Survive or die? Knowledge and learning for innovation as the keys to adaptability in organizations and regions

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Introduction

This paper combines two distinct approaches to understanding processes of learning and knowledge integration for innovation. First, studies of intra-organization knowledge-sharing which focus on the integration of specialist knowledge and expertise for new product or process development. Second, studies of inter-organization knowledge-sharing across entrepreneurial networks, as a source of new business development at the regional level.

Despite being largely separate these literatures show strong commonalities between the micro-level and macro-level routines, processes and networks through which specialist knowledge and capabilities are developed and combined for innovation. More specifically there is evidence at both levels that these same characteristics can either facilitate innovation, adaptability and regeneration or inertia, atrophy and decline.

Building on recent research a unifying framework is presented which allows us to examine four specific elements of the 'knowledge base' of both organizations and regions: agency, routines, capabilities and knowledge. This is used to argue that the presence or absence of what we term *latent* agency, routines, capabilities and knowledge in organizations or regions directly affects their adaptability and innovative capacity in the face of change. Latency represents the potential for a system to adapt.

A central aim of the paper is therefore to contribute to theory-building, partly by proposing a unifying framework to conceptualise the knowledge base and its components at multiple levels of analysis. By building on past empirical studies by the author and others it also aims to identify similarities in studies of knowledge, learning and innovation at these different levels. Together these can be linked to broader themes of

adaptability, serial regeneration, growth and development, versus embeddedness, inertia and atrophy of organizations, regions and socio-economic systems in general.

Theoretical foundations

The knowledge base of organizations and regions

The 'knowledge base' of an organization or region is comprised of individual human knowledge resources and mechanisms of interaction, including channels for individual and group learning, knowledge exchange, integration and application or leveraging (building on studies of individual organizations; Coombs and Hull 1998; Metcalfe and De Liso 1998; Leonard-Barton 1995). Flows of knowledge are determined by the characteristics of knowledge itself and the capabilities and interests of individuals (such as entrepreneurs) who develop, share and leverage knowledge for particular purposes in particular organizational or regional contexts (Alvesson and Karreman, 2001; Tsoukas and Vladimirou, 2001; Collinson, 2001, 1997; Rulke and Galaskiewicz, 2000).

At both levels of analysis the idea of network knowledge or 'know-who' (linked to the concept of 'transactive memory', Rulke and Rau 1997)**,** the network location of specific kinds of complementary knowledge is important. Similarly, knowledge of routines and procedures for communicating or acquiring knowledge, or co-opting specialists for knowledge integration, is also relevant.

There are a range of more-or-less effective mechanisms and 'control routines' and incentives (related to hierarchies, networks or markets) that align such individuals to a set of shared objectives. The development, absorption, assimilation, (re-)combination, distribution, application and leveraging of knowledge to achieve the objectives of individual agents or organizations are therefore seen here as predominantly people-based activities, requiring direct interaction between specialists. (Cohen and Levinthal, 1990; Hislop et al., 2000).

Entrepreneurial networks within regions

Whilst much of the work on knowledge-integration for innovation has been conducted at the intra-organization level there are clear parallels with studies of high technology 'clusters', 'agglomeration economies' or 'innovative milieu'. Innovation studies have examined the distinctiveness of regional institutional infrastructures and mechanisms for interaction, coordination and learning mainly through contrasting 'national systems of innovation' (Edquist, 1997, Freeman, 1995; Lundvall, 1992; Nelson, 1993). The regional implications of networks for the success or failure of agglomeration economies has long been a focus of studies in the field of economic geography (Coe and Townsend, 1998; Cooke et al., 1998; Malecki and Oinas, 1999; Oakey et al., 1999). Both areas of study have strong links with regional economic development policy literature.

The ideas of requisite critical mass and requisite connectivity are seen to be central to the propensity for regions to be innovative, adaptive and economically successful. These ideas can be applied in conjunction with the above knowledge-based approach.

Entrepreneurial network theory that suggests that strength, complexity and diversity of business relationships influence newly formed enterprise performance, resulting in improvement of the longer term chances of firm survival and growth (Shahidi, 1998; Tremblay, 1998). Monsted (1993) distinguishes between three types of networks, with each serving a different function for the entrepreneur: networks for service and assistance; networks for information and structuring, particularly for knowledge about whom to contact for a specific purpose; and networks for entrepreneurship and product development. In addition to a supply of resources, networks provide social support and self-confidence and strategic capacity to learn and organise for new activities (Johannisson, 1995). Effective network participation, however, requires communication skills, trust, co-operativeness and other capabilities in the entrepreneur (Pihkala et al., 1999).

The value or 'tradability' of different kinds of knowledge in different contexts (Fleck in Williams et al., 1998) and the long-standing link made between knowledge and power are important factors directing flows of knowledge in networks (Hislop and Newell, 2000). The notion of 'social capital' has long been used to encompass many aspects of the socially-constructed and mediated nature of knowledge and expertise (Fincham et al., 1994).

Latency and Adaptability

Expanding on the above characterisations the framework presented here incorporates the ideas of agency ('purposeful intent'), capabilities and routines. A variant of Nelson and Winter's (1982) conceptualisation of routines is adopted. In particular 'self-reflection, self-renewal and restructuring routines', used for examining and changing lower-order routines in response to external change, are used here to explore the adaptability question.

Amongst a variety of purposes served by the knowledge base this paper focuses on innovation to provide the link between these components and performance or sustained competitive advantage at the firm or regional level. As proposed by Feldman (2000) and Feldman and Pentland (2003) whilst routines can be perceived to be constraining influences on innovation and change (as core rigidities; Leonard-Barton, 1992; underpinning path-dependency; Coombs and Hull, 1998), they can also be a source of change and innovation (Zollo and Winter, 2001). A central question is the degree to which routines are conductive to change and innovation, or do they represent sources of inflexibility and embeddedness? (Dore, 1986, used the term 'flexible rigidities'). The above elements, knowledge, agency, routines and capabilities within organizations or regions, having evolved over significant periods of time, can facilitate efficiency and may stimulate change, but also give rise to a strong path-dependency and inertia.

To understand this better the term latency ('dormant, but capable of development') is introduced. Studies of capabilities, knowledge and routines show that not all of these resources are drawn upon all of the time in organizations. Managers draw selectively

upon a repertoire of resources which are aimed at supporting strategic decisions (Hickson et al 2003). Other capabilities, knowledge and routines are "inert" and can represent a 'portfolio of options or platforms for future development' (Kogut and Zander, 1992:385). Here we use the term *latent* to describe this platform of resources. To mobilise these latent resources need a form of agency which can be endogenous (managerial) or exogenous (environmental or legislative) (Feldman, 2000; Feldman and Pentland, 2003). (Winter has a slightly different concept of learning 'aspirations', 2000:987).

Figure 1 presents two simple stereotypes that can represent individual organizations or regions. The different ratios of active to latent agency, routines, capabilities and knowledge result in different degrees of adaptability in the face of change, whether endogenous or exogenous. The 'more adaptable' type can draw on a latent pool of these kinds of resources should the need arise. It is flexible and responsive. The 'less adaptable' type, whilst arguably more 'lean' and efficient in stable contexts, has a more limited portfolio of these resources to draw upon and is therefore more prone to inertia. The dimensions in Figure 1 are defined in the following ways:

- *Active routines, capabilities, agency and knowledge*: these are the existing resource base and characteristics of organization, such as structure, procedures, culture.
- *Latent routines*: practices or mechanisms that can be drawn upon and activated should there be a change in strategic direction of the organization.
- *Latent capabilities*: a combination of latent routines and knowledge which can be drawn upon to formulate and to help implement a new set of strategic objectives.
- *Latent knowledge*: the total pool of available knowledge characterised by such factors as experience, education, skill and expertise as well as training.
- *Latent agency*: the un-activated aspirations or motivations of agents such as managers, governments or other stakeholders.

Capabilities can be seen as a combination of resources and routines, which exist and evolve in a specific organizational context. Particular kinds of capability stem from the

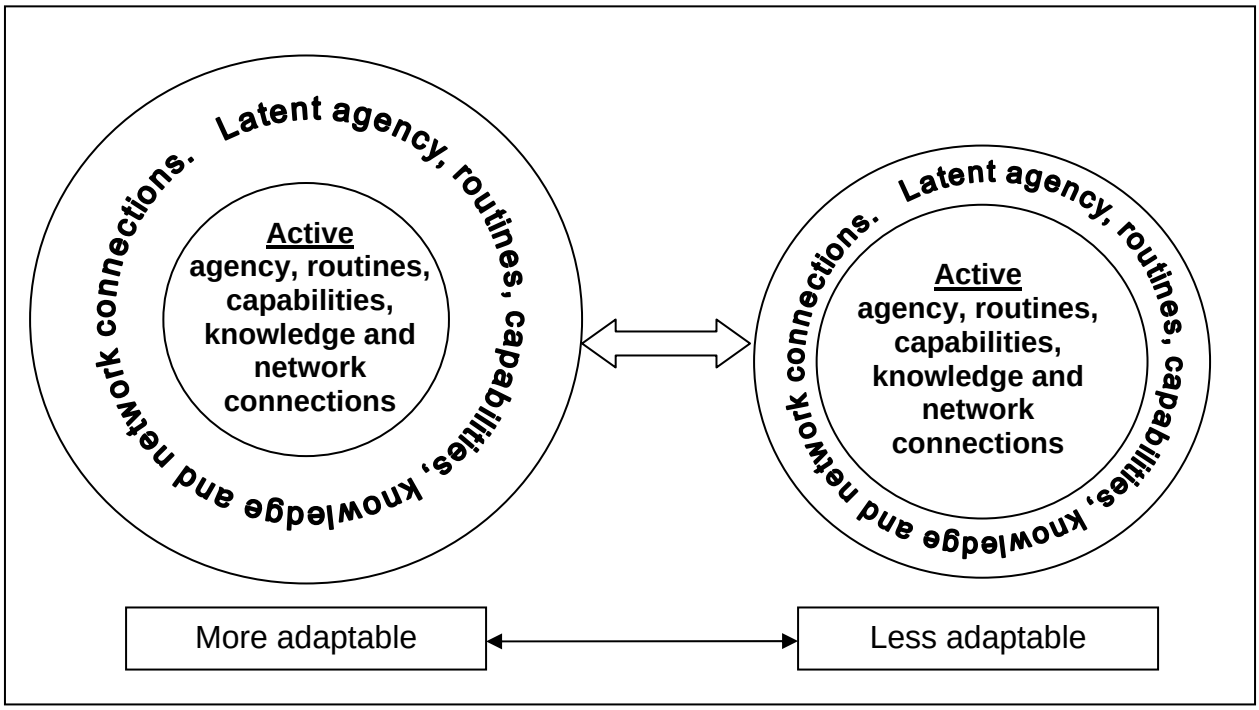
way in which firms integrate and jointly-operate different kinds of routines (Metcalfe and De Liso, 1998). This captures the complex, organization / context-specific and dynamic nature of capabilities.

Network connections reflect the scale and scope (variety and density) of different networks for accessing complementary knowledge and capabilities. These can similarly be active or latent or absent. An individual entrepreneur may actively use a variety of contacts across intra-organization or inter-organization networks to develop a technology, or product or improve a process at any one time. The same entrepreneur will be able to activate latent connections if the need arises, but may have to search for new connections and/or networks should the existing ones not be sufficient.

Control routines are also referred to as part of this approach. Although the term ‘control routines’ has appeared in a variety of studies, such as Birkinshaw and Fey (2000) the term used here draws mainly from the ‘political economy of expertise’ tradition epitomised by Hull (2000) who examines ‘discipline’ and ‘practices’ as distinctive influences on the ‘conduct of expert labour’.

Finally, in taking this approach we make certain assumptions about the availability of sufficient resources, financial and material, to support innovation initiatives. We also assume there are ready markets, local, national or international for the product or service in question. Whilst acknowledging that without these elements in place successful innovation would not take place we are focusing on the dimensions in Figure 1. This analysis is therefore concerned with ‘routine rigidity’ rather than ‘resource rigidity’ as a key cause of path dependency (Gilbert, 2005). In various ways the studies reviewed below focus on routines as the most observable and comparable organizational mechanisms for handling knowledge for corporate purposes.

Figure 1: More and Less Adaptable Organization Systems
(Adapted from Collinson and Wilson, 2006)



Empirical foundations

This paper draws on a number of past studies to illustrate the various components of agency, routines, capability and knowledge for innovation or inertia at both levels. At the intra-organization level the main evidence comes from comparative studies of the management of innovation in Japanese, UK and European manufacturing firms (Collinson and Wilson, 2006; Collinson, 2001a, 2001b, 1997). At the regional level two previous studies of knowledge networks, learning and high-technology entrepreneurship in Scotland form the basis of the findings discussed below. One examined the Scottish software industry (Collinson, 2000) the other was an international comparison of entrepreneurship network promotion (Collinson and Gregson, 2003). Because the regional studies also examined individual case study firms, as well as inter-organization networks, they provide a useful bridge between the two levels of analysis. Both intra-organization and inter-organization knowledge networks and routines were studied.

It is important to note that these studies were not designed to be comparative and each had a different set of initial objectives. However, they share a common knowledge-based approach which was concerned with understanding the multiple connections between capabilities, knowledge, networks and routines for innovation. Each study is briefly outlined below then the combined findings are discussed in terms of the main objectives of this paper: (1) mapping the similarities and differences between the intra-organization and regional levels of analysis, and; (2) explaining sources of rigidity, inflexibility and inertia that appear to be important at both levels.

Inter-organization study (1): An international comparison of local entrepreneurship promotion

This study compared three organizations established to promote new business start-ups in the USA, UK and Canada. A 'knowledge-based' approach was adopted to examine how networks of would-be entrepreneurs interacted with networks of experienced entrepreneurs and managers, venture capitalists, technical experts, consultants, IPR lawyers and other specialists. The Austin Technology Incubator (ATI), Texas; CONNECT, Edinburgh; and the Canadian Environmental Technology Advancement Corporation (CETAC-West) in Canada all promoted this interaction, acting as local network-nodes or 'knowledge integrators', as well as 'incubating' new ventures to increase the new business 'birth rate' in their respective regions (Collinson and Gregson, 2003).

At the heart of the study we held semi-structured interviews with 113 members of the CONNECT network and compiled in-depth case studies of 6 technology-based firms in central Scotland. This was supplemented with matching (though less comprehensive) studies of ATI and CETAC-West. All focused on the initiation, development, operation and local impact of these organizations.

The findings of the CONNECT study stress the importance of the regional context as a source of particular kinds of knowledge and expertise that may promote or inhibit new

technology-based business start-ups. In particular: the scale, scope and quality of ideas and business proposals in local networks; the availability of relevant expertise and experience for 'intelligent selection' and for successful mentoring; the nature of rewards and incentives for all players; and the importance of local champions or figureheads, were all factors that helped explain differences across the example regions (Collinson and Gregson, 2003).

As expected, rapidly-evolving markets and technologies increase the level of uncertainty for new technology-based firms (as noted by Oakey et al., 1999 amongst many others). For start-ups attempting to commercialise new internet or e-commerce related products or services, for example, a complex and continually changing array of both technological opportunities and threats and market opportunities and threats places a premium on 'integrative mechanisms' for combining relevant knowledge from various 'knowledge networks' to steer the research, development and commercialisation process (Collinson, 2000). Innovation is where technological and market opportunities coincide and in these kinds of highly dynamic environments it is more usefully viewed as an interactive learning process. The 'interactive' or 'coupling' model of innovation, as opposed to the 'linear model', has been shown to be more appropriate in such contexts (Asheim and Cooke in Malecki and Oinas, 1999).

This provides a role for CONNECT and the other organizations examined in this study. Metcalfe in Archibugi and Michie (1997) explains this in evolutionary economics terms, linking the need for market intervention to support innovative capacity with 'information asymmmetries' which are heightened in times of rapid change. Networks for particular kinds of information, knowledge and expertise are most important in such times, for such firms to maintain adaptability and survive.

This study concluded that the contribution of CONNECT could be best conceptualised by the term 'accelerated learning'. The ability of local entrepreneurs to continuously and successfully adapt their core technology or product idea to evolving markets, to explore and build partnerships with other technology developers, to make informed assessments

of available sources of finance, to find specific sources of advice on the constitution and managerial development of their ventures and in general to fill critical gaps in their own knowledge, was enhanced by the activities of CONNECT in Scotland, the ATI in Texas and CETAC-West in Canada. The 'integrative capabilities' of local entrepreneurs, their ability to search, filter, assimilate and integrate knowledge from a huge variety of sources has been improved by the activities of these three organizations. The huge 'transaction costs' which make the learning curve that much steeper and the process of reputation-building so much harder for such firms are subsidized through their access to these established and credible networks and continuous networking activities.

Beyond the activities of these organizations, however, the relative strengths and weaknesses of regional networks themselves underpin the overall potential of the innovation systems in these respective regions. This includes what has been termed 'institutional thickness' in the literature (Malecki and Oinas, 1999) which influences the volume and variety of entrepreneurial learning that can take place locally.

Inter-organization study (2): The Scottish software industry

This study adopted a sociotechnical constituencies (STC) approach to examine nascent firms in the Scottish software industry. The STC approach views new technologies and technology-based firms as 'dynamic ensembles of technical constituents (tools, machines, etc.) and social constituents (people and their values, interest groups, etc.), which interact and shape each other in the course of the creation, production and diffusion (including implementation) of specific technologies' (Collinson, 2000; Collinson and Molina 1998; Molina 1993).

In the context of this paper a new business venture can be treated as a constituency-building process consisting of many sub-processes, involving a variety of interrelated technical, organizational and commercial factors. These sub-processes can be configured, and reconfigured as they continually evolve, in a huge variety of possible ways, as they influence the emergence of new technologies. The approach emphasises the idea of

interrelation and interaction, including knowledge integration, between key players in technological development. The type of interactions between different sets of social constituents, across a variety of networks, is critical to the performance of sociotechnical constituencies.

In-depth case studies of 5 high-tech. firms, including three University of Edinburgh spin-off companies were compiled by the author. A series of interviews were held in each firm with Directors/Managing Directors (and founders where possible), project managers and researchers. One case study, involving more than 10 interviews, focused on a Dundee games software company, DMA Design, the original creator of an early PC game called ‘Lemmings’ and, more recently, ‘Grand Theft Auto’.

As expected, managers in this study emphasised the importance of both markets and finance as critical components of success in new high-tech. ventures, similar to entrepreneurs in other sectors. But the study also highlighted two other kinds of closely-related, complementary knowledge that appeared to be particularly important for entrepreneurs in multimedia companies and other high-tech. sectors. The first can be described as strategic knowledge, knowledge and information to support strategic decision-making. The second was 'knowledge of knowledge' or knowledge of where specific kinds of expertise can be found. The success of these specific types of ventures was therefore strongly dependent on the existence of specialist networks which acted as accessible, reliable and cost-effective sources of this knowledge (Collinson, 2000).

Adaptability is clearly central to the success of new ventures of this kind. Entrepreneurs are engaged in a continual, iterative re-positioning process which relies on the above kinds of knowledge. Both studies show that intervention by Scottish Enterprise and other regional agencies has largely failed to generate the kind of high-technology growth that other regions have experienced. The region’s strong science and technology base appears not to be translating into local commercial ventures through technology transfer or spin-off companies.

Both of the above studies conclude that a key weakness is the limited size of the region and the limited density of network connections in Scotland. Economies of scale and so-called 'agglomeration economies' stem from the variety of interrelated firms, technologies and types of specialist expertise at one location. The scale and scope that generated the requisite variety in the archetypal Silicon Valley region contrasts the relatively limited number and variety of interactions possible in Scotland, with fewer firms and specialists and a more fragmented pattern of interconnections.

Intra-organization study (1): Knowledge integration for new product development at Sony and Philips

Two matched multimedia (interactive-CD) product development projects were compared in this study, through a series of over 30 semi-structured interviews at Sony and Philips in the mid-1990s. Firms in this industry during this period had to respond to rapidly-changing markets and technologies which placed a premium on their ability to integrate specialist knowledge and expertise internally and from outside, to develop new multimedia products.

Harnessing the collective knowledge of the firm, when it is fragmented across specialist divisions around the firm, is difficult but critical to successful product development. Intra-firm knowledge integration is problematic in the same way that knowledge transfer been firms has been described as difficult, because knowledge itself is tacit, specialist and embedded in the context of host organizations (Polanyi, 1966; Metcalfe and Gibbons, 1989; Vicenti, 1990; Nonaka and Takeuchi, 1995).

The comparison showed that Sony had evolved a number of organizational mechanisms that appeared to facilitate flexible integration of both technological and market knowledge to guide the new product selection and development process. Philips, using a more conventional stage-gate, cross-functional process, had a range of organization constraints limiting the speed and flexibility of this process (Collinson, 1997; Collinson and Molina, 1998).

'Merchandisers' were new product 'enthusiasts' who acted as internal boundary-spanners, product champions and knowledge integrators. Sony also had in place a particular organizational culture, incentive structures and resource-allocation mechanisms to both encourage new ideas and filter the viability of new initiatives. More general organizational characteristics such as job-rotation, life-time employment, mentoring structures and external *keiretsu*-related networks at Sony facilitated these mechanisms.

Intra-organization study (2): The management of innovation in British and Japanese steel firms

This study, together with the two described below, were part of a three-year program comparing 8 matched British and Japanese firms: BT, ICI, British Steel and BAE and NTT, Sumitomo Chemical, Nippon Steel and JAE. The study included a questionnaire completed by R&D managers and an average of 12 interviews in each of the 8 firms, with managers, engineers, scientists and researchers. The interviews focused at two levels (1) the broad structure of the firm, examining the governance and procedures relating to links between central R&D, technical support departments, business units and manufacturing operations; (2) one or more detailed matched analyses of particular projects and/or a set of relevant management procedures to provide a "window" into the detailed organization of a particular innovation activity. This ranged from more basic, blue-sky R&D to applied, incremental or continuous improvement practices in manufacturing. As well the UK-Japan comparisons the study revealed cross-sector similarities and differences in the management of innovation. Two examples are summarized below to illustrate the approach taken and the findings from these comparative studies.

One of the matched UK-Japan company pairs, British Steel Strip Products and Nippon Steel Corporation, were involved in an alliance to help the UK firm improve its plant-level procedures for product and process development (Collinson, 2001a, 1999). The alliance proved successful and clear improvements in defect rates, productivity and product quality were achieved through learning from the higher-performing and more

productive Japanese company. Some practices, however, proved to be difficult or impossible to "learn" or develop in the organization context of the British firm. As a consequence strip steel plants at the British firm never reached the levels achieved by the Japanese firm, using industry-standard measures of defect-rates, output quality and productivity.

The approach focused on how differences in the organization context influenced knowledge-management capabilities, innovation and dynamic capabilities at British Steel. The findings highlighted important differences between the two firms, including aspects of managerial power and employee motivation, which influenced how specialist knowledge was developed, deployed, integrated and "leveraged" for manufacturing innovation. These contextual factors underpinned sustained differences between the firms and were therefore taken to represent sources of competitive advantage or disadvantage. Moreover, because of their 'embeddedness' (to use Lam's term; Lam, 1997) these characteristics were seen to contribute to inertia and path-dependency.

The study revealed aspects of the relationship between specialized knowledge, its integration and exploitation via innovation-related routines, and organizational control routines which acted as both facilitators and constraints. For example, specific kinds of expertise were present at British Steel but the routines for exploiting such expertise for process innovation were often not. Plant-level personnel were sometimes not motivated or faced organizational constraints limiting their contribution to continuous improvement initiatives, despite their obvious capabilities.

Beyond the plant-level the strip products division there were disconnects with key customers, including Toyota at Burnaston, which constrained customer-led product improvement and new product development. Respondents revealed latent knowledge and capabilities were present in a variety of departments at British Steel, but the routines to exploit these for customer-led innovation were lacking, compared to Nippon Steel's *keiretsu*-style connections with Toyota (Collinson, 2001a, 1999; Collinson and Wilson, 2006).

Intra-organization study (3): The management of innovation in British and Japanese chemicals firms

This study compared ICI and Sumitomo Chemicals in terms of: (1) the procedures governing recruitment, training and career-progression for R&D-related personnel; (2) the management new product development projects, involving cross-functional teams of specialists; (3) the routines adopted to coordinate between central R&D laboratories and market-facing business units (BUs); (4) involvement in collaborative R&D and joint product development projects with outside organizations (Collinson, 2001b).

The comparison showed that the Japanese firm had developed 'integrative capabilities' that supported a closer interface between R&D and the BUs and which in turn strengthened certain innovation-related capabilities. Some of the findings confirmed those of the well-known auto-sector comparisons that showed Japanese car companies have developed efficient cross-functional project management practices for new product development, compared to their Western counterparts.

By comparing individual innovation projects in each firm, key organisational characteristics were identified in the study that: (1) strongly influenced knowledge development, distribution, integration and utilisation in both the British and the Japanese firm; (2) differed considerably between both firms, and; (3) appeared to strengthen the 'integrative capabilities' of the Japanese firm, providing a more effective interface between R&D and the BUs. These characteristics were: career paths for R&D personnel and the particular systems for cross-functional job rotation, training, evaluation and rewards; project and personnel financing mechanisms, where Sumitomo Chemicals used a central (‘top-slicing’) system and ICI used a direct contracting system with BUs; mechanisms for facilitating bottom-up, informal ‘skunk works’; the internal (cross-functional) and external (buyer, supplier, contractor) networks for creating temporary coalitions of specialists to initiate and commercialise product and process innovations.

Differences across these kinds of routines and control routines led to the evolution of different kinds and combinations of knowledge and capabilities, suitable for particular portfolios of R&D projects. As a result we found that the Japanese firm, in keeping with the wider literature on cross-national differences in innovative capabilities, had clear strengths in incremental and customer or supplier-led innovation. Integrative capabilities had evolved partly at the expense of specialist capabilities. However, central R&D functions also have the role of creating new products and technologies (and developing the relevant knowledge and expertise) to maintain competitive advantage in the future, under conditions of uncertainty (and therefore risk), independently of the immediate market demands of BUs. Independent, blue-sky or science-led innovation appeared to be a weakness of the Japanese form of organisation and was the subject of a follow-up study described below.

Intra-organization study (4): Failure to adapt at Nippon Steel and Sumitomo Chemicals

Building on the previous UK comparisons a follow-up study was conducted to compare the progress of these two Japanese firms in their attempts to restructure in the face of a sustained domestic market recession in Japan. Both had explicitly targeted science-led diversification and internationalisation during the mid-1990s to revive their fortunes and both failed to achieve these aims.

Reported in Collinson and Wilson (2006) this study focused on the causes of inertia and path-dependency that prevented Nippon Steel and Sumitomo Chemicals from achieving their strategic aims. Relative to their British counterparts these firms were found to have strongly-embedded, context-specific capabilities and routines coupled with deeply-set network connections, both internally (across functions) and externally (across suppliers and buyers). These had been a strength in terms of being ‘fit for purpose’ during the era of a stable and successful Japanese economy and co-operative *keiretsu* networks, but at the expense of flexibility and adaptability during times of change.

The approach identified a lack of latent (specialist rather than integrative) knowledge, capabilities and routines required to innovate in a way that would respond to external changes. The Japanese firms had a particular set of dynamic capabilities appropriate to the (more minor) level of change in the pre-recessionary environment but not the kinds required for following a science-led business differentiation strategy, or internationalise away from the domestic market. This confirmed Nelson and Winter's (1982) central, yet largely unproven, proposition that a 'narrowing of the repertoire of routines' exercised and remembered by individuals or groups may result from a stable external environment, leaving organizations 'unfit' in the face of more radical change.

Discussion: Intra-organization and Inter-organization Levels of Analysis

The first aim of this paper is to map differences and similarities between the intra- and inter-organization levels of analysis; the second is to examine the nature of latency and adaptability at both levels. We will discuss each in turn in this section.

Differences and similarities?

When we compare the characteristics identified in the intra-organization and inter-organization studies above, using the dimensions listed in Figure 1, we find a range of differences and similarities. Table 1 summarizes these, with characteristics listed in bold being found just at the inter-organization level and those in italics at the intra-organization level. The rest are found at both levels of analysis.

Table 1: Active, latent or absent dimensions of innovation at the regional and/or organizational levels

Dimensions of innovation	Examples (active, latent or absent) at the regional (**bold**) or organizational (*italics*) levels, or both (normal text)
Agency	• **Venture capitalists** • **Government departments** • **University academics** • Competitors, suppliers, alliance partners • Entrepreneurs • Engineers, technology specialists or marketers • *Line managers / department heads / functional heads*
Individual capabilities & knowledge	• Specialist scientific or technological, product or process-related knowledge and expertise • Market / user–related • Finance-related • Managerial, operational and strategy-related • Knowledge of relevant routines and procedures to achieve objectives • Network capabilities; knowledge of sources of assets, materials, finance ('knowledge of knowledge' or 'know-who')
Routines for learning and leveraging knowledge for innovation	• Building team to combine specialist expertise • Developing products, processes; prototype trials, benchmarking etc. • Linking with users and markets • R&D trials • Training and career-development activities • *Cross-functional, team-based projects*
Control Routines	• **Venture capital financing procedures (and others like AIM, business angels etc.)** • **Promotion events, meetings, workshops, training** • **Government subsidies and support** • *Financing and budgeting mechanisms for capital allocation.* • *HRM systems & incentives, organizational structure/architecture, project management procedures etc. for the allocation of roles, responsibilities, reporting lines, personal training and development resources* • *Project management and performance measurement*
Networks (formal and informal)	• Financial: venture capitalists, angels, banks etc. • Scientific, technological and R&D-related (Universities, specialist suppliers, consultants etc.) • Materials, resources, inputs suppliers • Government-related

In addition to these attributes at the regional or organizational level we make certain assumptions about the availability of certain kinds of resources, financial and material to

support innovation initiatives. We also assume there are ready markets, local, national or international for the product or service in question. These basic building blocks are seen as minimum requirements for innovation. In this sense the approach focuses on routine rigidity rather than resource rigidity as a key cause of inertia. Both have been the subject of research independently and in combination, most recently by Gilbert (2005).

The major differences in Table 1, as we would expect, relate to the forms of agency and the types of control routines that dominate the different levels of analysis. With both dimensions there are parallels with the literature on markets versus hierarchies (Williamson and Winter, 1993). There are different actors at the regional level driving innovation initiatives for a variety of reasons, from pure speculative profit in the case of venture capitalists, to the regional economic policy remit of government departments or the technological ambitions of scientists and engineers. The nature of agency within individual organizations is equally complex once we move beyond the simplistic 'profit-maximisation' rationale. The R&D personnel in the firms described above were motivated by a wide range of incentives and supported or constrained by a variety of control routines.

Control routines also differ depending on the level of analysis. Arguably, a distinctive combination of communication, coordination, guidance, governance and incentive mechanisms, systems and procedures are one of the defining characteristics of an individual organization. Both agency and control routines were mapped effectively by the STC approach we used in two studies to illustrate the shifting array of interest groups, interactions and incentive mechanisms influencing the evolution of new technologies or products.

Finally, as anticipated, we can observe both differences and similarities in the kinds of networks used for integrating specialist knowledge and capabilities for innovation at the intra- and inter-organization levels. The firms studied all used extensive external networks, with suppliers, users, joint-venture partners and specialist contractors as we

would expect from the extensive literature on sources of innovation at the firm level. So the significant overlap in networks used at both levels was clear.

Beyond the characteristics listed in the table there are various other similarities between these levels of analysis. Innovation-related initiatives within firms progress through a lifecycle or stage-gate process similar to that of the new entrepreneurial venture at the regional level. Idea-generation, selection, refinement depend on a combination of network connections and the control routines which determine which initiatives will be allocated resources. Both the literature examining new product development practices in firms and the literature focusing on entrepreneurship and regional agglomeration development contain parallel notions of efficiency and effectiveness in network connectivity, critical mass and flexibility or adaptability in the face of change.

Adaptability, latency and sources of inertia

Figure 1 illustrates two archetypes of more or less adaptable intra- or inter-organization systems based on the concept of latency, to better-understand sources of inertia and path-dependency. Again, based on the empirical studies reviewed above, there are key similarities as well as some differences in the characteristics of latency and apparent sources of inertia at these two levels of analysis.

The Government-subsidized activities of CONNECT in Scotland measurably improved network connectivity by introducing routines (conferences, workshops, events, contact databases and mentoring programmes) that increased interaction between technology specialists, venture capitalists, marketing experts, experienced entrepreneurs and would-be entrepreneurs. However, this made little impact on the actual high-tech. business birth rate, relative to the other two regions studied in Canada and Texas. Both the CONNECT study and the Scottish software study show that the region does not have the requisite variety of specialist knowledge, or the critical mass of venture capitalist financing to fuel this kind of growth. Resource rigidities, the absence certain kinds of agency (speculative

financiers) and particular kinds of knowledge, not routine rigidities appear to be the stronger influence underpinning regional inertia in this respect.

At the intra-firm level, however, routine rigidities were found to be the chief cause of path-dependency, again in some cases alongside the absence particular kinds of latent knowledge. Agency was strong in all firms, in the form of the strategic intent at divisional and corporate levels, supported by resources. At Philips and Sony the strategy was clear and resources allocated to drive new multimedia product development, yet Sony succeeded where Philips failed. Nippon Steel and Sumitomo Chemicals had an explicit strategy of internationalisation and technology-led diversification and were directing resources and effort toward these yet also failed.

At Philips the lack of routines and control routines to support the knowledge integration required for successful multimedia product development amounted to a weakness in dynamic capabilities, relative to Sony. Sony's dynamic, integrative capabilities, based on cross-functional job rotation, mentoring and communication mechanisms, the Merchandiser role, and strong, embedded linkages with both users and technology suppliers were factors leading to its relative success.

Nippon Steel and Sumitomo Chemicals had active agency, knowledge, capabilities, routines and network connections configured closely for the kind of incremental customer-led product development they had relied on for over 50 years. Relative to their 'fitter and more flexible' UK counterparts they lacked latent knowledge, capabilities, routines and network connections to respond to the change in agency, prompted by the domestic market recession. Internal knowledge and networks were cross-functional, not specialist; external network connections were strong but with long-term, domestic suppliers and buyers. Their integrative capabilities were strengthened over time at the expense of specialist scientific and technological expertise required to lead the firm into new technology-based products.

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