresight exercises. Approaches that stress participative methods and strategic futures analysis have been labeled 'innovation–based strategic planning' (Montana, Reamer, Henton, et al. 2001), but they have also been identified as 'local social knowledge management' exercises (Gertler and Wolfe 2004). This approach is based on the insight that regions can enhance their potential for cluster growth, and economic development more broadly, through a strategic assessment of their existing assets and current weaknesses. "Innovation-led development suggests that how a region makes use of what it has becomes, in many ways, more important than the initial ingredients with which it starts" (Montana, Reamer, Henton, et al. 2001, 9).

Successful strategic planning exercises are concerned with identifying an area's unique local characteristics that support the development of regional industry clusters, which is also referred to as a competence system matrix (Andersson, Serger, Sorvik, et al. 2004, 79–80). These include knowledge economy assets (such as workforce skills, knowledge and research development, creativity, advanced telecommunications infrastructure, quality of place, and financial capital), collaborative institutions and organizations (such as regional development organizations, professional networks, research consortia, and entrepreneurial support networks), and the regional mindset (values and attitudes that encourage innovation, entrepreneurship, and collaboration). Strategic planning exercises have also been used to identify key gaps in the region's asset mix, as well as common opportunities that may be exploited by existing or emerging clusters. The common framework for understanding the region's potential and the shared vision generated through such a planning exercise can also help mobilize support at the local level for key activities needed to boost the cluster (Gertler and Wolfe 2004; Montana, Reamer, Henton, et al. 2001; Council on Competitiveness 2005).

There is a growing consensus in the literature on the common features of successful strategic planning initiatives, and indeed, a number of the urban centres in the ISRN study had undertaken such exercises. An essential feature is the role played by key civic leaders in directing the strategic planning process through a series of stages critical to the outcome of the exercise. The initial phase involves a process of visualization in which the participants develop a shared perspective on the desired future for their region or community. For the exercise to be credible in the eyes of its participants, the vision must be perceived as achievable — something that is grounded in the current reality of the regional or local economy and that could grow and develop logically out of its economic base or knowledge assets. The next stage involves building a broad and inclusive team of cluster participants to undertake the visioning exercise. The strategic planning exercise should develop mechanisms for engaging a broad cross–section of participants and ensuring that they remain committed to the process through its conclusion. This is followed by a process of framing the opportunities and challenges facing the community. This stage involves the process of developing a shared understanding of the current economic status and future prospects for the region and its existing or latent clusters. It must include a realistic assessment of the current challenges facing the clusters and the region more broadly, the assets and capabilities available to respond to these challenges, as well as potential opportunities that lie open ahead. The framing exercise should also specify key issues that require attention or action. The more effectively the framing exercise is able to present a realistic picture of the region that is credible to participants in the process, the more likely it is to establish the basis for buy–in for its eventual recommendations or action plan (Montana, Reamer, Henton, et al. 2001; Andersson, Serger, Sorvik, et al. 2004).

The framing exercise leads directly to the next step, which is the development of a series of concrete actions or initiatives that flow directly from the framing exercise. The ISRN case studies provided a number of examples of such exercises, which met with varying degrees of success. One illustration of a more successful process was the series of initiatives developed as part of The Ottawa Partnership's study of the region's clusters in 2000. The exercise generated a series of thirty three cluster–specific goals intended to promote the growth of the seven key clusters that were identified as the growth generators for the regional economy. The exercise also produced a higher–order set of flagship initiatives designed to work across the individual clusters to benefit the regional economy as a whole. Unfortunately the benefit of the strategic planning exercise was undermined by the onset of the telecom meltdown shortly afterwards (ICF Consulting 2000; Wolfe 2007). Other urban centres with clusters included in the ISRN cases launched comparable planning exercises in the same period, but they met with more mixed

success, due to the inability to develop a process where cluster members and community leaders took full ownership of the process.

An effective action plan should also include a roadmap for how to implement the specified initiatives. The process of developing the initiatives and the accompanying roadmap is an important exercise for developing the shared sense of how it can all be achieved. To create this buy–in for the roadmap at the community level, the initiatives must respond to real needs identified by the community participants, especially members of the local business community. Finally, the entire process must be seen as an iterative one. No strategic plan or technology roadmap is carved in stone. Economic conditions change and the challenges and opportunities facing a particular cluster are constantly evolving. To remain current and realistic, both the elements of the framing exercise and the initiatives that comprise the action plan must be revisited on a periodic basis. The process of revisiting the exercise is also an effective device for renewing cluster engagement with the overall planning process (Montana, Reamer, Henton, et al. 2001). Even the most successful clusters, including Silicon Valley, have adopted regular strategic planning processes to help them face the challenge of the continual need to refocus and renew. They have also used these processes as an effective means to reengage strong civic leadership with the cluster (Henton, Walesh, and Brown 2001).

Cluster Promotion Activities

Once a cluster strategy has been formulated, there are a wide range of cluster actions or initiatives that can follow from it. Often these involve leveraging existing federal or provincial programs to ensure that cluster firms take full advantage of them. In this respect, a cluster orientation can serve as a highly effective focusing device to ensure the appropriate degree of 'alignment' between existing federal, provincial and local policies with potential benefit for the cluster. It can also involve the development of cluster specific activities to raise the visibility of the cluster or assist cluster–based firms to market their capabilities.

As noted above, effective cluster policies must also make allowance for the sectoral specificity of the cluster involved and ensure that cluster policies are tailored towards the particular needs of the cluster in question. The authors of the TCI *Whitebook* observe that clusters based in specific, "(i)ndustries are also marked by varying requirements in terms of deep competencies, capital requirement and sunk costs, competition in factor and product markets, mixture of speed and maturity in product development, (and) influences on the demand side . . ." (Andersson, Serger, Sorvik, et al. 2004, 106). In a series of integrative papers that analyze the similarities and differences between individual clusters in the same industrial sector, ISRN

researchers identified some of the features of that characterize clusters in different sectors. Life science clusters are the purest analytic clusters, strongly rooted in the research infrastructure that provides the knowledge base for the cluster to draw upon, in some instances, intellectual property representing the primary commercial output of firms in the cluster. While they also draw upon research and intellectual property from external sources, the presence of a strong research base is what anchors the clusters in their location (Gertler and Vinodrai). A key challenge faced by these clusters in Canada is building effective linkages between the smaller startup firms in biotechnology and the larger, mostly multinational, firms that dominate the pharmaceutical sector, as well as coping with the political challenge that arise from managing the rising cost pressures within a publicly funded health care system.

Although ICT firms also draw upon an analytic knowledge base, for the most part, they are rooted in a specific locale by the prominent role of their lead anchor firm, such as Nortel in Ottawa or RIM in Waterloo. The firms draw upon the skilled labour produced by the research infrastructure in the city or region, but a large portion of the research that goes into product development is conducted in–house. Product innovation occurs through a process of user–producer interaction, with firms looking to the post–secondary and public sector research institutes as potential sources of problem–solving and technical solutions (Lucas, Sands, and Wolfe n.d.). The three multimedia clusters among the case studies bear a stronger affinity to the forms of sectoral organization and inter–firm relations that prevail in the film and television industries, than they do to clusters in the ICT sector. In these clusters, the majority of firms is relatively small and operates largely on a project to project basis. Access to a deep and plentiful labour market for the full range of skills required to undertake such projects is often the most valuable input for their continued success (Britton n.d.).

The mechanical engineering clusters are organized around supply chain relations and are grounded in the high quality of the local labour force. The key challenge faced by firms in the cluster is managing their relations with larger, Tier I firms, both local and global, and maintaining access to an adequate supply of highly skilled labour (Warrian and Mulhern n.d.). Specialty food and wine clusters are increasingly focused on their ability to brand higher quality products and successfully move up the value chain. In this case, marketing and brand management skills are the most effective resource that firms in these clusters draw upon, and government programs to help the clusters upgrade these skills have proven highly effective. A key challenge they face is gaining access to large scale distributors for their more specialized products, whether these be private retail outlets or government run monopolies. Cluster policies to enable them to gain this access to expanded marketing opportunities and ensure an adequate

supply of management talent can be the most effective supports provided to firms in these clusters (Donald n.d.).

A number of recent academic and policy reports document the range of relevant policies that flow from strategic planning exercises and can be adapted to the needs of individual cluster. They include: policies to support upgrading the innovative capacities of firms and promote the rapid diffusion of technologies, policies to promote improved networking among cluster actors and foster greater interaction among cluster firms, especially SMEs, and policies to increase the level of management skills and talent among cluster firms, as well as providing much needed mentoring programs for newly minted entrepreneurs. Often local industry associations formed by the cluster help in this role. The formation of angel networks and the attraction of venture capital into the locality can also be supported by appropriate government policies (Feldman and Francis 2004; Porter, Monitor Group, ontheFRONTIER, et al. 2001; Rosenfeld 2007).

One of the most useful initiatives to support cluster development involves the provision of collective services to help cluster firms gain access to crucial knowledge sources or facilities to assist in technology upgrading (OECD 2007, 96). This can involve the establishment of cluster specific information centres to facilitate access to the latest technology developments, as well as cluster–based fora to disseminate market intelligence and help cluster firms exploit new market opportunities. Senior levels of government can assist cluster development through the introduction of cluster specific technology upgrading programs, as well as the creation of collaborative R&D programs or centres. A valuable example of this approach in the Canadian context was the Biotechnology Cluster Innovation Program introduced by the Ontario Government to support the development of biotechnology clusters around the province. Based on initial experiences with the program, it was changed into a set of regional innovation networks in order to provide collective support to a broader cross–section of clusters in key urban centres (Wolfe 2007; Ontario's Regional Innovation Networks 2007). Cluster organizations, working with agencies from federal and provincial governments, as well as local post–secondary institutions, can establish cluster–based technology facilities to provide common access to critical services that can benefit a cross–section of cluster firms (Andersson, Serger, Sorvik, et al. 2004, 96). The establishment of the Photonics Fabrication Centre in Ottawa to support the firms in the local photonics cluster provides a good example of this type of initiative. The federal government in Canada has also supported a number of technology foresight exercises that provided crucial information of benefit to local cluster firms.

One of the critical gaps in building cluster capacity arises from the failure to effectively align cluster resources, particularly research institutions, with the capacities and potential of cluster firms. Two effective ways to overcome this are to involve local civic and cluster leaders

more effectively in the design of national and provincial government research initiatives, such as the creation of Centres of Excellence or programs that finance the provision of advanced research infrastructure, such as the Canada Foundation for Innovation (Wolfe 2005). Senior levels of government can also work with local clusters more effectively to facilitate joint university–industry research cooperation or to create incentives to enhance more effective linkages between cluster firms and local research institutions. In one case study from the ISRN project, interviews with local cluster firms revealed a somewhat surprising, but highly effective means for providing small and medium*–sized enterprises in the local cluster with better knowledge about, and access to, the university's research expertise — that is, the University of Waterloo's widely regarded cooperative education program. Cluster firms identified their coop placements as an invaluable means for gaining information about sources of expertise in various university departments that could help them solve a range of technical problems encountered in modifying existing products or developing new ones (Bramwell and Wolfe 2008).

Given the emphasis placed on the significance of factor input conditions for enhancing cluster competitiveness, not surprisingly, another type of cluster policy that has garnered a lot of attention is that designed to fill gaps in the local supply of factors or upgrade the quality of existing factor inputs. This can take a number of different forms. Local economic development officials and cluster organizations can target their investment promotion activities towards improving linkages within the cluster that are considered weak or relatively underdeveloped. They can also target inward investments to help fill gaps in the local supply chain, or attract major new R&D facilities to the region to build on existing capacity or create new ones (Andersson, Serger, Sorvik, et al. 2004, 96). An interesting variation on this approach involves current efforts underway by the Toronto Region Research Alliance (a coalition of the major research universities in the Greater Toronto/Waterloo region) to identify existing clusters of research expertise and use the information in support of investment attraction efforts to draw leading firms into the region. A number of examples already exist of major multinational corporations such as Google and IBM that have located new facilities in the region or expanded existing ones to draw upon the deep pool of talent available from local research universities.

A critical factor input for cluster strategies is the quality of the local labour pool. A plentiful supply of highly skilled personnel, particularly in occupational fields of value to cluster firms, can act as a strong inducement to inward investment and as an invaluable asset to help cluster firms grow and expand. Numerous cluster initiatives target the upgrading of skills and capabilities in the local cluster as a key strategy. This can take the form of encouraging local universities and colleges to introduce specialized training and educational programs geared to the needs of cluster firms, the establishment of cluster skills centres or the formation of regional

skills alliances (Andersson, Serger, Sorvik, et al. 2004, 96). The recent report on cluster policies by the National Governors Association and the Council on Competitiveness notes that, "training networks are one of the most widely used cluster specific resources. Offering company training through consortia, also called skills alliances, rather than to one company at a time makes programs more affordable to smaller firms and encourages them to invest in training" (Rosenfeld 2007, 17).

Entrepreneurship and Management Skills
Numerous cluster studies, including those conducted as part of the current ISRN project, affirm the centrality of entrepreneurship for cluster success. The way in which entrepreneurship evolves over the cluster life cycle is highlighted in the models discussed above and a key challenge involves the need to help dynamic entrepreneurs make the transition into effective managers. The National Commission on Entrepreneurship in the U.S. found that entrepreneurs thrive in regions where they can network easily with other entrepreneurs. Frequently, cluster associations provide an inexpensive and convenient forum where local entrepreneurs can meet and interact. A critical challenge faced by the founders of new business is their lack of an extensive network of contacts — a deficiency that entrepreneurial networks and cluster associations can help overcome. Peer to peer learning represents one of the most effective mechanisms that allow cluster entrepreneurs to share some of their hard earned knowledge. These organizations can also offer cluster entrepreneurs access to some of the key resources needed to grow their firms, including seed capital, technology, mentoring and potential customers. These networks provide a nurturing environment in which potential civic leaders can gain the knowledge and skills needed to support their local clusters. And, as noted above, they also help frame a common perspective on the challenges facing the local cluster, which is a crucial requirement for the success of strategic planning exercises (Pages and Garmise 2001; SSTI 2006).

As cluster firms grow and expand, the set of managerial skills required to maintain their momentum changes significantly. A key barrier that they often encounter is an adequate supply of the critical management skills needed. The ISRN study identified several different types of management knowledge, in addition to purely technical knowledge, that cluster firms require to succeed. Expanding firms confront a critical range of issues that include the need for more sophisticated human resource management skills, improved information about existing and potential competitors, expanded sales capabilities, more effective inventory and supply chain management and more sophisticated use of information technology resources. This is one of the least well documented, but critical elements, for cluster firms. Closely related to this is knowledge about external market conditions. For small and medium–sized enterprises, an

essential piece of knowledge they must acquire to expand concerns the competitive conditions in external markets and which ones constitute the most suitable targets for expansion. Entrepreneurial skill and market information can be transmitted through the cluster via a variety of mechanisms — some formal and some informal — but one of the most useful is peer–to–peer mentoring and knowledge sharing that is organized through local cluster or civic associations. This is also a policy area where local universities and colleges can play a role, often with the backing of state or provincial governments, in expanding training and research programs in the areas of greatest need (Wolfe and Gertler 2004).

Conclusions

There are no quick and easy solutions to the numerous challenges faced by individual clusters, nor should the adoption of cluster strategies and policies be mistaken as a panacea for solving all of the clusters' problems. As Martin and Sunley have warned, both academic researchers and policy analysts must guard against the danger of being seduced by the lure of the 'cluster brand' at the expense of serious analysis of whether the role of clusters actually contributes to sustained economic development in local and regional economies (2003). The most dynamic clusters view their strategies as part of an iterative process that must constantly be revisited and adapted to changing circumstances and competitive positions. Just as failed entrepreneurial ventures are taken as an indicator of acquired experience, so too must the refinement of cluster strategies be viewed as a reflexive exercise, where critical lessons are learned from past failures and mistakes, and new initiatives are designed to overcome failures and to build on areas of success.

Successful cluster initiatives exhibit a common set of characteristics. They are able to recruit and rely upon strong, local civic leaders and business champions. Government can play a supporting role for the cluster, but cluster initiatives that rely excessively on government for leadership have difficulty sustaining their momentum. Successful initiatives build the need for renewal and refocusing into their agenda from the outset. Cluster strategies that take too long to produce results can fail by attrition, as key participants lose their energy and commitment and fall by the wayside. It is essential to target small, achievable steps from the outset to provide concrete and measurable indicators of success for cluster participants. Finally, policy alignment can be highly effective for cluster strategies; strategies that require the implementation of major new programs by senior levels of government or require substantial budgetary commitments are likely to founder on the complexities of the public sector budgetary process. Often cluster initiatives can succeed by tapping into existing government programs and budgetary envelopes to access needed resources, or by co-opting new federal, provincial, or even, private sector initiatives and aligning their objectives to meet the goals of the cluster strategy. In this respect,

cluster strategies should be viewed as focusing devices; the greatest benefit can sometimes be derived from using the cluster strategy to align existing policies at the national and regional level more effectively to support firms in the local cluster.

There is no simple or comprehensive recipe for designing and implementing cluster strategies and policies, but the results of the ISRN case studies, and the numerous international policy documents cited in this paper, provide evidence that these goals are achievable. A final challenge for cluster policy is the need for policy continuity. Because electoral and policy lifecycles are shorter than cluster lifecycles, volatility or lack of continuity in the policy environment can destabilize the process of cluster development. Cluster policy is clearly one area where perseverance has the potential to deliver great rewards.

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