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Networks are Useful Description, Assemblages are Powerful Explanations

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Abstract

Network models are ubiquitous and offer useful descriptions of a range of a wide variety of phenomena. However, such models lack a consistent and robust ontological framework and, as a consequence, network models are often not models at all, but merely descriptions composed of fragmented and internally inconsistent models and theories that emerged over time and across a range of different perspectives, each with different underlying assumptions. To address this problem a more critical approach to network structures is required in order to move from a descriptive account to an explanatory account. This working paper addressing the topic of network ontology and introduces the notion of assemblages in order to give a clearer framework for network thinking. While this working paper serves merely to introduce the notion of assemblages, the concept is designed to be applied to actual network structures and, as such, has been operationalised in research undertaken in INGENIO between 2007-2010 examining the ceramics sector in Spain and Italy (see Haynes forthcoming).

1 Introduction

The rise of the network paradigm has been rapid and extensive, although specific network models reflect a diversity of approaches subsumed within this paradigm. One of the main features of network analysis is that it emphasises the interdependence of individuals within organisations rather than conceptualising them as sovereign elements that act autonomously. As such, the relationship between individuals is perceived to be the unit of analysis of social structures, with such relationships conceptualised as conduits for the flow of resources, and in particular, information. Network theorists therefore attempt to identify the relationship patterns that form network structures and analyse the network relationships to identify the conditions that enable or obstruct specific activity. While there are common features in the types of methods and metrics used to identify such patterns, and shared assumptions concerning the importance of ties of interaction in investigating behaviour and activity, there are fewer commonalities in the theoretical basis of such analysis.

An opposition to structural-functionalism characterise the network paradigm in the early stages of network research coupled with an implied opposition to perspectives that emphasise purposive action and non-relation characteristics although explicit theoretical or ontological frameworks with which to support these assumptions of network analysis are typically absent. Mustafa Emirbayer and Jeff Goodwin (1994) claim that there are, in fact, three *implicit* models or frameworks in network analysis, though all three models – structuralist determinism; structuralist instrumentalism; and, structuralist constructionism – seem to have fundamental problems (Emirbayer and Goodwin 1994: 1425-1436).

The first of these, structuralist determinism, as exemplified by Rosenthal et al. (1985), is characterised as "infrastructural" by Emirbayer and Goodwin. Network models within this category tend link entities only in their most tangible form, disregarding the importance of factors such as values or discourse in shaping social structures or collective outcomes, reifying rather than explaining social relations. As such the structure of social relations and that of cultural formation are transformed "into an *ontological* dualism" Emirbayer and Goodwin 1994: 1427).

A second category, structuralist instrumentalism, as exemplified by Gould (1991) is characterised by its predominant focus on interest seeking as a network mechanism.

Such models, though identifying the need to explain the effects of social action, tend to conceptualise these effects as little more than aggregate outcomes of material interests pursued through rational choice, focussing instead on the structural preconditions to explain the way networks afford change.

The third of Emirbayer and Goodwin's categories for network research, structuralist constructionism, as exemplified by McAdam (1986), is characterised as explaining action in terms of the interaction of normative commitments and network structures (see also Padgett and Ansell 1993).

While this category addresses some of the limitations identified within the previous two categories, for example by including an account of how personal identification can be converted into activity or describing the structural channelling of learning, in the authors' opinion a structuralist constructionism network model "pays insufficient attention to the structuring influences of cultural and political discourses upon historical actors" (Emirbayer and Goodwin 1994: 1426). This typology helps in clarifying a number of theoretical presuppositions – and identifying some important tensions and flaws in these theoretical types – but more importantly it draws attention to the lack of engagement in analysing such presuppositions. While the typology could be accused of being somewhat contrived, directed almost exclusively towards network consequences rather than causes, and overemphasises the theme of agency in analysing network models, nevertheless it provides a useful way of positioning the research paradigms of the *early* period of network research. In addition, it illustrates that during the expansion of social network research when methods were becoming ever more sophisticated, very little critical attention was directed towards developing an ontologically consistent framework to address potential limitations at the theoretical level, such as a tendency towards reification, reductionism and essentialism.

A broad analysis of more recent network models (Borgatti and Foster 2003), identifies a number of research streams and research dimensions with which to categorise the literature. While the themes are useful in demonstrating the degree to which concepts such as social capital, embeddedness and social cognition have gained resonance with network researchers, the four research dimensions that Borgatti and Foster identify is itself a useful tool in drawing out some of the current theoretical positions. The first dimension, the direction of causality, shows that research examining the consequences of networks is often informed by the paradigm of structuralism, while research directed

towards the causes of network formation, typically use concepts centred on individual motivation and psychological properties, in diametric opposition to the structuralist scheme. Additionally, Borgatti and Foster show that many of the agent-based models base their simulations on simple individual motivation to explain causes of network behaviour. The second dimension they identify is the level of analysis. The scale and complexity of the unit of analysis can often determine the type of theoretical framework employed. For example, networks of people are different from networks of organisational units, not merely in having different characteristics and capabilities, but in that the relationships themselves have different functions and meaning. As such, individualist and essentialist assumptions do not easily scale up to the organisational and macro levels, which could help explain why structural theories are more prevalent in organisational network research. Finally, the two remaining dimensions are examined together to examine the underlying assumptions of network models.

Borgatti and Foster examine the way these dimensions – explanatory goals and explanatory mechanisms – relate to the theories network researchers employ, though limiting their attention to research on network consequences. Their initial observation is that much of the research, especially that influenced by Burt: "seems to add a rational actor assumption to social capital theory to the effect that actors deliberately choose their ties (i.e. manipulate the network structure) specifically in order to maximise gain" (Borgatti and Foster 2003: 1002). Borgatti and Foster add more nuance to this claim use their "explanatory goals" and "explanatory mechanisms" dimensions to identify four canonical types of network studies. The first two – structural capital, and environmental shaping – are positioned as structuralist, in the sense that the content of the ties is less emphasised, with the main focus being the patterns of interconnection. Such approaches tend to perceive the actor as a rational active agent, exploiting their position to maximise gains or reach objectives. The remaining two categories – social access to resources, and contagion – are described as connectionist, in the sense that networks are perceived as conduits for the flow of resources and emphasis is given to these flows rather than to network structures. These perspectives are not intended to be mutually exclusive, but merely to emphasise differences in the conception of how ties, and ultimately networks, are said to function.

Borgatti and Foster present an expanded typology that is largely compatible with the type of network patterns identified in Emirbayer and Goodwin's critical typology. The

structuralist vs. connectionist approach also expands on a number of other network binary oppositions which have been useful in characterising network approaches: equivalence/cohesion, structural/ relational, typology/flow, girders/pipelines, positional/relational, to take a few examples. These typologies are, though, limited to dividing approaches according to their orientation rather than ontology, i.e. they draw distinctions between the different ways that ties create exploitable structures and the way they enable resources flow through such structures (opportunities vs. restrictions) without accounting for the nature of the component parts of such structures, or considering how they are formed or affected at different levels of interaction. Of the twenty two articles cited above, which though among the most cited articles in the innovation and networks literature are otherwise representative of peer reviewed research, each presents an approach dependent on existing multiple models and none are explicit about possible implications of ontological inconsistencies.

This dearth of ontological considerations in the network literature leads to, and is compounded by, a number of methodological weaknesses. Genuine theories are overlooked in preference to descriptions, although some of the stronger claims supporting these descriptions rely on data sets, such as patent data and citations, which are weak indicators of sophisticated networks, while other research relies on surveys and questionnaires, often leading to perceived ties being treated as actual ties (see Marsden 1990). In this way, such research is unable to develop findings through which new concepts or theories are able to emerge, perpetuating the choice of concentrating on description. To illustrate this with examples from the innovation literature, where such data is used to support hypotheses, researchers typically present as theory a range of mechanism through which networks generate and support innovation or a description of the way that the shape a network takes impacts on the success of innovation. Excellent research does indeed indicate that networks enable organisations to benefit from knowledge spillovers (Saxenian 1994; Adams and Jaffe 1996) the formalisation of collaboration on innovation (Powell, Koput and Smith-Doerr 1996) access to information and the embedding of trust (Ahuja 2000; Gordon and McCann 2000) or support and sustain the stock of social capital (Tsai and Ghoshal 1998; Cooke and Wills 1999; Burt 2004).

The development of useful research findings, though, is not the issue. The problem is that while the authors of these explanations often support their claims with empirical

evidence, demonstrating that networks form a condition of the organisational dynamics able to facilitate innovation, there is little actual theory to explain, rather than merely describe, why the processes function, what deeper mechanisms are at work, how the changing components of the networks impact on the processes produced by earlier interdependencies or the process of feedback and emergence on changes within collaborative groupings. As Gerald Salancik argues "network analysis has been used mainly as a tool for analysing data about organizations rather than for understanding organizations per se" (Salancik 1995: 345) and thus describing the effects of network phenomena may be useful, although, in addition, it must be coupled with explanations concerning why they exist in the form that they exist if the research is to be applicable to other cases.

There is some evidence of a consensus within mainstream network research to emphasise the nature of network concepts as a puzzle-solving research paradigm at the expense of undertaking research addressing the development of much needed organisational theory (see Kilduff, Tsai and Hanke 2006: 1031-1033). The literature fails to address, for example, the nature of the ontologically primitive elements that constitute network theory's basic concepts (see Parkhe, Wasserman, and Ralston 2006: 561-563) one of the fundamental reasons for the difficulty in comparing the outcomes of different network research. To address these gaps and identify the range of actors and ties responsible for organisational change within such networks, an alternative perspective must be developed. This paper examined one such alternative.

2 Assemblages – what they are and what they contribute to network thinking

The key problem facing network thinking as the problem of reductionism and to solve this problem is to solve a range of other problems – essentialism, reification, atomism, etc that limit the strength of the networks paradigm. Many of the solutions aimed at addressed this problem simply defer the reductionism from the macro to the meso level, such as with Anthony Giddens' theory of structuration (Giddens 1986), the concept of (transformative) praxis (see Bhaskar 1997), the notion of the routine within the multi-level perspective (see Nelson and Winter 1977) or by different forms of conflation based on act aggregation or agent orchestration (see Archer 1995: 93-134). A theory

based on networks might offer a promising alternative and yet networks themselves cannot provide a complete account of such interactions without additional theory. The problem of addressing the limitations of existing network theories can be coupled with this requirement to develop a theoretical solution to the problem of scale. It is for this reason that the concept of the assemblage becomes a very powerful theoretical framework for network thinking.

The majority of the features of assemblages are found in existing network descriptions but unlike standard network theories, additional features clarify these relationships. This is possible because the concept of the assemblage was not developed from fragmented theories with different supporting ontological assumptions, but devised with a clear purpose and directed towards a specific problematic within a unified philosophical scheme, though one which is complex and requires a series of steps in order to be fully conceptualised. The term "assemblage" is derived from the Greek word "sumbolon" meaning the act of bringing together. Gilles Deleuze uses the sense of summation in a technical sense, defining an assemblage (agencement) as a "multiplicity which is made up of many heterogeneous terms and which establish liaisons, relations between them" (Deleuze and Parnet 1987: 69) and uses the term as a way of conceptualising a wide range of patterns that hold heterogeneous elements together. These collectives are therefore devised in order to serve as the unit of analysis in explaining events on the micro, meso and macro scale. An assemblage structure, which will be described in detail shortly, expresses network relationships in which synthetic processes or emergent properties are not reducible to the properties of a network's individual parts and thus a means of engaging macro-level and micro-level configurations without recourse to reductionism:

> The minimum real unit is not the work, the idea, the concept or the signifier, but the assemblage … which is always collective, which brings into play within us and outside us populations, multiplicities, territories, becomings, affects, events (Deleuze and Parnet 1987: 52).

In this way, the term is appropriate to descriptions that aim to analyse action and interaction, key dynamics that any organisational network approach needs to tackle.

This paper, in attempting to develop a framework to express organisational dynamics will need to clarify the concept in detail and illustrate its advantages over existing descriptions, a very technical undertaking. The paper will therefore begin with an

overview of the development and application of the concept and give a brief account of its role in the analysis of organisational dynamics.

The concept of an assemblage, as developed by Deleuze and Guattari (1988) and later refined by DeLanda (Delanda 2006a; 2006b), was designed to explain the synthetic processes that sustain and modify the structures of entities such as formal and informal networks, organisations, industries or regions etc. in non dialectical terms. Unlike dialectical and organic wholes, the concept provides a non-reductionist and non-essentialist description for the properties of the entities it is applied to, enabling different intermediate scales to be represented in terms of appropriate units of analysis rather than epiphenomena. This is because unlike an organic totality, with mutually constituted parts fused into a seamless whole, the components of an assemblage have a degree of autonomy from the whole, which allows them to be disconnected and reassigned to other assemblages. To use an example, an extended family is an assemblage comprised of, but not limited to, different components of a biological, organic, technological, spatial and informational nature configured into, and modified by, a range of socio-cultural assemblages, such as languages, medicine, community and consumption. These emergent assemblages are themselves components serving larger assemblages, from small networks and organisations, to nation states and global events. The ontological status of these larger assemblages becomes, in turn "that of a unique, singular, historically contingent individual" (DeLanda 2006a: 40). In this way, the study of a specific cluster of assemblages is not prior determined according to a particular unit of analysis or pressure (such as individual agents, labour, utility and profit maximisation) as is often the case with network theories, but determining the scale, components and assemblages to be included in the description, forms a part of the investigation, which recognises the impact of using these, rather than other components, in framing the analysis (Callon 1998).

Deleuze developed and refined this model in relation to a number of features of his philosophical system, which collectively resist being transplanted unchanged within more traditional narratives of networks or organisational change. In order to benefit from such an engagement of ideas it is therefore necessary to stipulate the boundaries of the concepts and formulate these limits in terms that engage with existing concepts in the literature.

The work of Manuel DeLanda (2006a; 2006b), exemplified with some features from more mainstream research interests in assemblages, will greatly contribute to this task. DeLanda describes how the power of the assemblage approach is able to capture the variety of organisational dynamics in presenting an alternative to explanations based on organic totalities or descriptions based upon the organism metaphor. This is because unlike organic parts, the components of assemblages can be switched between assemblages while preserving their identity, as occurs on a daily basis in every organisation. Consequently the properties of the components do not explain the relations which constitute the whole, as the properties of the assemblage are not the result of the aggregation of components properties but the exercise of their capacities. This needs to be clarified further and the work of DeLanda provides such a clarification, in that he attempts to develop a full theory of assemblage as a framework with which to model organisational phenomena (see DeLanda 2006a: 1-7). While acknowledging the concepts needed to develop such a theory are dispersed throughout a number of Deleuze's texts, and such concepts are not given in a style suited to a straightforward interpretation, DeLanda identifies key features of a simplified scheme with which to develop a full assemblage theory framework, a framework this paper will attempt to operationalise shortly. The four key features identified as of particular importance in the scheme are the following:

1. Each individual entity is comprised of component entities at the immediate lower scale, i.e. scale relations are parts to wholes.

2. The component entities on each scale are interacting, and processes generated through these interactions are the source of the emergence of entities on a higher scale, as unintended consequences

3. On emerging, a larger scale entity becomes a source of resources, but also sets limits, for its components, i.e. the whole both facilitates and restricts the interaction of components.

4. At each scale there is a concrete singular entity and, as such there is no general entity or category as an absolute referent. (see DeLanda 2006b 251-252)

In terms of the Borgatti and Foster typology, an individual assemblage as represented by these features comprises *both* the structure *and* the flow of resources, but not as abstract aggregates, but as actual features of the narrative of the emerging network, i.e.

the structuralist dimension identifies the components to be included in the assemblage, while the connectionist dimension dictates the patterns that the assemblage imposes on the components. An assemblage, then, is not driven by stable preference functions and their related constraints, nor is it driven by competing essentialist forces, but is generated and modified by a multiplicity of heterogeneous interests which only emerge with the unfolding of the assemblage itself, in much the same way as a part of a network can switch from being an active part to a more passive part of a process as the organisation it belongs to evolves, for example when a group of politicians vote to change the leadership of their party.

In this way, the assemblage concept forces the narrative to address organisational dynamics because the main problematic is that of analysing the interdependencies and relationships within the organisation ("what needs to be including in explaining how the opportunities arose"), but, at the same time, address interdependencies with individuals, other organisations and a range of meta organisational structures ("which practices need to be included to explain the process of implementation"). A way of differentiating the variety of networks, detailing the effects of singular circumstances, accounting for the role of decision making and the influence of pressures that impact on such decisions as well as being able to develop a multi-scale description of a multiplicity of factors, is crucial in clarifying and doing justice to the complexity that each factor affords. In this way an assemblage begins to capture the interdependencies that are present in a network, a captured in the title of this working paper – although networks can be useful description, they cannot of themselves explain the components that are captured within the network structures. An assemblage description, as this paper illustrates, is designed to serve this purpose and help to explain the relationships captured by the network description.

3 Conclusion

The variety of research problems using network descriptions attests to the creativity of problem solving approaches that network-related themes are undertaking. The difficulty in addressing many of the fundamental questions concerning the nature of networks themselves is that much of the network research fails to tackle the need for consistency in conceptualising the different facets of a network approach. This is not

merely because ontological considerations have not been dealt with as part of the theory building problematic, but that the variety of network approaches available to academics will often result in research that uses a combination of fragmented network theories, each with different assumptions, without considering the theoretical import of this hybridisation. This paper has attempted to address this hiatus by presenting a consistent social-theoretical framework for using social network explanations in the social sciences.

This assemblage framework is not intended to replace network methods and models, but rather to add discipline to the application of such models – it enables the translation of different models to a common configuration of dynamic components, and not a reduction to a single organic whole or to atomic units. The added value of the assemblage approach is to enable the consideration of network connections as links to real heterogeneous entities, which must themselves play different roles from each other, and over time, in actively engaging in the networking processes.

The assemblage approach nevertheless requires a series of empirical case studies and additional research outcomes to confirm that such an interpretation captures essential elements for their specific social network research frame, if they are to create the sites, objects and tools appropriate to a theoretically consistent network theory, an undertaking described in detail elsewhere (Haynes forthcoming).

This working paper represents an early attempt in such a movement and it is hoped that it will raise important issues, emphasise the active nature of network connections between the heterogeneous elements that form such structures and expound consideration to be taken up by mainstream network literature, demonstrating that networks descriptions benefit greatly by considering the entire assemblages that the network both enables and emerges from.

References

Adams J. D. and Jaffe A. B. 1996. Bounding the Effect of R&D: an Investigation using Matched Establishment-firm Data *RAND Journal of Economics* **27**(4) 700-721

Ahuja, G. 2000. Collaboration networks, structural holes and innovation: A longitudinal study. *Administrative Science Quarterly,* **45**(3), 425–455.

Allen T.J. 1977. *Managing the Flow of Technology* MIT Press, Cambridge, MA

Archer. M. 1995. *Realistic Social Theory: The Morphogenetic Approach* Cambridge University Press, Cambridge UK

Bhaskar, R. 1997. On the Ontological Status of Ideas *Journal for the Theory of Social Behaviour* **27**(2/3) 139-147

Borgatti, S.P., P.B. Foster. 2003. The network paradigm in organizational research: A review and typology. *Journal of Management*. **29**(6) 991-1013

Brass, D.J., j. Galaskiewicz, H. R. Greve, W. Tsai. 2004. Taking stock of networks and organizations: A multilevel perspective. *Academy of Management Journal* **47**(6) 795-817

Burkhardt, M.E., D.J. Brass. 1990. Changing patterns or patterns of change: The effect of a change in technology on network structure and power. *Administrative Science Quarterly*, **35**(1), 104-127

Burt, R. S. 1992. *Structural Holes: The Social Structure of Competition*. Harvard University Press, Cambridge, MA

Burt, R. S. 2004. Structural holes and good ideas. *American Journal of Sociology*, **110**(2), 349-399

Callon, M., 1992. The dynamics of techno-economic networks. R. Coombs, P. Saviotti, V. Walsh, (Eds.), *Technological change and company strategies: economic and sociological perspectives*, Harcout Brace Jovanovich, London, 77–102

Callon, M. 1998. *The Laws of the Markets*, Blackwell, Oxford.

Callon, M. 2005. Why Virtualism paves the way to Political Impotence: A Reply to Daniel Miller's Critique of *The Laws of the Markets*. *Economic Sociology: European Electronic Newsletter* 6/2 (February): 3–20

Carter, C.R., L.M Ellram, W.L. Tate. 2007. The Use of Network Analysis in Logistics Research, *Journal of Business Logistics*, **28**(1) 137-168

Castells, M. 1996. *The Network Society, The Information Age: Economy, Society and Culture, Volume I*. Blackwell, Oxford.

Collier, S., A. Ong. 2005. Global Assemblages, Anthropological Problems, in A. Ong and S. Collier, (Eds.), *Global Assemblages: Technology, Politics and Ethics as Anthropological Problems* Blackwell, London, 3-21

Cooke, P. and Wills, D. 1999 Small Firms, Social Capital and the Enhancement of Business Performance through Innovation Programmes *Small Business Economics* **13**(3) 219-234

Cowan, R., N. Jonard. 2004. Network Structure and the Diffusion of Knowledge *Journal of Economic Dynamics and Control* **28**, 1557-1575

Debresson, C., F. Amesse. 1991. Networks of Innovators: A Review and Introduction to the Issue, *Research Policy* **20**(5) 363-379

DeLanda, M. 2006a. *A New Philosophy of Society: Assemblage Theory and Social Complexity* Continuum, London.

DeLanda, M. 2006b. Deleuzian Social Ontology and Assemblage Theory. M. Fuglsang, B.M. Sorensen, (Eds.), *Deleuze and the Social* Edinburgh University Press, Edinburgh, 250-267

Deleuze, G., F. Guattari 1988. *A Thousand Plateaus.* Athlone Press, London

Deleuze, G., C. Parnet. 1987. *Dialogues*. Athlone Press, London

Deroïan, F. 2002. Formation of networks and diffusion of innovations *Research Policy* **31**(5), 835–846

Emirbayer, M., J. Goodwin, 1994. Network Analysis, Culture and the Problem of Agency *American Journal of Sociology* 99(6) 1411-1454

Freeman, C. 1991. Networks of innovators: A synthesis of research issues. *Research Policy,* **20**(5), 499–514.

Giddens, A. 1986. *The Constitution of Society: Outline of the Theory of Structuration*. University of California Press, Berkley, CA.

Gordon, I.R. P. McCann. 2000. Industrial Clusters: Complexes, Agglomeration and/or Networks? *Urban Studies* **37**(3) 513–532

Gould, R. 1991. Multiple Networks and Mobilization in the Paris Commune 1871 *American Sociological Review* **56**(6), 716-729

Granovetter, M 1973. The Strength of Weak Ties *The American Journal of Sociology*, **78**(6), 1360-1380.

Granovetter, M. 1983 The Strength of Weak Ties: A Network Theory Revisited *Sociological Theory* **1**(1) 201-233

Gulati, R. 1998. Alliances and Networks *Strategic Management Journal* **19**(4), 293-317

Gulati, R., M. Gargiulo. 1999. Where do interorganizational networks come from? *American Journal of Sociology*, **104**(5), 1439–1493

Haynes P. (2008) Assemblages - Rethinking Networks of Innovation within the Ceramics Sector, First International Sociological Association Forum, Barcelona, September 5-8

Haynes P. (under review) Conceptualising Networks as Assemblages: Examples from the Spanish Ceramics Sector, *Revista Internacional de Sociología*

Hervas, J.L. J.I. Dalmau. 2005. How to Measure IC in Clusters: Empirical evidence *Journal of Intellectual Capital* **7**(3), 354-80

Katz, R., M. Tushman. 1981. An Investigation into the Managerial Roles and Career Paths of Gatekeepers and Project Supervisors in a Major R&D Facility *R & D Management* **11**(3), 103– 110.

Kijkuit, R., J. van den Ende. 2007. The Organizational Life of an Idea: Integrating Networks, Creativity and Decision-Making Perspectives *Journal of Management Studies* **44**(6) 863-869

Kilduff, M., W. Tsai. 2003. *Networks and Organizations*. Sage, Thousand Oaks, CA

Kilduff, M., W. Tsai, R. Hanke. 2006. A paradigm too far? A dynamic stability reconsideration of the network research program. *Academy of Management Journal*, **31**(4), 1031-1048

Latour, B. 2005. *Reassembling the Social* Oxford University Press, Oxford

Lewrick, M., R. Raeside, T. Peisl. 2007. The Innovator's Network *Journal of Technology Management and Innovation* **2**(3), 12-24

Liebeskind, J., A.L. Oliver, L. Zucker, M. Brewer. 1996. Networks, Learning, and Flexibility: Sourcing Scientific Knowledge in New Biotechnology Firms *Organizations Science*, **7**(4), 428-443

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

Marsden, P.V. 1990. Network Data and Measurement Annual Review of Sociology **16**, 435-463

McAdam, D. 1986. Recruitment to High-Risk Activism: The Case of Freedom Summer *American Journal of Sociology* **92**(1), 64-90

Meyer-Stamer, J., C. Maggi, S. Siebel. 2001. Improving Upon Nature: Creating Competitive Advantage in Ceramic Tile Clusters in Italy, Spain and Brazil. Institute for Development and Peace Gerhard-Mercator-University of Duisburg, INEF Report 54

Moreno, A. (2006) Ceramic Tiles: Above and Beyond Traditional Applications *Cerámica y Vidrio* **45**(2) 59-64

Morris, B. 2006. High Technology Development: Applying a Network Paradigm *Journal of New Business Ideas and Trends* **4**(1), 45-59

Nelson, R. and Winter, S. (1977) In Search of a Useful Theory of Innovation *Research Policy* **6**(1) 36-76

Obstfeld, D. 2005. Social Networks, the Tertius Lungens Orientation, and Involvement in Innovation *Administrative Science Quarterly* **50**(1), 100-130

Owen-Smith, J., W.W. Powell. 2004. Knowledge networks as channels and conduits: The effects of spillovers in the Boston biotechnology community. *Organization Science*, **15**(1) 5-21

Padgett, J. F., C.K. Ansell. 1993. Robust Action and the Rise of the Medici, 1400-1434 *American Journal of Sociology* **98**(6) 1259-1319

Parkhe, A., S. Wasserman, D. Ralston. 2006. New frontiers in network theory development. *Academy of Management Review,* **31**(3), 560–568

Patton, P. 2006. Order, Exteriority and Flat Multiplicities of the Social, in Fuglsang M., B.M. Sorensen, (Eds.), *Deleuze and the Social* Edinburgh University Press, Edinburgh, 21-38

Powell, W.W., K. Koput, L. Smith-Doerr. 1996. Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology *Administrative Science Quarterly*, **41**(1) 116-145

Rose, N. 1996. The death of the social? Re-figuring the territory of government, *Economy and Society* **25**(3): 327-356

Rosenthal, N., M. Fingrutd, M. Ethier, R. Karant, D. McDonald. 1985. Social Movements and Network Analysis. *American Journal of Sociology* **90**(5) 1022-1054

Russo, M. 1985. Technical Change and the Industrial District: the role of Interfirm Relations in the Growth and Transformation of Ceramic Tile Production in Italy *Research Policy* **14**(6), 329-343

Salancik, G.R. 1995. WANTED: A good network theory of organization. *Administrative Science Quarterly,* **40**(2), 345– 349

Sassen, S. 2006. *Territory, Authority, Rights: From Medieval to Global Assemblages.* Princeton University Press, Princeton and Oxford

Saxenian, A. 1994. *Regional advantage: Culture and competition in Silicon Valley and Route 128* Harvard University Press, Cambridge, MA.

Smith-Doerr, L., I.M. Manev, P. Rizova. 2004. The Meaning of Success: Network Position and the Social Construction of Project Outcomes in an R&D Lab *Journal of Engineering Technology Management* **21**(1-2), 51-81

Sorenson, O. 2003. Social Networks and Industrial Geography *Journal of Evolutionary Economics*, **13**(5), 513-527

Sorenson, O., J.W. Rivkin, L. Fleming. 2006. Complexity, Networks and Knowledge Flow *Research Policy*, **35**(7), 994-1017

Sparrowe, R., R. Liden, S. Wayne, M. Kraimer. 2001. Networks and the performance of individuals and groups. *Academy of Management Journal* **44**(2), 316–325

Stengers, I. 1997. *Power and Invention* University of Minnesota Press, Minneapolis.

Tichy, N., M. Tushman, C. Fombrun. 1979. Network analysis for organizations. *Academy of Management Review* **4**(4), 507–519

Tracey, P., G.L. Clark. 2003. Alliances, Networks and Competitive Strategy: Rethinking Clusters and Innovation *Growth and Change*, **34**(1), 1-16

Valente, T.W. 1996. Social network thresholds in the diffusion of innovations *Networks*, **18**(1), 69-89

Wasserman, S. and K. Faust. 1994. *Social Network Analysis: Methods and Applications.* Cambridge University Press, Cambridge, UK

Wellman, B., S.D. Berkowitz. 1997. *Social Structures: A Network Approach* JAI Press, Greenwich, CT.

White, H.C. 1995. Social networks can resolve actor paradoxes in economics and in psychology. *Journal of Institutional and Theoretical Economics* **151**, 58–74.

Yu, G., Gao, J., Hummelen, J. C., Wudl, F. and Heeger, A. J. (1995) Polymer Photovoltaic Cells: Enhanced Efficiencies via a Network of Internal Donor-Acceptor Heterojunctions. *Science* **270,** 1789–1791