Cohesive subgroup formation: Enabling and constraining effects of social capital in strategic technology alliance networks

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ABSTRACT

In this paper we will examine the role of embeddedness and social capital in the process of cohesive subgroup formation in strategic technology alliance networks. More in particular, we will investigate the social mechanisms that enable and enforce cohesive subgroup formation. We will argue that the enabling effects of social capital in the beginning of the group formation process can turn into paralyzing effects as the block formation process progresses. Through the formation of subsequent ties, firms in social systems tend to rely heavily on their direct and indirect contacts in forming new partnerships. This so-called "local search" enables firms to create trustworthy and preferential relations. Over time, those relations tend to develop into strong ties, as firms rely on the same partners by replicating their existing ties. This enabling effect of social capital at the group level can, however, turn into a paralyzing effect as actors become locked-in, as they only rely on partners in their closed social system. Then searching for or switching to partners outside of the cohesive subgroup is hard to rationalize, in particular when trustworthy partners are already available in this system. The firms in cohesive subgroups tend to become more similar over time as a result of contagion and replication of their existing ties. This so-called phenomenon of overembeddedness induced by the paralyzing effects of social capital at the group level can lead to decreasing opportunities for learning and innovation for blockmembers involved.

INTRODUCTION

In the academic literature on strategic alliances interdependence and complementarity have been addressed as the most common explanation *why* firms form inter-organisational ties (Richardson, 1972; Pfeffer and Nowak, 1976; Nohria and Garcia-Pont, 1991). This stream of research made progress in examining the factors determining the propensity of firms to form alliances, i.e. the exogenous dynamics. The decision whom those firms should tie themselves to is less clear (Gulati, Gargiulo, 1999). This so-called endogenous dynamic refers to building preferential relationships, which are characterized by trust, stability and rich exchange of information between partners (Dore, 1983; Powell, 1990; Gulati, Gargiulo, 1999). Some academic attention has focused on the role of social structural context as an important driving factor in the alliance formation process (e.g. Gulati, 1995; Walker, Kogut, Shan, 1997; Gulati, Gargiulo, 1999; Chung, Singh, Lee, 2000). This social structural context refers to embeddedness as well as to social capital influencing the decision with whom to tie up.

Embeddedness implies that the partners' actions influence the behavior and relations of firms in the network (Granovetter, 1992; Gulati, 1998). Embeddedness influences the firms' tying behavior, because it enables preferential relations to emerge from the direct and indirect contacts firms have built up in their past partnerships. Preferential relations tend to reduce search costs and tend to ease the risk of opportunistic behavior between the partners involved (Gulati, Gargiulo, 1999). Thus, as this process of finding the right partners with complementary resource configurations is costly and time-consuming, firms tend to engage in local search for forming their subsequent ties, based on the social capital (Burt, 1992) that firms have built up in their past partnerships.

Social capital refers to the shared values, norms and trust between alliance partners and is thus by its very nature dependent on history (Chung, Sing, Lee, 2000). It enables firms to rely on both direct and indirect alliance-experiences in partner selection (Chung, Singh, Lee, 2000) and hence to shortcut the partner-selection process. Moreover, the current relations of firms stem from its prior relational activities and form the basis upon which the actor establishes future social relations (Gulati, 1998; Walker, Kogut and Shan, 1997; Chung, Sing, and Lee, 2000). Social capital manifests itself as a specific social context, where social ties, trusting relations, and value systems facilitate behavior, if located within that context (Tsai and Ghosal, 1998). These different aspects of social context are labeled the structural, the relational, and the cognitive dimensions of social capital (Nahapiet and Ghoshal, 1998; Tsai and Ghosal, 1998).

Through preferential partnering, firms become embedded in densily connected networks of relations. These closely connected parts of the network provide a strong basis of trust and intimacy for the companies involved (see Krackhardt, 1992; Brass, Butterfield and Skaggs, 1998; Granovetter, 1973) and hence provides the basis for further reproduction of this collective asset.

However, apart from this network enabling effect of social capital (see figure 1), the academic literature has given considerably less attention to the constraining effects of social capital in the decision with whom to partner. In many cases, the enabling effect of social capital in alliance formation that is based on preferential relations can turn

into a paralyzing effect as actors become locked-in, as they only rely on partners in their own closed social system. Then, over time those firms may start to suffer from "over-embeddedness" (Uzzi, 1997) in technological terms as well as in relational terms. The latter refers to "relational inertia" (Uzzi, 1997; Gargiulo and Benassi, 2000). This phenomenon, also known as strategic gridlock (Gomez-Casseres, 1996) forces firms to exclude attractive partners and therefore is likely to put a severe strain on their ability to move flexible into other "resource niches" or into new windows of opportunities. This is what we refer to as the constraining or paralyzing effect of social capital.

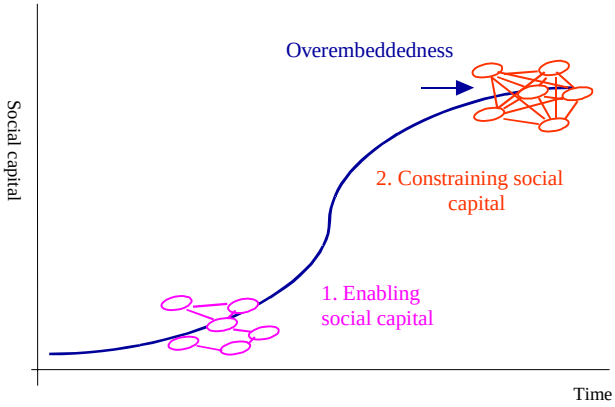

Figure 1 Enabling and constraining effects of social capital

In this paper we will investigate the main social mechanisms that create enabling effects of social capital and drive cohesive subgroup formation. Additionally, we will examine the social mechanisms that result in paralyzing effects of social capital and enforce cohesive subgroup formation. We expect that the enabling effects of social capital in the beginning of the group formation process can turn into paralyzing effects as the block formation process progresses.

THEORETICAL BACKGROUND AND PROPOSITIONS

Social capital relates to the investment in social relations that generates expected returns (Lin, 1999). It is defined as "the sum of resources that accrue to a firm by virtue of possessing a durable network of relationships" (Bourdieu and Wacquant, 1992: 119; Koka and Prescott, 2002). Thus, social capital refers to the network of relations as well as the resources embedded in that network that may be accessed and mobilized in purposive actions (Bourdieu, 1986; Burt, 1992; Nahapiet and Ghosal, 1998; Lin, 1999). In the literature we find consensus that investing in social relations and accessing and using the resources embedded in social networks, results in gaining returns (see e.g. Bourdieu, 1983, 1986; Coleman, 1988, 1990; Lin, 1999).

Although most literature on social capital has taken on a focal firm perspective in describing the full dynamics of group formation in social networks, the effect of social capital at the group level also has to be taken into account. Social capital at the group level refers to aggregation of individual returns that benefits the collective (Lin, 1999). Most of the literature on this subject focuses on how certain groups develop and maintain their social capital as a collective asset and how such a collective asset enhances group members' life chances (Bourdieu, 1983,1986; Coleman, 1988, 1990; Putnam, 1993; Lin, 1999). Through dense or closed networks collective social capital can be maintained and reproduction of the group can be achieved. Norms and trust play an important role in producing and maintaining the collective asset (Lin, 1999). Then, being part of a dense, cohesive and redundant network promotes a normative environment that involves trust and cooperation among its members (Coleman, 1988, 1990; Gargiulo, Benassi, 2000) and eventually leads to a situation of strong social cohesion within these subgroups in the network (Burt, 1984; Collins, 1988; Friedkin, 1984). Cohesion refers to the extent of relative direct interaction among individuals in a social system, requiring only few intermediaries, e.g. indirect links (Bovasso, 1996).

Cohesive subgroup membership can be seen as one of the strongest forms of embeddedness and social capital. Individuals who form cohesive cliques directly influence each other, resulting in homogeneity in attitudes, behavior and beliefs (Friedkin, 1984: 417; Wasserman and Faust, 1994). When actors have relatively frequent contact (face-to-face) and when they are linked through intermediaries (Friedkin, 1984), greater homogeneity is expected.

Cohesive subgroups

In the conceptualization of cohesive subgroups, there are four general properties that apply: the mutuality of ties, the closeness or reachability of subgroup members, the frequency of ties among members, the relative frequency of ties among subgroup members compared to non-members (Wasserman and Faust, 1994). Specifically, the number of ties an individual has to the group and the closeness of the entire group to outsiders matters (Collins, 1988; Wasserman and Faust, 1994). Cohesive subgroup members have more numerous or more intense relations with each other than non-

cohesive subgroup actors. Cohesive subgroups are generally characterized by highly cohesive subsets of similar actors in a network (Knoke and Kuklinsky, 1992). Social forces operate through direct and indirect contacts among subgroup members and through the cohesion within the subgroup as compared to outside (Wasserman and Faust, 1994).

Enabling social capital: From loosely coupled alliance networks to the formation of cohesive subgroups

Since trust is an important basis for knowledge sharing and partner selection, firms tend to be locally-biased in their search strategies (e.g. Nelson and Winter, 1982; Cyert and March, 1963; Stuart and Podolny, 2000). They often engage in "local search" in their subsequent ties. They tend to initiate new partnerships that share the context with the outcomes of prior searches.[1] In their technological positioning, firms also search for those technologies that enable them to extend their established technological capabilities (Stuart and Podolny, 1996). They generally search for partners with whom they share technological content and with whom they are either directly or indirectly linked to in the technological network. These preferential relations are path-dependent as prior ties determine the formation of future linkages (e.g. Gulati, 1995; Levinthal and Fichman, 1988; Walker, Kogut and Shan, 1997; Tsai, 2000). Furthermore, these ties ameliorate information sharing, reduce resistance and provide comfort amongst the partners.

Because of the lack of information about the competencies and reliabilities of potential partners, developing a relation with a new actor involves uncertainty (Tsai, 2000). Because firms invest a substantial amount of time and energy to establish these strong relationships (Burt, 1992), changing transaction partners in the short run is not likely, since it involves significant switching costs and implies a risk that existing relationships will dissolve. Therefore, changing transaction partners in the short run, involves significant switching costs at the risk that existing relationships will dissolve (Chung, Sing and Lee, 2000). As actors develop 'specific routines for managing an interface with each other' (Gulati, 1995: 626), they tend to become blind for new

[1] This concept of local search was raised by Stuart and Podolny (1996), were local search concerns initiating new R&D projects that have common technological content regarding outcome of their prior searches.

partnership opportunities and instead rely on previous partners and routines only (Tsai, 2000). Thus, when trustworthy partners are readily available, searching for, or switching to, new partners is hard to rationalize in the alliance formation process (Chung, Sing and Lee, 2000). Therefore actors rather replicate their existing ties (Gulati, 1995, 1998; Walker, Kogut and Shan, 1997) through local search and hence look for partners they are familiar with and with whom they share similarities in technological content in their densely connected social system. In the past, several scholars have addressed the fact that social relations develop in a path-dependent way, in the sense that previous ties determine how the future relationships evolve (see e.g. Gulati, 1995; Levinthal and Finchman, 1988; Walker, Kogut and Shan, 1997; Tsai, 2000).

Another reason why firms tend to replicate their existing partnerships is the fear of loss of reputation. This fear deters firms in a web of relations from behaving opportunistically against each other and thus increases the stability and longevity of their alliance formation in their closed system. The likelihood that a firm acts unethically decreases when the firm is structurally as well as relationally embedded in a network of relations, since this behavior is communicated quickly to other partners in the network. Actors then update their evaluation of the opportunistic actor and may not trust or interact with that firm in the future, since the opportunistic actor violates against the trust created at the network level as well as on the dyadic level (Rowley, Behrens, Krackhardt, 2000). Since unethical behavior damages the reputation of the opportunistic firm, this becomes a critical issue in partner selection. These reputation effects prevent cohesive subgroup-members to behave unethically. However, it may be difficult for actors involved to maintain ethical norms regarding actors outside of their cohesive subgroups. The expression “honor among thieves” (Brass, Butterfield and Skaggs, 1998) may be the result of strong and dense connections among the thieves, who do not hesitate to act unethical to outsiders, i.e. non-cohesive subgroup members. Furthermore, cohesive subgroups may be more powerful in number and positions and therefore can afford to act unethically without fearing the consequences (Brass, Butterfield and Skaggs, 1998).

Over time, partner attractiveness will remain high or becomes even stronger (Madhavan, Koka, Prescott, 1998) and preferential relations tend to develop into

strong ties, since there is frequent interaction and partners commit heavily to the relationship. Strong ties (Granovetter, 1973), are characterized by a solid, reciprocal and trustworthy relationship. This type of relationship creates a large basis of trust and intimacy between the partners (Brass, Butterfield, Skaggs, 1998; Granovetter, 1973). As those firms replicate these preferential relations based on their social capital at the group level (Lin, 1999) and embeddedness, we see cohesive subgroups emerge in this network, which becomes a growing repository of information on the availability, competencies, and reliability of prospective partners (Walker, Kogut, Shan, 1997; Gulati, 1995; Powell, Koput, Smith Doerr, 1996).

In the first part, we addressed embeddedness and social capital that drive the alliance network formation process in general and the block formation process in particular (table 1). Especially, the social mechanisms of local search and replication of previous ties or preferential partnering behavior cause the network to evolve, as those mechanisms constitute the enabling effects of social capital. In the next section, we will address the paralyzing effects of social capital at the group level caused by constraining social mechanisms (figure 2) in the block formation process.

Alliance network formation		**Cohesive subgroup formation**	
why do firms create ties?	***with whom do firms create ties?***	***enabling social mechanisms***	***constraining social mechanisms***
strategic interdependence (exogenous)	**preferential relations** through social capital (endogenous)	**social capital at group level** embeddedness: -local search -replication	**social capital at group level** -contagion -similarity relational inertia: -lock-in/lock-out gridlock

Table 1 The alliance network formation process

Social capital is crucial in reproducing the alliance network over time. Being embedded in a densely connected network as a result of a high amount of social capital, makes engagement in subsequent ties more likely (Walker, Kogut and Shan, 1997). Social capital at the group level (Lin, 1999) in particular, is crucial in the process of cohesive subgroup formation as the network becomes more dense. When the size of the network grows and hence the density of the network increases as the

actors engage in multiple relationships, the possibility that alliance cohesive subgroups are formed, increases. The latter results from actors who develop strong, densely connected and cohesive ties through local search. Since current alliance networks provide future alliance opportunities (Gulati, 1995), early participation may provide firms with potentially valuable partnering possibilities for the future. Alliance proactive firms in networks are therefore more likely to possess the specific knowledge related to the identification and the selection of appropriate alliance partners (Sarkar, Echambadi, Harrison, 2001). Alliance pro-activeness is a first mover advantage, as early mover firms tend to capture advantageous positions resulting from their partner choice. Thus, pre-emption of valuable and scarce resources in partner space can be a source of strategic advantage (Dyer & Singh, 1998; Sarkar, Echambadi, Harrison, 2001). As a result, certain partners are not available, because they are already tied to the focal firm's competitors. Thus, if the size of the network increases, cohesive subgroup formation is more likely.

P1: If the size of the network increases, cohesive subgroup formation is more likely

Constraining social capital at the group level: Overembeddedness as a result of similarity and relational inertia

As discussed above, the decision with whom to partner is influenced by the network of past partnerships (Gulati, Gargiulo, 1999) and depends on the embedded relations the firm is already engaged in (Granovetter, 1985; Gulati, 1998). Resulting from this repeated alliance formation caused by local search, frequent interaction and increased commitment in the relationship, trust and intimacy have grown strong between the partners (Granovetter, 1973; Brass, Butterfield and Skaggs, 1998). As partners have become more familiar with each other, because of frequent and face-to-face contact, (this is referred to as "familiarity breeds trust",

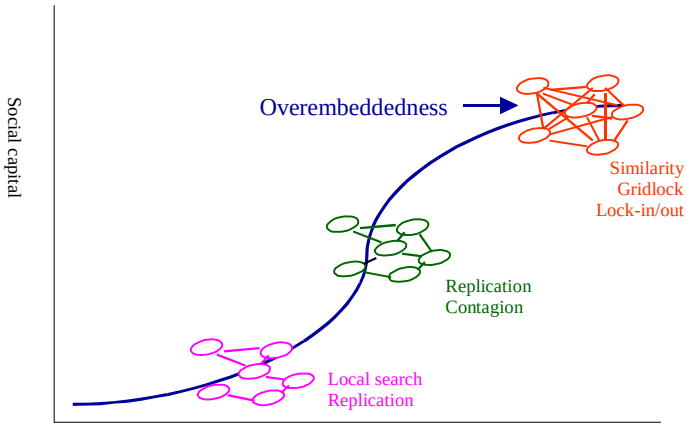

Figure 2 Social mechanisms

Gulati, 1995), greater homogeneity is expected than when they have less contact (Friedkin, 1984). "The more tightly that individuals are tied into network, the more they are affected by group standards (Collins, 1988: 416)"[2]. Social contagion shows up when individuals take up the attitudes or behavior of others who influence them (Bovasso, 1996) Social contagion is both an individual and a group phenomenon (Burt, 1992; Bovasso, 1996). The cohesion approach therefore suggests that similarity in attitudes stems from the proximity between actors, implying that directly linked actors will be more similar and homogeneous than indirectly linked individuals (Brass, Butterfield and Skaggs, 1998). This holds especially for actors that are connected by strong ties rather than weak ties (Brass, Butterfield and Skaggs, 1998).

Similarity Actors that are densily connected and who maintain strong ties among themselves, like in cohesive subgroups, are more likely to act similarly, to share information, to develop similar preferences, or to act in concert (Knoke and Kuklinsky, 1992). Thus, similarity can induce interaction, or can be the cause of attraction. Scholars refer to this process as "similarity breeds attraction" and "interaction breeds similarity" (Brass, Butterfield and Skaggs, 1998). These processes increase a firms' tendency to replicate their existing ties. In similar vein, social identity theory (Gómez, Kirkman, Shapiro, 2000) states that similarity strengthens self-image as actors are attracted to similar others. Furthermore, actors treat those similar others -e.g. group members- more favourably than others (Gómez, Kirkman, Shapiro, 2000).

From a technology point of view, we expect that firms need to have some pre-alliance technological overlap (see e.g. Cohen & Levinthal, 1990; Hamel, 1991; Lane & Lubatkin, 1988; Mowery, Oxley and Silverman, 1996) to absorb their partners technological capabilities (Tsai, 2001). Thus, some technological similarity in their technology portfolio is required for the replication of the actors' ties. The extent to which these firms are able to learn from their partners depends on their intent. We expect that if actors intend to internalise their partners' technological capabilities (Hamel, 1991), instead of only accessing them, their post-alliance technological

[2] In: Wasserman and Faust, Social Network Analysis, 1994, p.250

profiles will be converging and will become more similar (Mowery, Oxley and Silverman, 1996).

P2: As firms replicate their existing ties, their technology profiles become similar

Relational inertia The familiarity and strong ties that have been built up through the replication of ties and the increasing similarity of firms within the cohesive subgroups, can lead to constraints in partner choice when facing opportunities for linking up with actors of another strategic block. Once firms have established links in a specific block, the formation of ties outside that block can be difficult, because of the possible conflict of interest among its partners (Nohria, Garcia-Pont, 1991). This implies that some actors in blocks are locked in as a result of initial alliance choices and actors outside the block are locked out in order to prevent knowledge leakage to competing groups. Another reason for locking out actors of other groups is the implicit expectation of loyalty to group members, since many alliances preclude the parties from allying with firms from competing groups (Gulati, Nohria, Zaheer, 2000). As a result, certain partners are not available, because they are already tied to the focal firm's competitors.

Actors have limits to the resources they can devote to the search process for new partners. These resource constraints imply that ties with one actor place constraints on ties with others (Gulati, Nohria, Zaheer, 2000). Therefore, some potential partners are simply excluded in the partner selection phase. This phenomenon of strategic gridlock (Gomes-Casseres, 1996) forces firms to engage in local search for partners within its own strategic block (see figure 2). This relational inertia makes group members rigid and cognitively locked-in (Uzzi, 1997; Gargiulo and Benassi, 2000). This cognitive lock-in effect filters the information and perspectives that reach the group members and isolates them from actors outside of the group. In this state of rigidity and overembeddedness (Uzzi, 1997) caused by similar actors and relational inertia, cohesive subgroup members suffer from decreasing opportunities for learning and innovation. This state of overembeddedness is likely to put a severe strain on their ability to move flexible into other "resource niches" or into new windows of opportunities.

P3: When looking for new partners, firms replicate their existing ties within the subgroup through local search

DATA

The data on strategic alliances and characteristics of companies involved in these alliances is derived from the MERIT-CATI databank on strategic technology alliances. The database covers the period between 1970 and 1996 and contains information on nearly 13000 alliances of parent companies active in biotechnology, information technology, new materials technology and "non-core" technologies. The most important data sources are international and specialized trade and technology journals for each sector of industry and many fields of technology. From the primary modes of cooperation presented in this database like joint-ventures and research corporations, joint R&D agreements, technology exchange agreements, direct investment, customer-supplier relations and one directional technology flows, we chose two-directional technology flows.

Sample

In this paper, we study strategic technology alliances in the microelectronics industry. We will test our hypotheses by examining alliance network formation in the microelectronics industry from 1970-2000 (figure 3). Strategic technology alliances are defined as the establishment of common interests between independent (industrial) partners that are not connected through (majority) ownership. The transfer of

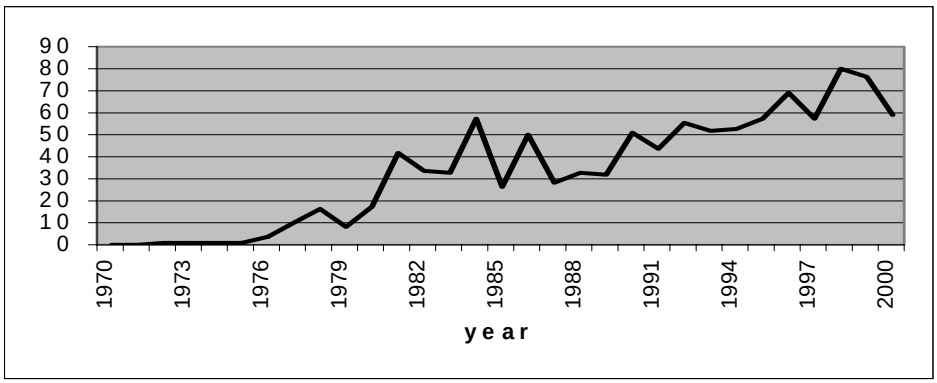

Figure 3 Number of alliances formed in microelectronics 1970-2000

technology or the undertaking of joint research has to be part of the arrangement. Mere production or marketing alliances are excluded. Examples of strategic technology alliances we included are joint research pacts, joint development

agreements, R&D contracts, (mutual) second sourcing, cross-licensing, research corporations, agreements and joint ventures with technology sharing or R&D programmes and cross-holdings. For the purpose of the present analysis, information was used regarding the industrial sectors in which companies operate, their core business, the year of establishment of the strategic technology alliance and the industry affiliation of the alliance.

Our sample was drawn from an update of the CATI database, which covered the period 1970-2000. In the IT sector, i.e. computers, industrial automation, microelectronics, software and telecom, 5745 collaborative agreements were formed in this period (table 2). The strategic technology alliances in microelectronics count for 1047 alliances in this period. This sector comprises semiconductors: i.e. processors, accelerator chips, RISC-processors, memory chips, ASIC's, expansion and other chip boards and transistors.

Table 2 Sample drawn from CATI database

Number of collaborative agreements in IT 1970-2000	*Number of strategic technology alliances IT 1970-2000*	***Number of strategic technology alliances in microelectronics 1970-2000***
5745	3905	**1047**

For measuring our hypotheses we computed several social network measures by constructing adjacency matrices representing the relationships between the firms in the strategic technology alliance network. Various network measures like degree centrality and network density were calculated using UCINET 5 (Borgatti, Everett and Freeman, 1992). Furthermore we used software from the Centre for Global Corporate Positioning (CGCP) to plot the network graphs.

DISCUSSION AND CONCLUSION

This paper can be seen as one of the first empirical attempts to study the process of cohesive subgroup formation from a longitudinal perspective. In order to shed more light on these subgroup formation processes we investigated the social mechanisms that enable and enforce cohesive subgroup formation over time. Our main argument is

that social capital in first instance can be seen as an enabling factor for cohesive subgroup formation. Over time, however, the enabling effect of social capital can turn into a paralyzing effect which locks-in partners in their closed social system, thereby reducing these organisation's flexibility and innovative strength. We tested our main hypotheses by an empirical analysis of cohesive subgroup formation patterns in the microelectronics industry from 1970 to 2000.

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