Agile supply: rethinking systems thinking, systems practice

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Abstract  
There has been extended debate about how to conceptualise inter-organizational restructuring and the impact of twenty-first century capitalism, giving rise to a number of models that attempt to represent productive change. A number of such conceptualisations of transformation under the banner of “agility” attempt to provide guidance about “managing” physical and social relationships between companies in response to growing market complexity. The theoretical argument in this paper is that inter-firm agility cannot be objectively understood in all cases using simple unidirectional cause and effect as such theories do not take into account more subjective aspects of interaction. Specifically, we argue that there is a significant gap in the literature when theoretical attention has been paid to inter-firm agility. Inter-firm functioning in “agility” frequently involves the application of systems engineering thinking to describe and optimise factor conditions for the transfer of artefacts and information between companies. This approach has been successfully used, amongst others, Mason-Jones et al. (1997). The result is the production of diagrams to describe the interaction between companies using either a physical transfer of materials and/or explicit knowledge (Forrester, 1961). However, it will be argued that tacit knowledge which is captured and transferred in networks is much more dynamic and difficult to codify than “explicit” flows of material or inventory data (Hall and Andriani, 1998). These “invisible” data are often constructed under different and variable regimes of power and trust and constructed unevenly through dynamic human-to-human discourse. These conceptual and often abstract forces are extremely elusive and have been notoriously difficult to measure or predict (see Clegg, 1997; Child and Faulkner, 1998). Such data are often difficult to record or measure, which makes the use of systems theory somewhat inappropriate as a unitary methodology for representing the formation and operation of inter-firm agility. These issues make finding a universal set of laws problematic for this form of intangible interaction.

We suggest therefore that a blanket prescription of systems theory cannot capture the “softer” aspects of interaction. Therefore, it is restrictive as an academic “tool” for the description and analysis of this new area of research in some respects, with other appropriate frameworks needed to capture the essence of inter-firm interaction. This theoretical paper will contribute to the debate by arguing that to have a “vision” of inter-firm agility there must be an appreciation of the complexity in the “grey area” between organisational boundaries. Without this understanding, the analytical methods (see Mason-Jones and Towill, 1999; Christopher, 1992) for describing and intervening in “agile” supply networks will not capture the essence of spatially or virtually agglomerated firms operating under the principles of agility.

Introduction  
As an allegedly “new” concept “agility” has increasingly been associated with manufacturing organizations seeking to secure competitive advantage from a production system that can be both responsive and efficient. Concepts concerning the satisfaction of customer demand by mass customisation (Davis, 1987; Pine, 1993) have been present in the literature for some time. Debates have also emerged that attempt to locate the essence of “agility” as what some have called a “new” productive regime (Iaccoca Institute, 1991), with the aim of identifying what role it can play in re-structuring sub-optimal forms of productive organisation within the focal firm. In order to clarify the basis of our argument we define agility as “the ability of an organisation to thrive in a constantly changing, unpredictable business environment” (Iaccoca Institute, 1991).

However, there is a significant gap in the literature when theoretical attention is paid to inter-firm agility. Inter-firm functioning in “agility” frequently involves the application of systems engineering thinking to describe and optimise factor conditions for the transfer of physical artefacts and information between companies. This approach has been used successfully by, amongst others, Mason-Jones et al. (1997). The result is the production of diagrams to describe the interaction between companies using either a physical transfer of materials and/or explicit knowledge (Forrester, 1961). However, it will be argued that tacit knowledge which is captured and transferred in networks is much more dynamic and difficult to codify than “explicit” flows of material or inventory data (Hall and Andriani, 1998). These “invisible” data are often constructed under different and variable regimes of power and trust and constructed unevenly through dynamic human-to-human discourse. These conceptual and often abstract forces are extremely elusive and have been notoriously difficult to measure or predict (see Clegg, 1997; Child and Faulkner, 1998). Such data are often difficult to record or measure, which makes the use of systems theory somewhat inappropriate as a unitary methodology for representing the formation and operation of inter-firm agility. These issues make finding a universal set of laws problematic for this form of intangible interaction.

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Conceptualising inter-firm agility  
Investigations of agility can easily lead to a complex and often mixed theoretical and prescriptive debate due to its conceptually “young” nature. The content of this so-called “new paradigm” is still ill defined, although there are a series of
research areas that have been used to describe the conceptual ideas surrounding the agile (Goldman et al., 1995; Booth and Harmer, 1985; Bennett and Katayama, 2000; Christopher, 2000; Harrison, 1999). The majority of this work is based on examining the emergent strategy of organizations for signs of agility. However, as a primary basis for understanding agility, the term can be conceptualised using four basic principles (see Nagel, 1993).

In short, the four principles of agility (Figure 1) are concerned with enriching customer interaction by providing “added value” which requires the organization to adopt a solution-based approach to satisfy individual customers’ needs. In some cases it may be unlikely that any single company will be able to both produce artefacts with the correctly configured customisation and added value to satisfy a particular emergent market demand. To this end agility suggests co-operation to enhance competitiveness, with two models suggested in the more prescriptive literature: virtual corporations (Goldman et al., 1995) and agile webs (Booth and Harmer, 1995). In order to investigate the functioning of inter-firm agility further, we need to examine both models of co-ordination in closer detail and determine on what basis both of these approaches have been built.

**Virtual organisations**

The concept of the virtual corporation is built on a clustering of non-geographically agglomerated companies that synergistically combine core competencies to very quickly satisfy emergent market needs and demands. This requires an ability to adapt as a result of potentially rapid change and market uncertainty, which has been associated with a more entrepreneurial approach to conducting commercial activities. The formation of a virtual corporation involves the combination of two or more companies’ core competencies to maximise and exploit emergent opportunities in the market place (Hamel, 1991). The participants are chosen solely by virtue of their competencies and abilities, which could be a combination of either intra- or inter-enterprise resources. These participants would then share and manage the cost, personnel, skills, access to markets and revenues generated from temporary association. This horizontal integration enables the virtual company to rapidly configure and reconfigure its joint competence to reach beyond the ability of any single company. Membership of the virtual company will vary depending on product or service composition, with the association remaining fluid and dynamic as opportunities emerge. In short, the virtual organisation is involved with identifying core competencies and then complementing them with core competencies from other companies to synthesise a complete production capability, thereby gaining competitive advantage.

The virtual organisation is able to selectively integrate participating people and processes, expertise and physical resources, regardless of their spatial location, within a company or within its suppliers or even competitors. This type of collaborative activity is partly facilitated by linking information systems, production and relationship management processes to other stakeholders in the virtual corporation to enable co-ordination without centralisation. It is a networked production capability facilitated by the electronic integration of resources and expertise distributed among peers that enables virtually close yet spatially distant relationship management.

The crucial difference between the strategic alliance and the virtual organisation is that strategic alliances generally bring about organisational learning (Child and Faulkner, 1998), as alliances offer a unique opportunity to learn from partners in areas such as process technology and marketing related skills. This allows partner organizations to strengthen the areas in which they do not have a competence. This is not a primary concern for a virtual corporation. Here, the necessary resources should be integrated into a coherent operational unit, while leaving those resources intact as far as possible. Participants interact as collaborators and competitors, unlike the organizational structure akin to hierarchy. This structure reflects the equal status of the participants.
in an enterprise that neither of them fully owns.

The agile web

In similar form to the virtual corporation, the agile web is an organisational framework (Booth and Harmer, 1995) based on distant ties facilitated by information sharing and transparency between partners. Booth and Harmer characterise an agile web in Figure 2, using the analogy of business processes that cut across organizations to highlight the seamless transition of production between web partners.

The web configures a team that may include personnel from outside the firm, which can include designers, manufacturers, marketers, purchasers and financiers so long as they possess the necessary core competencies to form a virtual organisation. These teams cross over functional lines, allowing less opportunity for narrow thinking that can take place in functional silos. Co-operation between trusting partners is facilitated by utilising electronic inter and intra-company communications, sharing human and material resources and data.

Underlying issues in cross-organization collaboration

In outlining the two conceptual models of inter-organizational agility, it is apparent that both frameworks facilitate the creation of value in a network form of organization. By comparing the criteria set down by Powell (1991), the virtual corporation and the agile web can be characterised as network forms of organization. This type of organisational collaboration is described by Powell, who argues that:

Many firms are no longer structured like medieval kingdoms, walled off and protected from hostile forces. Instead, we find companies involved in an intricate latticework of collaborative ventures with other firms, most of whom are ostensibly competitors (Powell, 1991, p. 269).

It is therefore clear to see that the virtual corporation and agile web have a strong association to the network form of organization where the two forms of transactional governance, termed market and hierarchy, mix to form a hybrid type of co-ordination (Bradach and Eccles, 1991). In this most general form of co-ordination, networks can be identified as “two or more connected exchange relations” (Cook and Emerson, 1978, p. 712). However, the networks and inter-organisation theory literature appears to have been eclipsed as the dominant factor in conceptualising typologies of inter-firm agility by variants of general systems theory (see Emery, 1969; Checkland, 1981).

The role of systems theory in agility is addressed by Mason-Jones and Towill (1999) who suggest that the supply chain can ensure competitiveness and maximise bottom line performance by eliminating uncertainty in both the materials and information pipelines between companies. This task can be accomplished with the application of systems engineering thinking. The analysis used here is that of “a predominately hard systems approach to [the] optimisation of supply chain management … via the use of simulation, which was backed by analytical analysis” (Mason-Jones and Towill, 1999, p. 63).

Although the use of systems theory is valid, and has been tested with the use of simulation experimentation, we argue that a blanket approach to discovering the “optimal” form of agile inter-firm organization must take into account other approaches to understanding the form and operation of inter-firm ties. Before we examine the alternative theoretical approaches that, we argue, can be used to highlight contrasting views of inter-firm co-ordination, we will examine the further dominant position that systems theory has taken in agility. In doing so we will expose some of the caveats in using this theoretical approach as a dominant form of theorising about agile supply networks.

Figure 2

A theoretical application of an agile web

Source: after Booth and Harmer (1995)
Identifying the role of systems theory

In the early 1950s general systems theory was adapted and used to re-design manufacturing operations, with success in this arena prompting further uses of systems methodologies to build and reorganise business processes. Here, subsystems are investigated and optimised in an application of “total systems” thinking. The main focus of this type of optimisation has been the co-ordination of internal functions of the business (Forrester, 1961). Due to the success of the traditional systems approach it is thought that an extension to this methodology can be used to go beyond the boundaries of an individual company to the complete supply chain, with the virtual corporation and agile web used as concepts to understand this type of interaction. The underlying shift from closed to open systems thinking is the acceptance of the importance of interacting with the environment, as the survival of individual organizations depends on the ability to adapt to markets, technologies and other situations.

The very definition of a system implies a set of “connected things, an organised group of things; orderliness” (Anon., 1991). The methodology for the implementation of this systems approach from an operations management perspective considers a company’s internal supply chain as a subsystem of the overall supply chain system. Each subsystem will display the characteristics of a system in terms of having inputs, transformation activities and outputs in a particular environment. Within these subsystems there are tasks such as designing, making, buying and selling that can be considered to be multidisciplinary activities that cross traditional functional department boundaries. When we come to consider that a supply chain comprises several companies, these subsystems can be considered to be individual sub-units of multi-divisional firms or companies with their own legal identity.

The usual focus for improvement in the supply chain has been the optimisation of a particular company’s inventory or scheduling protocols. This can lead to adapted subsystems that attempt to match external environmental needs such as product markets, factor markets, technical knowledge and social and political factors (Child, 1969). The systems approach therefore attempts to analyse a subsystem in a wider context by co-ordinating a connected network of companies (Christopher, 1992). This approach requires the development of a solution that has radical consequences for the whole supply chain and often results in some operational and organisational redesign activities. In some cases the strategic alignment of sub-units becomes essential to enable seamless co-ordination along the supply chain.

These systems analysis and redesign methods are excellent at describing and modelling the physical flow of materials, inventory data and demand patterns. This is due to the relatively quantifiable roles regarding dynamics of variability in order patterns or location significance of work-in-progress. However, the human-to-human interaction in network forms of organisation has a much higher degree of complexity. Here we are not only concerned with the physical flow of materials and counter flows of information, but with the wider interactions that occur between companies participating in a supply chain. Relationship formation, development and occasional collaborative breakdown are driven by factors such as trust (see Blois, 1999; Sako, 1992), power, the manipulation of intangible resources and the changing nature of inter-firm interactions over time (Gadde and Mattsson, 1987).

There is a danger in systems thinking of perceiving that organizations are akin to objective entities adapting to an environment. In practice, open systems theory gives a central role to “management” to maximise bounded rationality (Simon, 1956). This “gatekeeper” role requires management to predict and design appropriate structures and responses and to manipulate resources and connected actors in what is perceived to be a desirable manner. To some extent these processes require access to information to reduce uncertainty, which highlights the connection between environmental uncertainty and dependency to issues of decision-making (March and Simon, 1958; Cyert and March 1963). Because of the uneven access and flow of informational, technological and other environmental conditions, and in power relationships between sub units, decision makers must cope by forming dominant alliances (Thompson and McHugh, 1995). As a result, “Organisational decision-making becomes much less a matter of unquestioned command or rational appraisal and much more a process of political bargaining and negotiation in which the exercise of power plays a key role” (Reed, 1986).

In the agile supply chain the task of optimising the system is made all the more difficult by the fact that the sub-systems of members in the wider system will
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continually change through time (Gadde and Mattsson, 1987). The determination of the appropriate strategy for supply chain co-ordination is complex to effectively relay unless it is under conditions of buyer or supplier dominance. Further, if the strategy was relayed across sub-units it would almost certainly be out of date by the time that a useful analysis could be performed and converted into any type of implementation plan.

Even soft system methodologies, where a realisation of this human element has been made, cannot capture the essential essence necessary to fully describe the situations being currently researched in the field of agile supply chains (see Day 1999). Systems change and any “time slice” is partial and temporary, so “steady state” models only give a partial representation of events. Any agile supply chain must have a common element of human, subjective social experiences which influences purposeful action which is shaped by the shared histories of actors in a supply network.

**Alternative approaches to conceptualising inter-firm agility**

In order to overcome some of the limitations of what Granovetter (1985) would call an undersocialised view of the world we must look elsewhere for theoretical insight that assists with understanding inter-organisational relations in agility. As we have argued already, the two forms of agile enterprise resemble a network. Using New and Mitropoulos’s (1985, p. 55) classification system, the agile form of enterprise is a network of firms working as an operational system, where each member of the “collective” negotiates a task and manages internal process in a way that is beneficial for other collaborators. Theorising about such a network is in fact not new, with this type of corporate interaction already coming in for a great deal of attention across the sociological, marketing and economics literature. Although too numerous to identify in a typology for this paper, the different strands of literature are brought together well by Oliver and Ebers (1998), who argue that the inter-firm literature can be divided between two strands – inter-organisational relations and networks. Both have blurred boundaries, but choose different research foci and have taken distinct research interests, but they share some similarities. Generally stated, both focus on sets of recurring ties (e.g. resource, friendship, relational, informational ties) among a set of actors (e.g. individuals, groups, organisations, professional associations, etc.) and both aim to identify why actors forge which specific linkages under different circumstances, and what consequences result from the inter-organisational links and positions of the actors within their relationships.

The network and inter-organisational literature encompass a number of different approaches for understanding the “grey” area between what are perceived by some to be islands of planned co-ordination within a sea of complexity. There are a number of main theoretical contributions which have shaped the way that we understand inter-organisational ties, from neo-institutional economic approaches (Williamson, 1985) that take the comparison of transaction costs as the main focus, to structuration theory (Giddens, 1991) where focus is placed on the interplay (duality) of structures and action in the generation of order. In order to open up this field to the agility debate we will choose an approach that builds and refines both transaction cost economics and resource dependency theory (Pfeffer and Salancik, 1978) to highlight some of the inter-organisational issues that arise as a result of linking not just internal processes, but organisations, together.

When inter-firm ties are broken down into their basic components we can see that there are a series of actors (e.g. individuals, functions, organisations), resources (e.g. raw materials, part finished goods, useable products) and activities that occur when one or several actors combine to transform resources. These basic building blocks were used by the Industrial Marketing and Purchasing (IMP) group to construct a model of industrial networks. Using this model as an initial step-off point we can make some observations about the shifting, dense and sometimes turbulent relationships that make up the interaction between a firm and what general systems theory would call “the environment”.

The interaction approach, developed by the IMP group from the mid-1970s onwards, is based on data from a large number of case studies of buyer-supplier relationships in five European countries. The inter-organisation theory component of the IMP approach is focused on the nature of functions being performed by the network of organisations that interact on a prolonged basis. Hakansson (1989), Cunningham (1980), Ford (1980), and Axelsson and Easton (1992) contribute to the four classes of variables that comprise the IMP model to describe the basic concept of interaction:
variables describing the actors involved in the interaction;
variables describing the elements of the process of interaction, such as product, information, financial and social exchange episodes;
variables describing the environment within which the interaction takes place; and
variables describing the atmosphere affecting and affected by the interaction, such as power, dependency, conflict and co-operation.

The network model of the organisation-environment interface stems originally from causal observations that businesses operate in environments which include only a limited number of identifiable organisational entities (Hakansson and Snehota, 1989). These entities are continually involved in interactions with the organisation, with each party exerting influence over the organisation. The propositions of such a model refer to situations and cases in which the environment of the organisation is concentrated and structured in nature. Rather than treating the environment as a factor that can be singularly conceptualised, it is more useful to adopt the concept of context. The context is enacted, it is created by itself and in a sense even constitutes the organisation itself (Smircich and Stubbart, 1985). This form of interaction-based understanding is multidirectional in cause and effect terms. Hakansson and Snehota (1989) summarise the network model using a number of observations which support the main argument that organisations engage in continuous interactions that constitute a framework for exchange processes. Importantly, the distinctive capabilities of an organisation are developed through its interactions in the relationships that it maintains with other parties, with such relationships often constructed by individual personnel. This level of control over network activity means that relationships are often in a continual state of flux, with Hakansson and Snehota (1989) commenting that, “We have been amazed by the complexity of the industrial markets and at the same time by the apparent smoothness of their working. Gradually, we have acquired respect for their importance and complexity”.

There are several aspects to information exchange that are drawn from the model. While the content of exchange is the primary driver for interaction, the width, depth and formality of exchange may impinge on wider organizational interaction issues. Social exchange, as a further aspect of interaction episodes, has an important part to play in the reduction of risk (Hakansson and Ostberg, 1975). Indeed, social exchange episodes may themselves be important in avoiding short-term problems between two parties, with mutual trust being viewed as a definite feature of relationship stability.

The routinisation of exchange episodes over time will lead to a clear expectation of the responsibilities to be expected on all sides. Eventually these expectations become institutionalised to such an extent that either side may not question them. At this point, a transition has been made from episodes of interaction into a relationship built and maintained with interaction. Another important aspect of the switch from episodes of exchange to a relationship is the adaptations that one or both parties make as a result of changed conditions. In these terms, this building of knowledge and accommodation mirrors what Williamson (1985) would term asset specificity.

The processes of interaction and the relationships that build between organisations depend as much on the elements of interaction as the features of the parties. These include the characteristics of individuals who represent them and the wider organizational variables of firm size, structure and strategy, organizational experience and technology. In terms of personal interaction between organizations, at least two parties are commonly involved in a relationship. These are usually the buyer and seller in terms of a trading relationship. More commonly, several individuals are involved at different hierarchical and functional levels, building relations and social bonds that influence the decisions made by each side (Day, 1998). This role as a mediator or negotiator between two sides was recognised as a crucial interface between the organization and environment by Aldrich (1979), who coined the term “boundary spanner” to explain the role of such individuals.

The interaction between buyers and suppliers or collaborators cannot be analysed in isolation, but has to be considered in the wider context (Anderson et al., 1994). The wider environment in which relationships sit has a number of aspects that affect interaction. First, market structure can determine relationship form, with parallels being drawn to economic notions of imperfect markets (Cohen and Cyert, 1975). The dynamic nature and internationalisation of the market also serve as factors for consideration. However, of specific interest in terms of agility are the two other factors
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listed by the IMP group (1990), with position in the manufacturing channel cited for review along with the embedded nature of activities as Granovetter (1985) suggests that there will be implications elsewhere in the network for decisions taken in individual relationships. An associated feature of the embeddedness argument is the role of the social system that supports collectively held norms and principles such as the atmosphere of exchange, mutual understanding and expectation.

The resulting discussion of the factors related to interaction show that a wide array of relationship types can form as a result of a combination of various interaction factors. This implies that there will be reasons for firms wishing to enter into relationships that promote high degrees of closeness, as well as other situations where it is prudent to avoid such closeness (Ford, 1990, p. 17). The reasons behind these decisions are broken into two dimensions, economic and control-related. Summing up the reasons put forward for close relations, it is argued by the IMP group that relationships are established and used in order to gain (directly or indirectly) economic benefits, lower costs, and/or an improvement in the organisation’s control over some part of its environment. A critical aspect of the management of these relations is the balance of inter-dependence with others whereby the focal firm must seek to balance the advantages to be accrued from closer relations with the costs of that single relationship.

Conclusions

The central theme in this paper is that the use of a singular foundation of theorising may detract from addressing some of the critical questions in inter-firm agility. We have done this by arguing that the dominant theoretical approach, systems theory, would benefit by using more holistic interpretations to question and challenge some of the assumptions that have been taken for granted when prescribing solutions to issues that have yet to be addressed in a rigorous manner. While this paper has uncovered some of the less mechanistic issues in agility, it poses more questions than it answers, with a series of issues coming out of the interpretation of agility from the IMP perspective.

Rather than treating the “grey” space between partners in virtual corporations or agile networks as a predictable and in some way “manageable”, we would argue that a great degree of complexity exists in this domain. This may pose problematic questions for prescriptive accounts that map in some way an “ideal” solution for “aligning” optimal solutions in an agile environment. Part of this complexity is driven by the recognition that what New and Payne (1995) term “soft” data – such as managers’ expectations or fears concerning the behaviour of suppliers and customers – is as important as data on stock turns or delivery patterns. These complications are made even more difficult by systems approaches having difficulty in the appreciation of softer factors such as power, trust, dependency and other human factors that cannot be captured at this level of analysis. Even approaches such as “soft systems” methodologies cannot capture the essential nature of these relationships and human factors sufficiently to account for “maverick” episodes.

In order to address the issues raised in this paper it is suggested that the lack of communication between functional disciplines be broken down to ensure that grounded, more robust insight can be generated. Rather than following an extended debate related to definitions and boundaries for agility, further research needs to consider the concept in holistic terms, exploring the space between organisational boundaries in an inclusive rather than theoretically exclusive mode of enquiry.

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