

Technological Advance and the Changing Structure of Transnational Standards Organizations¹

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Introduction

Since the 1980s, there has been a significant shift in standards activities from traditional standards development organizations (SDOs) to IT consortia. Included among these, for example, have been consortia to develop standards for Switched Multimegabit Data Services (SMDS), Fiber Distributed Data Interface (FDDI) over twisted pair, asynchronous transfer mode (ATM) and frame relay technologies. The major user consortia have included the Corporation for Open Systems (COS), Manufacturing Automation Protocol (MAP), and the Technical Office Protocol (TOP) (Weiss and Cargill 1992). Operating on a relatively exclusive basis, these groups greatly simplified the standards process. Unlike traditional standards organizations, consortia have tended to be relatively loosely coupled, and unbound by rules requiring elaborate processes and openness on a broad scale (Cargill 2004; Hawkins 1999; David and Schurmer 1996).

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The rise of consortia has been explained in a variety of fashions. For example, focusing on the role of transaction costs, some have argued that, because consortia involve fewer players and not as many due process constraints, it takes far less time and resources to negotiate standards outcomes in consortia than it does in traditional standards developing bodies (Cargill 2002; Weiss and Cargill 1992). Others have pursued a rational actor model, contending that firms have more incentives to join consortia than they do traditional SDOs, not only because there are fewer members to share the benefits, but also because side agreements are more easily negotiated (Schallop 2000; Garcia 2005). Still others argue along institutional lines, suggesting that today's standards development organizations are becoming isomorphic both with respect to each other and to their larger institutional environments (Bunduchi et al 2005; Egyedi 2000; Werle 2000). While these explanations provide considerable insight into the nature of consortia, they fail to provide a totally satisfactory explanation. In particular, they do not adequately account for the role of network structure. That is, they fail to consider what is it about today's networked-based global environment that has led to the rapid emergence of consortia as the standards organization of choice, and what is it about the network structure of consortia that matches the needs of the times?

This paper addresses these questions. It argues that what differentiates today from the earlier industrial period is the fast paced, network-based, intensively competitive nature of the global economy. In such an environment, firms must place a premium on gaining competitive advantage not solely by reducing costs, but also—and perhaps more importantly—through information access and continuous innovation. The preference for standards consortia over traditional SDOs reflects this imperative.

In making this case, we proceed from the notion that social structure³ matters. In particular, we contend, along with Burt (2005), that significant innovative advantages can be derived from the resources and social capital that are associated with bridging structural holes⁴--the unconnected spaces in the social structure. On this basis, we hypothesize that consortia—given their more loosely coupled organizational arrangements—will afford greater bridging activities, thereby providing greater opportunities to access information resources and develop an innovative vision than do traditional, more

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A social structure is a stable order or pattern of social relations among positions, consisting of the set of direct and indirect connections between the actors occupying these different social positions (Laumann and Pappi, 1976: 6)

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Structural holes, according to Burt, are empty spaces in social structure. The value-potential for structural holes is that they separate non-redundant sources of information, sources that are more additive than overlapping (Burt 2005: 16). Burt argues that information access, power, and influence can be maximized when actors create ties between relatively dense networks across structural holes. Structural holes increase variation within a group, whereas closure decreases variation (Burt 2005).

bureaucratic, standard setting organizations. In addition, we hypothesize that consortia members can extend their repertory of structural holes without sacrificing the trust associated with network closure (Burt 2005) and the prestige associated with exclusivity, (Podolny 2001), because of the relatively restricted nature of their memberships.

The paper proceeds as follows. It begins with a characterization of traditional standards setting organizations as they emerged within the context of the industrialized economy. Second, it recounts the rise of consortia, and describes how they relate to the imperatives of the globally networked economy. Based on this analysis, the paper hypothesizes that one reason why consortia have thrived is because they exhibit a greater number of brokerage opportunities than traditional SDOs, providing them an advantage in acquiring and controlling knowledge resources. We then test this hypothesis using social networking tools.⁵ Focusing on interoperability standards, we develop two affiliation networks, one for traditional SDOs and the other for consortia, based on data drawn from a number and variety of standards development organizations. From this affiliation network, we generated two adjacency matrices with which we measure the structural variables defining brokerage opportunities and prestige indicators.

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See, for instance, Stanley Wasserman and Katherine Faust 1994; and John Scott 1991.

Because of their different structures and processes, consortia have often been criticized on antitrust, due process, and intellectual property grounds, among others (Lea and Hall, 2004; Balto, 2000; Anton and Yao 1995). An adequate evaluation of them requires a better understanding of what role, if any, structural variables play in accounting for the growth of consortia.

Standard Setting in the Industrial Era

In the United States, the emergence of standard setting as an institutionalized process was directly linked to the advent of industrialization. With the transition from local agrarian based economies to a nationally based industrial economy, firms had to contend with far greater uncertainty and information asymmetry than ever before. At the same time, advantages in communication and transportation technologies, combined with the mechanization of industry, generated a crisis of control, forcing firms to invent new ways to speed up production processes (Beniger 1986). To meet this challenge, firms adopted two basic strategies—the bureaucratic, vertically integrated firm and mass production (Williamson 1951). Standardization was integral to both strategies.

The relationship between standards and mass production was self-reinforcing. As tasks became more specialized and societal actors more interdependent, interoperable parts allowed for standardized production

processes, which drove the need for standardized machine tools and precision gauges, which led in turn to standardized measures (Williamson 1951).

Likewise, industrial organizations gained greater access to resources and reduced their transaction costs, when they adhered to standardized rules and procedures institutionalized in their environments (Beniger 1986). In so doing, bureaucratic organizations themselves became standardized (DiMaggio and Powell 1991).

Standard setting organizations soon emerged in the private sector to meet the growing need for standards⁶. By 1925, there were approximately 365 national organizations in the U.S. accredited to develop standards (OTA 1992). Not surprisingly, the organizational form that standards development organizations took was in keeping with the bureaucratic climate of the times. Standards organizations were highly specialized and operated independently of — if not at odds with— one another (OTA 1992). They were, in effect, third-party administrators, who specialized in coordinating the participants engaged in developing standards. Lacking government support, these SDOs were supported in varying degrees by membership fees and the sale of standards.

Although their independence allowed them to develop according to their own

⁶ The first American standards organization was the United States Pharmacopial Convention, which was set up in 1829 to establish uniform standards for drugs. The American Iron and Steel Institute, established in 1885, was the first trade association to develop standards. The American Society of Civil Engineers, which was formed in 1852, was the first scientific and technical society involved in standards development.

lights, they were actually quite similar to one another. All were structured along hierarchical lines, with technical committees reporting to higher-level committees in a well-defined vertical process. Moreover, standards organizations typically operated in accordance with well-specified rule-based procedures. For many, these included rules to ensure relative openness, a balance of interests, due process, an appeals process, and a rough consensus. In addition, a good number of SDOs coordinated their activities through the American National Standards Institute (ANSI), a private, not-for-profit federation of standards organizations, which served as the accepted US representative in international standards organizations.

European standards organizations, which were also triggered by industrialization, were even more bureaucratic than their US counterparts. To begin with, European standards organizations were dependent on governments for their support. In addition, because European governments generally pursued broad-based industrial policies, they typically played an activist role in standards development. In Germany, for instance, standards policies evolved through negotiations among economic interests and other key groups in society, organized nationally through peak associations. German standards organizations were similarly centralized, operating through a nationally recognized standards organization, the *Deutsche Institute for Normung (DIN)*. Likewise, in France,

standardization mirrored the dominant role of the state in French politics (Hayward 1982), emerging at the national level from a presidential decree. In 1984, the French Government declared standardization a public service, and entrusted AFNOR, the national standards body of France, with responsibility for sourcing, coordinating, approving, and promoting standards training as well as controlling the use of the NP label—a trade mark that shows compliance with a French national standard.

The traditional international standardization organizations were likewise cast in a bureaucratic mold. Key among these are the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and the International Telecommunications Union (ITU). Although these international organizations provide a venue for producing international standards, their activities are to a significant degree constrained. Representation in these bodies is on a national basis, even in some cases—such as the IEC—in the standards technical committees. Given a direct line of authority from the committee level to the nation state, participants in the international standards setting bodies are insulated to a certain degree from the full range of activities in the overall standards setting environment.

The bureaucratic model of standard setting worked well throughout the industrial era, in which cost reduction and overcoming complexity were major

priorities. Because traditional standards organizations specialized in the business of setting standards, they greatly reduced the transactions costs that would have overwhelmed more ad hoc arrangements. Likewise, the costs of haggling over standards outcomes were diminished, given due process and rough consensus norms. Moreover, supported in part through standards sales or—as in Europe—by government subsidies, standards organizations were able to overcome problems of collective action. Equally important, because these organizations came to resemble one another as well as other bureaucratic organizations in society, they were able to secure the institutional legitimacy and external resources required for survival (Powell and DiMaggio 1991; Meyer and Rowan 1991). One downside of the bureaucratic model was the time required to execute the formalized standard setting process. However, timeliness was not a major problem during the industrial era because technologies and business methods were relatively stable, and the number of participants was limited.

Standard Setting in the Knowledge-Based Global Economy: The Rise of Consortia

Gaining competitive advantage in a knowledge-based global economy increasingly depends on businesses' ability to innovate, respond just in time, focus on quality, and establish more cooperative interfirm and intrafirm relationships. In this new environment, information and knowledge are primary resources, and a prerequisite for the development of all other resources.

Just as standards provided the building blocks for the industrial economy, so will they constitute a critical platform for economic activities in the globally networked, knowledge economy (Libicki 2001). Interoperable systems not only reduce transaction costs, they also provide businesses the flexibility needed to customize applications and support changing business processes and flexible business relations. Moreover, with the freedom to mix and match a wide variety of new components, businesses can employ information technology to add value as well as develop and support new products and services, not only in the traditional fields of telecommunications and information technologies but also in a wide range of service sectors, such as health care and home security (Bolin 2005).

Not surprisingly, firms are turning to standards setting organizations to help develop interoperable networking solutions. However, instead of looking to the traditional SDOs of the past, firms are increasingly bypassing them in favor of a wide array of more flexible, *ad hoc* standard setting arrangements, generally referred to as standards consortia⁷ (Cargill 2002; Werle 2001; Libicki

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As Updegrave points out, consortia vary with respect to the scope of their undertakings. Some consortia emerge to fill a specific technology gap, or a small piece of a larger puzzle, often with an existing technology. As he says, these consortia, “. . .are often formed to develop a standard to fill an important niche-industry technical gap that is not large enough to merit the attention of an industry standard setting body.” (Updegrave 1995b: 327). The other type of consortia, which Updegrave calls ‘ahead of the curve,’ focus on developing standards, which

2001; Hawkins 1999; David and Shurmer 1996; Updegrove 1995; Weiss and Cargill 1992)

The rise of consortia can be traced back to the late 1980s when many vendors, discouraged by lagging standards setting processes, began to develop standards in more ad hoc, focused, interest-based consortia⁸. These consortia proliferated in the 1990s, leading to a major shift in the standard setting field. Spurred on by the Internet and the growth of the World Wide Web, technology manufacturers and vendors set up consortia to develop standards that were compatible with these new growth technologies. Commenting on the changing landscape in which standardization now takes place, Werle has noted:

In the last two decades standardization organizations (SOs) in telecommunications and information technology . . . have proliferated. Both the globalization of markets and the blurring of technical boundaries have induced an overlap of the domains of international and regional SOs. At the same time, SOs at the national level are losing significance. Traditional organizations have been restructured and—assisted by governments—new official SOs have been created at the regional level. Most dramatic, however, has been the growth of private consortiums and forums. Thus, official standard setting is confronted with an ‘informal sector’, the evolution of which indicates some discontent with the traditional organizations and entails an inherent potential of jurisdictional conflict (Werle 2001: 392).

support large- scale systems or architectures. He cites the Object Management Group, the largest software consortium in the world, as a prime example of such a group (Updegrove 1995a).

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Past efforts to make allowances for technology advance, and facilitate interoperability among an increasing number of interdependent parties, often meant that networking standards were incorporated into elaborate reference models and defined in very broad and general terms. This process was so complex and time consuming that the window of opportunity closed and those standards were overtaken by new technologies and events (Cargill 1989).

Just as traditional standards development organizations mirrored the bureaucratic environment in which they operated, so too these new types of standards consortia tend to replicate the networked, alliance-based business models associated with the post-Fordist, global economy⁹ (Powell, 2001; Grabbher, 1993; Nohria and Eccles, 1992). For example, unlike traditional SDOs, consortia are not general-purpose organizations; they are set up on an ad hoc basis by companies in search of a solution to a specific but common business problem. Thus, instead of providing for broad-based access, membership is on a 'pay to play' basis; hence, is it typically limited to those with a direct business interest. Moreover, membership rights, which can vary considerably, are generally assigned based on the size of the financial investment or technical assistance that participants contribute to the effort (Updegrave 1995). Because of this exclusivity, consortia often replicate the dynamics of the market; participants invest in the process because of an anticipated 'pay off.' Not surprisingly, consortia are far less preoccupied with administrative issues than traditional SDOs (Updegrave nd). In most cases, the size of the administrative staff is quite small; in fact, in a number of instances, administrative tasks are carried out by

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As Storper notes: "In the American economy. . . total vertical integration declined from 30 percent to 21 percent between 1987 and 1997, and even manufacturing vertical integration decreased from 30 percent to 27 percent. In most of the specific sectors said to be increasingly flexibly specialized, these declines were even more dramatic." (Storper 1997: 6)

the 'host, or sponsoring, company,' or outsourced to a service entity set up for that purpose. Overall governance is executed by a board of directors, which is also tasked with developing the consortia's general strategic business plan. As in SDOs, technical committees and special interest groups are responsible for actual standards development. Much of their business is carried out in virtual space (Updegrove nd).

Accounting for Consortia

The rise of consortia can be explained in a number of different ways—employing an institutional analysis, a transaction cost approach, and a rational actor model. Although each of these explanations builds on a different analytical framework, they are not mutually exclusive.

Institutional Analysis

Institutional analysis posits that organizations are socially embedded in a common domain of activity—generally referred to as an organizational field.¹⁰ So situated, they become isomorphic both with respect to each other and to their environments¹¹ (DiMaggio and Powell 1991; Meyer and Rowan 1991). As Meyer and Rowan have described it:

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As described by Scott, an organizational field is “a population of organizations operating in the same domain, as indicated by the similarity of their services or products. Included also are those others that critically influence their performance, including exchange partners, competitors, funding sources and regulators (Scott 2001: ---)

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. . .organizations are driven to incorporate the practices and procedures defined by prevailing rationalized concepts of organizational work and institutionalized in society. Organizations that do so increase their legitimacy and their survival prospects, independent of the immediate efficacy of the acquired practice (Meyer and Rowan, 1991: 41).

Because organizational structures are aimed primarily at ensuring stability and maximizing external support, they are not necessarily efficient. In fact, organizations will generally trade off some economic performance in exchange for social support (Meyer and Rowan 1991). However, despite their inefficiencies, organizations tend to become mythologized over time, and subsequently locked in¹² (Meyer and Rowan 1991; Powell 1991). Organizational members, having invested heavily in a given mode of operation, have a tremendous stake in maintaining the status quo, as do all other organizations with whom they interact¹³. As a result, organizational change is rare and

DiMaggio and Powell identify three forces leading to isomorphism; formal and informal pressures exerted by other organizations, a common legal environment, and organizational benchmarking, especially during periods of uncertainty (DiMaggio and Powell, 1991)

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In this sense, organizations are constitutive of the broader institutional environment in which they operate. At the same time, the institutional context serves not only to constrain organizational options; it also helps to determine and reinforce the criteria by which people develop their preferences and evaluate organizational behavior (DiMaggio and Powell 1991; Berger and Luckmann 1967).

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As Pierson notes, "In the context of complex social interdependencies, new institutions and policies are costly to create and often generate learning effects, coordination effects, and adaptive expectations. Institutions and policies may encourage individuals and organizations to invest in specialized skills, deepen relationships with other individuals and organizations, and develop particular political and social identities. These activities increase the attractiveness of existing institutional arrangements relative to hypothetical alternatives. As social actors make

discontinuous. When change does take place, it is typically during periods of fundamental transformation, when new needs emerge, which cannot be met by existing, homogeneous organizational structures (Powell 1991; Hannan and Freeman, 1989; Berger and Luckmann 1967). An opportunity then exists for newcomers to emerge on the periphery, so as to challenge existing practices and introduce new organizational forms. However, in order to successfully challenge incumbents, newcomers must not simply compete for resources based on new forms of practices; as importantly, they must reinterpret current practices in light of an alternative and compelling institutional logic (Schwartz, 1997).

Institutional analysis provides a fruitful basis for exploring the evolution of standards setting organizations. To begin with, it helps to account for the longevity of the traditional standardization process and the similarities among standards organizations that engaged in setting totally different types of standards (Garcia 2004). In fact, Werle (2001) employs the notion of isomorphism to account for the many similarities that continue to exist in the practices of consortia and traditional SDOs. Although its main focus is on the homogeneity of organizations, institutional analysis can also account for organizational change and transformation, such as the rise of consortia. As predicted by the theory (Powell 1991), consortia emerged in the periphery,

commitments based on existing institutions and policies, their cost of exist from established arrangements generally rises dramatically” (Pierson 2000: 259).

initiated by vendors with unmet needs, who—not being central players in traditional SDOs—were relatively unconstrained by existing institutional prescriptions. The rapid diffusion of consortia within the IT community can also be understood as a process of mimetic isomorphism. As Updegrave points out, not having a blueprint for organizing new standards bodies, many founders benchmarked the best practices of others (Updegrave nd). Moreover, in legitimating their approach, consortia capitalized on the parlance of the day, stressing economic issues, while downplaying those related to process.¹⁴ This ideological rationale resonated with the public, as evidenced by the passage of the Cooperative Research Act of 1993, which supported the creation of business alliances as a means of promoting US competitiveness.¹⁵

Transaction Cost Analysis

Whereas institutional analysis downplays the importance of economic efficiency, transaction cost economics places it front and center. From a transaction cost perspective, economic actors structure their activities so as to

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Accordingly, they characterized their policy of restricting access to those who ‘pay to play,’ as the key to their success. What matters, they contended, is not that the process is open to all, but rather that standards are developed, which are widely used. As proof, they pointed to the willingness of so many businesses to invest in consortia (Garcia 2004)

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As one might expect, the shift towards consortia was accompanied by contested by traditional standards development bodies. As Cargill has described: “. . .both groups believed they were in a ‘do or die’ situations, in which their specific survival depended upon the ability to diminish (but not destroy) the other side whilst retaining hegemony for their set of beliefs.” Cargill 2002: 33).

minimize the costs of transacting. (Williamson 1985; Coase 1960) These costs include the time, energy, and money spent gathering, processing, and using economic information; they are a function of uncertainty and the opportunity for economic actors to take undue advantage of one another (Williamson 1985).

According to the theory, when transaction costs are high, it behooves economic actors to expend their resources to set up governance structures, such as vertically integrated firms, which will help reduce these costs¹⁶. On the other hand, when transaction costs are low and non-recurring, economic actors will be better off avoiding these governance costs and doing business instead in the market place (Williamson, 1985; Coase, 1960).

Like institutional analysis, transaction costs economics is a useful lens through which to trace the evolution of standard setting organizations. As described above, standardization was a primary means of reducing transaction costs in the rapidly expanding and increasingly complex industrial economy. At the same time, traditional SDOs, which specialized in administrative tasks, greatly reduced the transaction costs entailed in coordinating standards

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Depending on the level of uncertainties, the size and scope of their activities, and the time frame involved, organized relationships can be governed in a variety of ways. For example, governance structures can take the form of narrowly focused contracts, loosely coupled strategic alliances, joint ventures with share equity or vertical integration. Likewise they can vary with respect to command structures and authority systems, incentive systems, standard operating procedures, dispute resolution procedures and non-market pricing. (R. Gulati and H. Singh, 1998.).

development. Equally important, because traditional standards organizations followed formal, prescribed rules relating to due process and consensus building, they helped to reduce procedural uncertainties and the possibilities for opportunism (Gulati and Singh 1998). Today, given the changing IT environment, in which firms require a fast-tracked process from specification to implementation, the decline of the SDO and the rise of consortia can similarly be understood in transaction costs terms. In light of the rapid pace of technological change, and the number of standards efforts in which firms must participate, long-term bureaucratic solutions no longer make economic sense. Instead, today's businesses might better invest in specialized arrangements, which are specifically tailored to particular business needs. Similarly, because speed is of essence, firms are better off in consortia, which have limited membership, and hence less time-consuming negotiations and administrative costs associated with them. As well, in such an environment, firms can more easily share information allowing for bargaining and side-payments (Farrell and Saloner 1998). Equally important, in contrast to traditional SDOs, consortia can operate according to streamlined rules and procedures with less risk of opportunism¹⁷. Opportunism

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As Updegrave has noted, consortia must act in accordance with a number of legal prescriptions. They must have a certificate of incorporation, detailed bylaws, an explicit intellectual property policy, a statement describing the policies and procedures of the technical committees, and a membership application that serves as a legal contract, binding members to the rules of the organization (Updegrave nd)

can be minimized not only because of network effects and the interdependencies among consortia members¹⁸, but also to the extent that, given fewer members, participants are likely to be more densely interconnected and have closer working relationships, which allows for the monitoring of behavior and the building of trust (Burt 2005; Nooteboom, Berger and Noorderhaven 1998; Jones, Borgatti, and Hesterly, 1997; Krackhardt 1992).

Rational Actor Approach

A third approach to interpreting the shift from traditional standards organizations to consortia is one that focuses on the individual motivations of rational actors, and the problems associated with collectively providing a semi-public good, such as standards¹⁹. Notwithstanding the many benefits associated with standards, their development is costly. These costs include not only those entailed in bringing actors together and coordinating their activities, but also in

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Describing how network interdependencies discourage excessive proprietary interests, Updegrove notes: "Some proprietary vendors invest considerable time and effort in forming and participating in a consortium with the objective of injecting some proprietary element into the final standard which they believe will favor them in the marketplace. Such tactics are dangerous, however: if the vendor overplays its hand, the standard will be viewed as too favorable to, or dependent on, one vendor and that vendor's competitors will back away from the standard The vendor not only may fail to reap the special advantage which it sought, but may also in fact jeopardize its entire business when the standard underlying the development of its product line is not seen by its potential customers as being useful." (Updegrove 1995)

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Public goods are those goods whose benefits are available to everyone (non-rivalry) and from which no one can be excluded (non-exclusivity), so no one can fully appropriate the benefits. Thus, public goods are typically under produced. Standards often fall in this category (Berg 1989; Kindleberger 1983).

setting up governance structures and maintaining them over time (Gulati and Singh 1998; Litwak and Hylton 1962). One major question for standard setting, therefore, is what kind of organizational arrangements might minimize collective action problems and encourage standards participation. Generally speaking, the best situation for overcoming collective action problems obtains when participation in an activity can be linked to some private gains; when the potential gains exceed the costs; when rewards are exclusive to the participants; and when actors can trust that everyone will play by the rules (Sened 1997; Cornes and Sandler 1986; Olson 1971). Organized on this basis, firms can be said to constitute a “club” insofar as they comprise a group of like-minded actors who voluntarily assemble for a common end. Moreover, the goods they produce are ‘club goods’ rather than ‘public goods.’ Although club goods are shared goods, they are shared on an exclusive basis among the members of a club (Cornes and Sandler, 1986).

Traditional standards development organizations were originally able to overcome the problem of collective action by supporting themselves via the sale of standards, membership dues, and government subsidies. However, as noted above, by the late 1980s, these organizations began to lose their support—both in terms of active participation as well as membership dues—when companies began to shift their efforts to standards consortia on the grounds that the benefits

to be derived from participation in SDOs did not merit the costs involved (Cargill 2002; Spring and Weiss 1995). This shift is understandable, given that consortia standards are more like club goods than public goods. Although the cost of membership in consortia is far from trivial—ranging between \$25,000 and \$50,000 per year—the benefits are divided among an exclusive, and much smaller group, of members²⁰. Equally important, the contributions that participants make to belong to consortia are generally finely tuned to the rights that they receive. Thus, for example, director seats, voting privileges and early technical access are typically given to those who contribute the most to the effort²¹. Of course, a more general reward is working with others who are results-oriented, so that specifications and implementations can be developed in a time frame that corresponds to market forces.

What role does structure play in explaining consortia?

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Characterizing this situation, Updegrove notes: “There are two hard economic realities affecting consortia: the first is that completely voluntary, low budget organizations have difficulty producing standards in real time. The second is that, for the most part, only the large hardware vendors and the small number of large software companies which currently exist have sufficient revenue to pay the membership fees typically required to produce “good” standards. Not surprisingly, the members which pay the lion’s share of the budget of a consortium expect to receive greater privileges as a result. (Updegrove 1995b: --).

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As Updegrove emphasizes, “. . .the challenge is to grant enough special privileges to those bringing the greatest economic support while providing adequate incentives for other interest groups to promote a common cause with sponsoring members, and affording such interest groups sufficient opportunity to give useful input” (Updegrove 1995a:).

Together, these three intellectual frameworks provide considerable insight into the rise of standards consortia. Notwithstanding the richness of these approaches, some key questions about consortia remained to be answered. One that particularly merits attention is how does the network structure of consortia, as compared to traditional SDOs, affect their ability to meet the imperatives of the knowledge-based global economy? More specifically, to what extent does this structure afford consortia greater amounts of “social capital”²² in the form of knowledge resources and prestige?

Commenting on the importance of taking structural variables into account Knoke and Kulinski (1982) note:

The structure of relations among actors and the location of individual actors in the network have important behavioral, perceptual, and attitudinal consequences both for the individual units and for the system as a whole Regardless of the particularities of a given structural analysis, virtually all network analysts share the presumption that a complete explanation for some social phenomenon requires knowledge about the relationships among system actors. To ignore structure gives, at best, a deficient explanation and, at worse, an incorrect one. (Cited in Knoke, 1990: 9)

There have been, in fact, an increasing number of studies that demonstrate the relationship between structural variables and social outcomes. Thus, for

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Social capital refers to the resource and assets that can be derived from social structure. As Birdied and Wacquant note, “Social capital is the sum of the resources, actual or virtual, that accrue to an individual or group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition” (Bordieu and Wacquant, 1992: 119).

example, Granovetter has found that weak ties among social actors are conducive to the diffusion of information (Granovetter 1973). Similarly, Burt has shown how bridging 'structural holes' within a network can generate social capital in the form of resources and power (Burt 2005). MacAdam, for his part, has demonstrated that, in the case of social movements, strong ties are essential for the establishment of collective action (Fernandez and Mac Adam 1988). Likewise Uzzi has illustrated how network density and cohesion are related to trust and innovation (Uzzi, 1996).

For the purposes of this paper, which seeks to understand how consortia might best meet the *competitive knowledge imperatives* of the global economy, accounts relating structural variables to the ability to gain and capitalize on information are the most relevant. And, in fact, there is considerable agreement in the social network literature to the effect that new, innovative information is typically accessed and diffused via relationships that bridge gaps in the social structure (Burt. 2005, Rogers 2003; Granovetter, 1974).

The rationale underlying this perspective is that people who are in closed networks, or clusters, are tightly linked through strong, reciprocal ties²³. As a result, the views they hold and the information they possess are likely to be the

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According to Burt, The network is closed around a relationship between two people to the extent that the people have no contacts through whom they are not indirectly connected. Where a set of people are connected to one another by strong direct or short indirect connections, [he] refer[s] to the set as a cluster, a group, or more generally a closed network" Burt 2005: 25)

same—that is to say, redundant²⁴. At the same time, social pressures among the members of the cluster to maintain the status quo is likely to inhibit the acceptance of new, innovative ideas (Burt, 2005, Rogers, 2003, Granovetter, 1974). In contrast, members of different network clusters are likely to possess diverse information and ideas. Thus, those who bridge the gaps—or as Burt defines them, structural holes²⁵—will likely garner new and, for that reason, highly valuable information (Burt 2005, Zaheer and Bell, 2005 Tsai, 2001). As Rogers has described it:

Our intimate friends are usually friends of each other's forming a close-knit clique Such an ingrown system is an extremely poor net in which to catch new information from one's environment. Much more useful as a channel for gaining such information are the individual's more distant (weaker) acquaintances; they are more likely to possess information that the individual does not already possess (Rogers 2003: 54).

Information in a network will also be redundant, and hence less valuable, to the extent that the individuals who constitute the nodes in the network are

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As Burt points out: "The defining feature of structure is clusters of dense connections linked by occasional bridge relations between clusters . . . The clusters are associated with events that bring people together such as involvement in the same project. . . .The events create a 'homophily' bias in networks, which means that relations are more likely to be between people who share socially significant attributes" (Burt, 2005: 12).

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As Burt points out, "Gaps between clusters are holes in the structure of information flow, or more simply, structural holes. A structural hole between two groups means . . . only that people are focused on their own activities such that they do not attend to the activities of people in the other group. Holes are buffers, like an insulator in an electric circuit. People on either side of a structural hole circulate in different flows of information. Structural holes are the empty spaces in social structure. The value potential of structural holes is that they separate nonredundant sources of information, sources that are more additive than overlapping. (Burt, 2005: 16).

“structurally equivalent”. People are structurally equivalent, when they “have similar relations to external groups such as a functional category in a company or an industry in the economy” (Burt 2005: 11). Under such circumstance, individuals are likely to have similar perspectives not only because they have equivalent experiences but also because they have links to the same people, and hence are subject to the same information (Knoke. 1990: 11). A bureaucracy is a classic example of a network that is high in structural equivalence (Burt 2005). Accordingly, as Burt notes, when there is a tight bureaucracy connecting persons in separate clusters, there will be less innovative information available (Burt 2005: 20).

As Burt has emphasized, positioning oneself to bridge structural holes that link diverse network clusters is a good way to generate social capital. Such brokers—as Burt refers to them—are rewarded for their efforts in three specific ways: first, they gain access to a greater diversity of information; second, they are the first to access that information, and third, they control how that information is diffused (Burt 2005: 18). Viewed more broadly, from the perspective of the clusters themselves, those who are interconnected by brokers benefit from the learning and greater vision one acquires by selecting and synthesizing ideas and options that might otherwise have gone unseen (Burt 2005: 59). As Burt sums it up:

Across the clusters in an organization or market, creativity is a diffusion process of repeated discovery. A good idea is carried across structural holes to be discovered in one cluster of people, rediscovered in another, then rediscovered in still others—and each discovery is no less an experience of creativity for people encountering the good idea. Value accumulates as an idea moves through the social structure, each transmission having the potential to add value (Burt, 2005: 65).

Notwithstanding these benefits, there are costs and trade-offs associated with brokerage. To begin with, resources must be expended in developing and maintaining bridging relationships. As importantly, these resources may be employed at the expense of generating another, complementary, form of social capital—that is to say, the trust and collaborative alignment that is derived by nurturing relationships within a cluster or group²⁶ (Burt 2005). According to Burt, groups can maximize social capital, given these constraints, to the extent that they are structurally autonomous. As he characterizes this situation:

A structurally autonomous group consists of people strongly connected to one another, with extensive bridge relations beyond the group. A structurally autonomous group has a strong reputation mechanism aligning people inside the group, and a strong vision advantage from brokerage outside the group. They have a creative view of valuable projects, who to involve, and they work together to make it happen (Burt 2005; 141).

²⁶

As Burt notes: “Facilitating the trust and collaborative alignment needed to deliver the value of brokerage, closure is a complement to brokerage such that the two together define social capital in a general way in terms of closure within a group and brokerage beyond the group” (Burt 2005: 11).

Viewed from a structural perspective, traditional standards development organizations and standards consortia can both be conceived as clusters that are linked together within the broader field of organizations that constitute the field of standard setting. As we have seen, traditional SDOs are structured along hierarchical lines, whereas standards consortia are both more exclusive and more loosely coupled. When seen through the lens of Burt's notions about structural holes and social capital, we arrive at the following hypotheses.

Hypothesis One: Given their bureaucratic structures, traditional standards development organizations will have relatively few bridges linking them across structural holes to innovative knowledge resources.

Hypothesis Two: Given their relatively exclusive and loosely coupled organizational arrangements, standards consortia will approximate the condition that Burt refers to as structural autonomy. Accordingly, actors within standards consortia will exhibit both high levels of internal cohesion as well as extensive bridging relationships across structural holes to diverse clusters.

Joel Podolny points to an additional trade-off entailed in extending one's network to bridge structural holes (2001). According to Podolny, excessively expanding bridging relationships across structural holes can lead to a loss of status, or prestige. As he points out, networks serve not only as pipes, to afford producers access to resources and information, but also as prisms through which users and potential allies evaluate the quality of producers' products and services. According to Podolny, when networks are extended too broadly, status symbols can become diluted, so users may face uncertain choices. As he notes,

the trade off between investing in developing structural holes or in reinforcing status symbols depends on the location of uncertainty in the market. Bridging structural holes is more valuable to the extent that uncertainty is on the producer side of the market, whereas shoring up status symbols is more beneficial when there is uncertainty on the user, or buyer's, side (Podolny 2001).

As regards standard setting in today's global economy, uncertainty pervades both the producer and the user sides of the market. Producers are unsure about which technologies will comprise a standard, while users and potential allies are uncertain about which technologies will win out in any given competition. Because of the externalities associated with network standards, the stakes in the outcomes will be extremely high in both cases. Hence, relatively equal attention must be given to both developing structural holes and promoting status symbols. Given their relative exclusivity as well as their loosely coupled organizational arrangements, consortia would appear to be able to do both. On that basis, we propose the following hypothesis.

Hypothesis Three: The actors within standards consortia will exhibit relatively high levels of prestige even as they extend their relationships across structural holes to other standards fora.

Methodology

Data Description:

To test our hypotheses, we began by bounding the universe of our analysis²⁷. Our aim was to generate a sample sector of the standards field that was related to IT interoperability. To this end, we gathered data through a questionnaire sent out to standards experts and scholars. We selected the interviewees based on their having contributed to a major body of work on standards setting, entitled *Standards Edge*²⁸. We chose this set of respondents because all of the authors were knowledgeable enough about standards to have been included in the volumes, and because the database was readily available, so the work could be easily replicated. To analyze the data we used UCINET, a widely employed social network analysis software.²⁹

In our survey, each respondent was asked the following question:

If you had to choose the top ten standard setting efforts within the last five years that relate to IT interoperability, what would they be?

We received 58 responses. Eleven of these were disqualified because they referred to a technology or product rather than to a standard. This gave us a total to 47 standard efforts. These standards efforts and the standards

²⁷ The first step in conducting a social network analysis is to bound the universe. Although having a full network rather than a sample yields better and more accurate information, it was impossible in this case, given the size and unwieldiness of the data set (Hanneman and Riddle 2005).

²⁸ *Standards Edge* is published by Bollin Associates. There have been five volumes to date.

²⁹ Hanneman, Robert A. and Mark Riddle. 2005. Introduction to social network methods. Riverside, CA: University of California, Riverside (published in digital form at <http://faculty.ucr.edu/~hanneman/>)

organization to which they were affiliated were then correlated, allowing us to develop an affiliation matrix that mapped the standard organization to the efforts. Once we had correlated these, we searched each organizational website to identify the active participating members from technical committees or, in some cases, technical architecture groups (TAGs) who had been involved in the standard setting effort. This yielded a second affiliation matrix that mapped the technical committee members on the Y-axis to the standards organizations on the X-axis.

Limitations of the Data set:³⁰

We were somewhat disappointed with the results of our survey. We had anticipated that there would be greater convergence about which standards were the most critical interoperability standards. Instead, we received many diverse answers, so we had no basis for collapsing them into a smaller number. We were also somewhat concerned lest the results might be biased insofar as respondents may have prioritized standards efforts in favor of those in which they participated. In the end, we included all the respondents' choices in our analysis.

Additional problems occurred in identifying members of the technical committees. For example, some organizations, such as ETSI, have privacy

³⁰ The datasets that we developed are available upon request. They were too large and unwieldy to incorporate in the paper.

policies that prevent membership information from being made publicly available (even for published standards that are freely available online³¹). Other organizations, such as the DVD Forum, required that the data remain anonymous in order to protect the members' privacy. To adjust for these problems, we reduced the dataset further from 47 to 40.

We encountered other problems during the analysis. Because the data was based on survey responses and the location of members on advisory committees, we could not establish directional ties between actors, that is, how information flowed from one actor to another. Without directional data, it was more difficult to determine levels of prestige, the dependent variable in our third hypothesis. However, we circumvented the problem by substituting measures for power for prestige measures. While not an optimal approach we believed that in this case power can be translated into prestige.

Also problematic, our data could not account for the internal organizational working of consortia or traditional SDOs. Thus we had to rely on secondary sources and our historical analysis to assess the cohesiveness and structure of the organizations. However, our data did help explain how *actors*

³¹ IEEE too has a strict privacy policy where access to information about standard efforts is only available to members. However, it does provide information of participating members if the standards are freely available to download.

that were bound within each type of organizational structure interacted with one another.

Data Analysis

Using UCINET, we converted our tag/organization affiliation matrix into two adjacency matrices³². The first matrix mapped consortia actors while the second matrix mapped traditional SDO actors. Based on these matrices we were able to characterize the structure of the standards field, and test the three hypotheses laid out above.

Measures

Independent Variables:

Hierarchy:

Hypothesis 1 is based on the assumption that traditional SDOs are bureaucratic and hierarchical in nature. We drew this conclusion, given secondary sources and historical data. As noted above, we were unable to formally verify this state of affairs based on structural analysis, given the limitations of our dataset.

Cohesion:

Hypothesis 2 assumes that although consortia are loosely coupled, the actors' relationships are more cohesive than traditional SDOs, given the private

³² An adjacency matrix is a square matrix that gives us information about if there are ties between each actor in the network (Hanneman et al 2005).

incentives to act collectively, such as the 'pay to play' rule. We assumed that the price of entry would discourage unengaged participants. As in the case of hierarchy, we used theoretical materials, secondary sources and historical data to argue this point.

Dependent Variables:

Brokerage:

To determine the extent that actors capitalize on structure, we measured the number of bridges that extended out from consortia, using the UCINET "brokerage" function. The brokerage function requires assigning attributes to actors. In our case, we divided our data into three groups: corporations, government bodies and university researchers by creating an attribute file in UCINET and then running the attributes with the consortia adjacency matrix through the brokerage function.

The key determinant for brokerage is the amount of times the actor served as a "gatekeeper" in the network. *Gatekeepers* are those actors that have high degree of betweenness allowing them to disseminate information from their group to members of another group and vice versa. To test if consortia have more brokerage opportunities than traditional SDO networks, we calculated the average number of times the actors in both dataset are gatekeepers and divided it by the total number of members in the respective networks. This enabled us to

test our hypotheses by comparing the brokerage opportunities between the two datasets.

Centrality:

Testing hypothesis 3 required that we identify levels of prestige among network actors. The best tools for measuring prestige are the Bonacich centrality measures. However, we were unable to use these measures because the data set does not show directional ties.³³ Thus, we used instead Freeman's degree centrality measure based on the number of ties that an actor has in a network. This measure can be used to show where power in the network lies because centrality measures the number of contacts and hence the ability to propagate the flow of information to others in the network. The more ties an actor has, the more actors he can influence, and the more prestigious he becomes (Knoke 1990).

Findings:

Brokerage:

For Consortia:

The output matrix grouped all actors that had brokerage opportunities together. Our data was broken into three sections or groups that were based on the ties that the actors had with one another. The first group was an isolate actor

³³ Bonacich measures can be applied to test power and influence to those ties that have directed values. Since our data was gathered through survey responses, it was not possible to assign a directed value. Using Knoke's theory of power and influence, where he believes communication that occurs between two actors, we derived which actor has more influence by virtue of his position in the network (Knoke 1990).

that did not interact with any of the other players. The second and third groups were substantially large in size and included key corporations such as Sun Microsystems, Hewlett Packard, Fujitsu and Ericsson in key brokerage positions.

The results of the brokerage analysis, showed each actor's role as coordinator, gatekeeper, representative, consultant and liaison³⁴. The role of gatekeeper is of greatest importance for our analysis because the actor in that role is the one with the most strategic position to link to seemingly disconnected clusters. Some of the actors with the highest propensity to be gatekeepers include Hewlett Packard, Hitachi, IBM, Sun Microsystems, Alcatel, Oracle, AOL Time Warner, Ericsson and Cisco.

For Traditional SDOs:

When examining traditional SDOs for brokerage opportunities, we saw that there were fewer opportunities for gatekeeping among SDO actors than consortia members, thereby supporting both hypotheses 1 and 2. In terms of average brokerage opportunity, consortia had a value of 200.1486, which was significantly higher than the traditional SDO value, which was 72.3761.

Interestingly enough, those SDO actors that exhibited high degrees of brokerage were also those that actively take part in consortia. For example, IBM and Intel

³⁴ A coordinator is an actor that allows information to flow between nodes in the same group. A Representative role is one when the recipient of the information belongs to a different group. A Consultant is when the broker is of a different group but the other two nodes belong to the same group. Finally a liaison is the role when all the nodes belong to different groups.

Corp have 12496 and 10856 counts for gatekeeper opportunities. Other prominent players were country actors such as Australia, Canada and Germany. However, their opportunities for brokerage were significantly less than those for corporations with the values at 1573 (for Australia and Canada) and 8632 (for Germany).

Centrality:

Centrality measures likewise support Hypothesis 3. The top three actors with the highest degree were IBM, HP, and Sun Microsystems with values of 382 implying that these actors had the most number of ties in the network. The lowest value in the network was 11.00 which was shared by ten actors. The mean degree of the consortia network was 112.887. 181 out of the 445 consortia actors have a degree that is higher than the mean degree representing 40.67% of the entire network. This output lends credence to Hypothesis 3 because 40% constitutes a sizable portion of the consortia members.

Discussion

In this paper we have attempted to provide insights into how social structure matters in standards development. Although institutional analysis, transaction costs, and rational actor models are important approaches in explaining the rise of consortia in standard development, the structural position of consortia actors' is also an important explanant in helping to account for the

rise of consortia in a knowledge based economy where access and control of information is critical for gaining competitive advantage.

The analysis supports our three hypotheses. Consortia have a greater number of bridges across diverse clusters within their network as compared to traditional SDOs that have very few bridges. When it comes to measuring prestige, we see that 40% of the network has a degree centrality value higher than that of the average value suggesting that most of the network maintains high prestige because almost half the actors are associated with power.

Although our analysis is partial given the various limitations of our dataset, it represents a first attempt to gain some insights about the role of structure in standards development. Our hope is that it will spark interest and inspire additional research in this area.

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