Via Po, 53 – 10124 Torino (Italy)
Tel. (+39) 011 6704917 - Fax (+39) 011 6703895
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WORKING PAPER SERIES

From population thinking to organization thinking: Coalitions for innovation. A review article of Complexity *perspectives in innovation and social change*, by Lane, D.A., van Der Leeuw, S.E., Pumain, D., West, G. (eds.), Springer, Berlin, 2009, pp.1-493.

Cristiano Antonelli

Dipartimento di Economia “S. Cognetti de Martiis”

LEI & BRICK - Laboratorio di economia dell'innovazione "Franco Momigliano"
Bureau of Research in Innovation, Complexity and Knowledge, Collegio Carlo Alberto

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From population thinking to organization thinking: Coalitions for innovation. A review article of *Complexity perspectives in innovation and social change,* by Lane, D.A., van Der Leeuw, S.E., Pumain, D., West, G. (eds.), Springer, Berlin, 2009, pp.1-493.

Cristiano Antonelli, Dipartimento di Economia, Università di Torino and **BRICK** (**B**ureau of **R**esearch in **C**omplexity, **K**nowledge and **I**nnovation), Collegio Carlo Alberto.

This important collective book presents an articulated and original approach to understanding innovation, as a collective, systemic and evolutionary process, engendered by generative relations that enable agents and social systems to overcome the challenges of the limits to growth. It elaborates the basic intuitions of complexity theory, and, makes the remarkable effort to try and apply them to social sicences. This new effort provides quite a coherent and inclusive, yet rigorous and consistent, analytical frame that marks a major progress along the lines of previous attempts to apply the basic tools of complex system analysis to social sciences and to implement an actual economics of complexity (Arthur, Durlauf, Lane, 1997). The frame elaborated in this new book recognizes the central role of innovation, both as the key explanandum and the basic explanatory variable in the understanding of the social and economic dynamics of a system. It actually assumes explicitely that innovation is the basic engine of the dynamics of social and economic systems. Innovation takes place in organized contexts characterized by qualified interactions among heteoregenous and creative agents that are able to act intentionally to face the risks of decline. The outcome of their interactions is determined by the structured contexts into which they are embedded. At the same time however their actions and interactions do affect the structure of the system and hence ultimately the aggregate outcomes of the dynamics. In this approach neither interactions nor the organized structures into which they take place are exogeneous, as they are determined internally by the dynamics of the system. The individual and intentional action of creative agents is central in the dynamics of the system, yet no individual agent can claim responsibility or even long-term sight on the eventual results of his or her action.

The notion of coaltions for innovations, to graft a term borrowed from political sciences, is at the core of this book as it elaborates the view that innovation takes place when effective coalitions based on the purposed convergence of the incentives, the structured complementarity of the competences of a variety and multiciplicity of heterogeneous actors, and the aligned and mutual directedness of their interactions emerge so as to

enhance the cohesion of the group and organize the inherent complexity of the system around a common goal and shared objectives (David and Keely, 2003).

The book is structured in three Parts and articulated in 17 chapters. Part I of the book: *From biology to society*, provides the foundations and asserts the view that human societies are characterized by a 'self-monitored, directed and intentional modality of social change and demonstrates that innovation is the result of the integration of a variety of social interactions. Part I elaborates and implements the basic theoretical framework according to which innovation is, at the same time, the cause and the consequence of the endogeneous creation of an organized complexity articulated in market systems and urban systems. As David Lane point out in the Introduction: "the chapters of this part show how the 'modifications in social organisation, that are directed at monitoring social changes, and that produce emergent patterns instantiated in organisations, do affect a social system in every aspect and at all its levels of organisation and describe how function, structure and process are affecting each other, so as to provide a dynamic, interactionist interpretation of the evolution of social systems". Part II, *Innovation and urban systems,* and Part III, *Innovation and market systems,* based upon case studies, econometric evidence and simulation modelling implement the application of this approach analyzing the creation of economic and social coalitions based upon the coherence of incentives and perspectives of creative agents endowed with the capapbility to change both their technologies and their preferences around an innovative project respectively in the emergence of specific 'market systems' centered upon a radical technological innovation and in the dynamics of urban systems.

The approach advocated by David Lane and his colleagues pays much attention to analyzing the evolving organization of the systems into which agents interact and innovate. Lane contrasts the traditional 'population thinking' upon which social sciences have traditionally relied to focus on static and structural descriptions of social organization that were primarily concerned with the *position* of individuals in the organizations and the distribution of populations in order to identify organizations, with the new 'organizational thinking' that focuses on the *relationships* between individuals to understand the structures and the functions of the *organizations* that emerge and their evolution.

The single act of ingenuity of a creative individual can become actual innovation only if and when the complexity of the complementary interactions and transactions is organized in coalitions of interests so as to

engender generative relations that enable the participation, by means of negotiations and hierarchization, and the convergence of the incentives of a variety of actors able to put in place complementary actions converging towards the realization of a common, innovative goal. In other words, the organization thinking approach stresses the role and the need for the dynamic coordination of heterogeneous actors that concur to integrate, improve, adopt and use a new artifact, and to extract and exploit all its potential advantages. In so doing the organization thinking approach is able to integrate in a novel frame the appreciation of individual decision-making, that stretched to the methodological individualism pretends to reduce the understanding the dynamics of the system and the perfomances of each agent to its action, and the holistic approach, that priviledges the role of the system into which individual action takes place, disregarding the role of individual action. In an organized complexity frame of analysis, methodological individulism and the holistic approach merge as complementary rather than alternative components of a broader system of dynamic and organized interaction. Such a complementarity in fact can be understood only if a dynamic perspective is taken, one where both the structure and the endowments of the system and the performances of the individuals are allowed to change and shape each other interactively.

This approach contrasts sharply the Social Darwinism upon which much research in innovation studies has been based. As David Lane argues "much of modern biology is based upon Darwin's theory of biological novelty, which analyzes the processes through which species come into being and are transformed, by means of mechanisms of heritable variation and selection. Given the tremendous scientific success of this theory, it is not surprising that many authors have sought to adapt it to other contexts. In particular, it is becoming increasingly fashionable to construct theories of innovation in human society and culture on a Darwinian foundation. We shall argue that this move is mistaken." (Lane: 12)

Social Darwinism is typically characterized by the association of individualism and evolutionist optimism originally framed by Herbert Spencer to justify a policy of *laissez-faire*. As the sophisticated chapter by Andrea Ginzburg argues: "the assumptions that free competition between individuals and enterprises would provide the best environment for social progress and the association of "survival" with "optimization from fitness" has come in for much criticism, which may also be directed towards certain interpretations of Darwinian selection." (Ginzburg: 127). As Ginzburg notes, the increasing awareness of the limitations of

Darwinian evolutionary approaches, emerging to-day in innovation studies, finds an interesting precedent in the radical criticism raised by Edith Penrose (1952) to the attempts to integrate Social Darwinism into mainstream economics based upon by the well known article by Armen Alchian (1950). According to Penrose "those who employ the biological metaphor in dealing with economic topics have a common characteristic: that of suggesting "explanations of events that do not depend upon the conscious decisions of human beings….to abandon [the] development [of the firms] to the laws of nature diverts attention from the importance of human decisions and motives, and from problems of ethics and public policy, and surrounds the whole question of the growth of firms of an aura of 'naturalness' and even inevitability." (Penrose, 1952: 809).

In chapter 3 Sander van Der Leeuw, David Lane and Dwight Read provide a clear account of the bootstrapping dynamics upon which innovation takes place: "1. A trial-and-error process identifies conceptual dimensions that summarize observations and experiences in a particular domain, so that these can be stored and transmitted in an economic and efficient manner; 2. The more such dimensions are available, the more questions can be asked, and the more answers found, further increasing the available know-how to solve emergent problems; 3. The human capacity for abstraction allows increasing numbers of conceptual dimensions, questions, and functional domains to be conceptually and hierarchically linked, thus structuring and increasing the connectivity between different domains of knowledge and understanding; 4. This leads to a continual increase in the density of identified conceptual dimensions in the cognized 'problem space' of the individuals involved, and thus gives those individuals an immediate edge over others, as well as over their non-human environment. 5. In the longer term, each solution brings with it its own unexpected challenges, requiring more problem-solving, and a more costly conceptual and material infrastructure to survive." (Van der Leeuw et alii: 98).

In chapter 13 Roberto Serra, Marco Villani and David Lane provide a solid analytical account of the basic model. At each point in time agents are embedded in a context that is shaped by past innovations and keeps growing because of the successful introduction of innovation in the past. Agents are confronted with the increasing limits of their context. As Serra and colleagues assert: "systems without innovation collapse unless there is an external market or a self-sustaining loop is already present within the system. Imitation alone is unable to introduce a significant number of novelties; and the simultaneous presence of imitation and jump actions allows a strong increase of diversity in the resulting artifact space." (Serra

et alii: 368). The model is based upon the following basic assumptions: a) agents are heterogeneous and characterized by intentionality, their competence and knowledge is inherently localized in a limited region of the knowledge space; b) when the limits to growth become apparent and the risks of decline are too strong, agents try and react with the introduction of innovations; c) to innovate, however, each agent must rely upon qualified interactions with other gents endowed with complementary expertise: nobody invents alone. As Serra and colleagues stress: "Agents come to invent and share a new interpretation, based on the discovery of different perspectives and uses of existing or expected artifacts, by means of interactions"; d) the generative potential of a relationship depends upon the 'aligned directedness' of the agents – whether they are all interested in operating in the same region (or in neighboring regions) of agent-artifact space; and their 'mutual directedness'- whether the agents are interested in interacting with each other.

The simulation model implemented by Serra and colleagues provides the basic tools to implement and operationalize the notion of coalitions for innovations. Coalitions are formed when the diverse incentives of a multiplicity of heterogeneous agents is organized so as the exhibit clear elements of mutual and aligned directedness. When the colation is formed, and the relationships among the members are actually generative, the puntual invention of a 'creative' agent can lead to the actual introduction of an innovation.

The case study analyzed in chapter 9 authored by David Lane and Robert Maxfield and in chapter 10 authored by Federica Rossi, Paolo Bertossi, Paolo Gurisatti and Luisa Sovieni shows how the eventual introduction of LonWorks, an innovative technology for distributed control networks, first introduced in the Silicon Valley, is the result of a lonstanding process of construction of a 'market system' where the complementary competences and incentives of an array of diverse agents performing an array of specific functions are identified and brought together to cooperate to the successful introduction of the innovation.

Market systems are presented as the emerging property of an organized complexity based upon structured transactions enriched by interactions. Agents interact in the market place by means of structured transactions. Such transactions are far from the typical impersonal exchange depicted in textbook microeconomics. These transactions take place within the context of long-term, incomplete contracts and as such are recurrent, personalized and based upon reciprocal trust and confidence. They are

characterized by intense user-producer interactions where both parties cooperate in valorizing the shared learning processes that arise by using new artifacts that have been the object of prior and possibly subsquent transactions. The understanding of all the potentialities of a new artifact and their active and intentional exploitation, in other words, requires the interactive participation of both parties involved in the transaction and the convergence of their choices towards common perspectives. Long-term, incomplete contracts emerge from recurrent interactions and shared interest so as to provide the context into which transactions are enriched by forms of tacit cooperation. The notion of transaction-based-interactions is quite novel and important as it elaborates and identifies a key aspect of market interactions comprised between the extreme cases of 'perfect transactions' and 'perfect interactions'. The former miss the appreciation of the rich context into which real transactions in real market places take place. It may apply to quite a limited spectrum of actual exchanges concerning only perfectly homogeneous commodities, highly standardized. The latter fail to appreciate the economic aspects of social interactions and risk to portray collective innovation processes as the by-product of spontaneous exchanges of gifts by cooperative agents with no rent-seeking perspectives. The notion of transaction-based-interactions fits instead quite nicely to explore the wide spectrum of actual circumstances that characterize real markets exchanges and enables to appreciate the convergence of the rent-seeking behavior of intentional agents that try and maximize their individual benefits by means of their participation to the emerging creation of a new organized form of social exchange centered upon an innovation.

The approach to innovation as a collective process, shaped by the coalition of interactive an intentional agents within a structured context, contrasts the notion of technological trajectory much used in the innovation studies literature as it show clearly how the development of a new technology is the result of a sequence of complementary and cumulative actions that take place through time where each is characterized by ontological uncertainty and is the result of a specific choice shared by a variety of individuals. At each node of the sequence the direction of the process is far from being predetermined: a variety of alternative directions are possible, different outcomes are possible with different structures of generative relations; even the rates of the process are indetermined as the pace varies across times in which it may loose momentum and stop or gain momentum. Only the convergence of a plurality of complementary actions aligned through sequential chains of user-producers relations can shape the actual direction and speed of the process. The architecture of coalitions plays a key role here and at each

point in time exclusion and inclusion of specific, idiosyncratic characters, embedded in different groups of agents, with different profiles in terms of skills, competence and incentives, may alter the direction and the rate of the process, as well as its actual chances of success or failure. Ex-ante, in other words, there is no trajectory, but rather a multiplicity of possible paths.

Retrospectively everybody can easily identify a trajectory in any sequence of cumulative steps that implement and develop a specific technology: any historic sequence of technological advances can be intepreted as a trajectory. The notion of technological trajectory should be replaced by the understanding of the effects of the past upon the choices that agents make at each point in time: path dependence in other words appears to be much a more fertile frame of analysis of technological change. As Federica Rossi and colleagues stress, "innovation processes are not simply driven by the technical characteristics of certain artifacts: the interpretations that different agents make of them are also crucial in driving their actions and hence in determining the overall shape of the process" (Rossi et alii :306).

The excellent case study of the attempts to implement the use of LonWorks in Italy, shows that issues of technological superiority are not obvious attributes of a new technology since its first intuition, but, on the opposite, they are the end result of the active construction of a market system based upon cascades of generatives relationships and social negotiations. The actual technological superiority of an innovation does not immediately guarantee its success over its competitors. Even the technology's basic features are the object of negotiation, debate and participation of a wide variety of agents involved at different stages and in different roles in its successful development. The success of an innovation is the result of the construction of a market system that, as the case study of LonWorks shows, often, is a process that spans across established industries and over a very long time stretch, requires the widespread accumulation of competence, the introduction of new interoperability standards, the formation of dedicated skills and the creation of networks of suppliers of complementary devices. The intertwining of an array of different forms of increasing returns is necessary to substantiate the actual superiority of a technological innovation: economies of scale, density and learning on the supply side interact with economics of scale to adoption of the demand side. External economies matter on both sides to help the individual agents to contribute to building and appreciating the superiority of the new artifact. This detailed analysis enables Federica Rossi and colleagues to note that "the

processes that construct a new market system result from a combination of innovation projects, which trigger subsequent cascades of changes but that are not lined up along a 'natural' trajectory (Nelson & Winter, 1982) determined by the artifact's intrinsic features. Each of the agents that we encountered developed its own course of action in conditions of ontological uncertainty (…) based on personal evaluations, attributions, and narrative structures (…..) the sum of these individual actions cannot be considered as the predictable consequence of certain events. While the concept of 'technological trajectory' (Dosi, 1982; Nelson & Winter, 1982) may be useful to describe, retrospectively and with the benefit of hindsight, the evolution of a broadly conceived technological system, it is not useful to interpret innovation processes in the making, since they are characterized by constant novelty, idiosyncrasy, and path dependency, and they are affected by the 'hierarchically tangled' (….) actions and interactions of agents located at different levels of social organization." (Rossi et alii: 309)

The chapter by Denise Pumain, Fabien Paulus and Celine Vecchiani Marcuzzo provides a comprensive application of the dynamics of generative relationships to explore the role of innovation as the essential driving force in urban dynamics. Generative relations are the loci of innovation and are phisically based in cities. Cities are the centers for the integration of human capital embedded in different firms and different individuals and are the phisical context into which the scaffolding of generative relations take place more easily because they make possible the flow and exchange of ideas. As stressed by Denise Pumain "it is the organization of cities, that provides scaffolding structures where *knowledge* can be generated, developed, stored and accessed, and economic organizations – firms and networks of firms, as well as development agencies etc. – that carry out economic activities – production, exchange, finance and so on – which generate growth" (Pumain et alii: 256-7). To do so cities attract talents and creative individuals and firms. At the same time cities are the organizational component of the social system where the limits to growth appear more evident and compelling. The dynamics of growth spurred by the successful introduction of an innovation at time t-1, and sustained by the attraction of new skilled agents, encounters quickly the limits of congestion. Negative externalities, at time t, exceed the positive ones and decline is likely take place. Only the capability to face the emerging challenge by means of the activation of a new loop of generative relations may enable a city to contrast the slide into decline and pave the way to a new stage of growth based upon a new wave of innovations. The strong empirical evidence about the effective working of the 4/3 power law in

the relations between the size of cities and their performances as incubators of inventions, as measured by an array of indicators including patents, provides a superb test to the theoretical model and complements the rich historic analysis based upon the compartive evidence on the changing structure of the urban systems, both at the national and global levels across centuries.

The historical evidence elaborated by Pumain and colleagues documents how the hierarchical organization of cities and the related flows of information and knowledge among them varies both for the effects of bottom-up processes of entry of new cities in the system and for the bottom-down changes in the organization that take place when new key cities are able to emerge as central nodes in the global and national systems and the architecture of the flows of communication among cities changes. The urban system appears as an organization of cities related to each other by a hierarchy based upon their creativity. Cities grow in the national and international urban hierarchy only if they are able to support, at a more than proportionate rate, the creation of new technologies and the introduction of innovations.

The chapter by Federica Rossi and Margherita Russo explore the policy implications of the appreciation of the key role of generative relationships as the 'privileged loci where shifts in attributions of identity and functionality take place and eventuallty lead to the actual introduction of an innovation. To foster innovation, policymakers should attempt to promote the formation of effective coalitions for innovations able to increase and monitor relationships with high generative potential. Rossi and Russo elaborate a consistent road map for a successful innovation policy based upon a well defined sequence of complementary steps. In order to help the memergence of a coalition for innovation that favor the successful introduction of a specific innovation it is necessary to identify: a) what kind of agents are most likely to possess actual and potential complementarities with respect to the specific characteristics of the new artifact; b) what kinds of interactions – among which kinds of organizations and concerning which kinds of activities – are likley to support the specific innovation processes; c) what are the most likely interaction loci that promote the emergence of generative relationships; d) whether local actors belong to local, regional, national, or international competence networks and which structures, if any, coordinate the competences required at the local or industry level with the training needs of individuals and organizations, and e) to compensate for possible 'missing links' with the creation of specific cognitive and physical scaffolds and competence networks.

The analysis of Rossi and Russo paves the way to radical rethinking of innovation policies mainly based upon the dissemination of incentives and subsidies to compensate would-be-innovators for the pretended non-appropriability of knowledge and hence remedy to the ensuing market failures. The implications of organization thinking for innovation policy are well elaborated by Rossi and Russo who implement successfully the notion of coalition for innovation and stress the role of possible purposed interventions to create or at least strenghten the scaffoling structures that constitute the basic support to innovation processes: "policymakers should explore how such structures can be monitored and supported, whether there are any 'missing links' in the competence networks at the local or national levels, whether coordination with other policy fields (education, social, industrial) is required to design appropriate interventions, and, finally, whether it is possible to design policies that foster the emergence of new competence networks – promoting interactions between organizations that are involved in producing, using, installing the same technology or similar technologies – thereby encouraging the development of new applications." (Rossi and Russo: 322 and 323).

The chapter of Federica Rossi and Margherita Russo shows all the limits of the national, sectoral and regional systems of innovation approach, as it has been mainly implemented in innovation studies. The systems of innovations, in fact, are far from being the static and exogenous precondition for the successful introduction of innovations as they are considered in this literature (Malerba, 2005). Systems of innovation do not fall from heaven, like manna, nor do they stay put through time. Systems of innovation are the endogenous product of coalitions for innovations, that is the dynamic coordination of the incentives and the performances of a multiplicity and variety of actors with diverse skills and technological profiles when and where the intentional action of agents happens to share clear elements of potential 'aligned and mutual directedness'. Hence the creation of systems of innovations, or 'market systems' in the parlance of this book, should become the objective of intentional decision making at the policy level and of strategic action for corporations with the implementation of centered coalitions around technological platforms able to implement and guide the working of specific coalitions (Consoli and Patrucco, 2008) and collective entities organized in technological districts (Lane, 2002).

Much of the analysis carried out in the book explores the creation of the coalitions for innovation as the result of complex processes that involve

the interactive participation of a variety of heterogeneous actors and is characterized by the typical features of the emergence of spontaneous order (Hayek, 1978). Yet this chapter opens a new perspective about the possibility to complement the dynamics of spontaneous order with deliberate and intentional interventions specifically designed to favor, accelerate, strenghten, if not build from scratch, the creation of new coalitions for innovation. The design of coalitions for innovations, the identification and inclusion of the potential members, the organization of their competences and their incentives, their governance by means of the strenghtening of their ties and their interactions, and focussed interventions, aimed at increasing the compatibility of their incentives and performances, in other words, can and should become the objective of multilevel decision-making not only at the policy level but also as a component of a business strategy that is aware of the dynamic advantages of the creation, implementation, governance and guidance of a coalition for innovation centered upon specific purposes.

In conclusion, this book makes an important contribution. It provides new foundations to implementing a broader evolutionary approach to economics and contributes the integration of complexity approaches to enrich economic geography, regional studies and the economics of innovation and new technology (Antonelli, 2009).

This contribution is important at a time of growing concern with the evident limitations of the applications of Social Darwinism to understanding innovation. Once more, and for the second time, after the clever inclusion of Alchian's intuition into the neoclassical frame operated by Milton Friedman (1953), the results of Social Darwinism have been easily integrated into mainstream economics. The analysis of innovation and technological change as the result of the spontaneous, un-intentional, ubiquitous, 'natural' and steady recombination of learning agents has fed in fact the notion of endogenous growth and new growth theory at large.

Evolutionary economics needs to accommodate the understanding of innovation and structural change as an endogenous process where the intentional action of human agents plays a role. It is clear that we need to analyze innovation as the result of some intentional decision-making: innovation plays too strong a role in social and economic change to be treated as an exogenous event. It cannot be treated as manna, neither as the outcome of spontaneous and uncontrolled learning processes, nor as the product of random variations and accidental mutations.

The limitations of the Darwinian evolutionary thinking that pretends to explain innovation as the product of accidental interactions, that take place with no intentionality, no explicit decision-making and no causality are becoming more and more evident at a time when both the rate and the direction of technological change exhibit strong variance and increasing inequalities across nations, regions, cities, sectors, and companies (Mokyr, 1990 and 2001). Darwinian evolutionary thinking is clearly unable to provide a satisfactory reply to the basic question of the economics of innovation: why some countries, and regions, some cities, some sectors and some firms innovate more or less than others, at different times? As a matter of fact it seems quite evident that the applications of Social Darwinism to the economics of innovation have contributed, at best, to explain the selective diffusion of innovations, but not the introduction of innovations.

The complexity perspectives implemented in this book by David Lane and colleagues provides a rich framework that is able to integrate the microeconomics of innovation, that is the analysis of the intentional decision making of singular agents with the appreciation of the organized complexity of purposed coalitions for innovation into which their individual creativity can be socialized, valorized and finally emerge. It complements the recent, parallel product of the Santa Fè group by Brian Arthur (2009) which applies a similar approach based upon the basic tools of complexity analysis to exploring the dynamic structuring and creation of new technologies with a much stronger emphasis on the analysis of the mechanisms by means the necessary variety of incentives and competence profiles of a multiplicity of agents is brought together within coalitions for innovations. In so doing this book makes a substantial contribution to implementing a systemic theory of innovation. The analysis of innovation in fact cannot be based only upon an individualistic approach, nor can the intentional role of individual innovators be disregarded. Innovation is a systemic event and more specifically the emergent property of a complex system where the act of ingenuity of the rent-seeking, intentional invention of individual agents, facing the risks for decline, become an actual innovation when the conditions for the creation of social consensus and the active participation and convergent intentionality of a variety of individual actors, within coalitions for innovations are fulfilled. Innovation is clearly the emergent property of a dynamic system that takes place when qualified interactions become effective generative relationships structured by appropriate scaffolding social organizations that take place in cities and across cities within the national and global urban system.

Coalitions for innovation are mainly the product of spontaneous order, yet their emergence can be guided and designed by means of the intentional intervention of policy makers and the business strategy of corporations that are able to appreciate, understand and guide the advantages of the convergence of incentives and competences of a variety of complementary actors. The successful introduction of an innovation may be regarded, to stretch the grafting from political science, as the result of a hegemonic coalition, that is a coalition that has been able to design a group of complementary agents, coordinate their incentives and integrate their competences so as to of achieve hegemony in a given product and functional space.

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