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LEARNING TO COLLABORATE: NETWORKS IN THE BRITISH AND ITALIAN MOTORSPORT INDUSTRIES

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Abstract

This paper reports empirical research into the nature of business relationships, knowing and learning in the British and Italian motorsport industries. The research demonstrates the importance of collaboration and the emergence of network relations as key in innovation processes. Networks are the locales in which learning and knowing occur in this industry. The degree to which organizations learn about new opportunities and ideas is a function of the extent and nature of their participation in the network. In particular, it is shown that there have been extensive efforts in the Italian industry to encourage the formation of networks with a shared identity. This is contrasted with the way in which the motorsport industry is developing in the United Kingdom. In making sense of these developments, the paper extends the work of Lave and Wenger (1991) and Brown and Duguid (1991) by using the concept of 'communities of practice' at an inter-organizational level of analysis.

Introduction

At least since the 1950s, the concept of inter-organizational networks and relationships has interested scholars (Nohria, 1992). Different research traditions have contributed to this topic and this has resulted in a voluminous and heterogeneous literature. In particular, in recent years in sociology and organizational theory there has been a growing interest in network configuration strategies and their linkage to competitive advantage (see for example, Burt, 1992; Powell et al. 1996; Uzzi, 1996). However, as Nohria (1992: 3) has argued, the field has yet to provide a fully adequate explanatory model which can "cohesively pull together the actual formation, reproduction and transformation of inter-organizational networks". The aim of this paper is to advance our understanding of network formation issues by focusing on the strategic structuring of inter-organizational relationships operated by lead firms. In particular, the strategic choice argument put forward in this paper suggests that networks do not necessarily emerge spontaneously, but can be subject to managerial design (Nohria and Eccles, 1992; Madhavan et al., 1998; Lorenzoni and Lipparini, 1999; Dyer and Nobeoka, 2000; Human and Provan, 2000). As we will show in this paper, the lead-firms may deliberately act to create a network architecture which combines the competencies of the partnered organizations. In so doing, lead-firms learn to select and mobilize external expertise by adopting explorative and exploitative learning strategies (March, 1991). Simultaneously, they may also develop the ability to interact with other actors and to create a common identity and rules for knowledge sharing (Dyer and Nobeoka, 2000; Human and Provan, 2000; Das and Teng, 2002). Hence, lead-firm can be understood as network orchestrators (Lorenzoni and Baden-Fuller, 1995; Nooteboom, 2000).

The paper also offers empirical support for the network perspective proposed by Nohria and Eccles (1992) and Powell et al. (1996). According to this view, 'networks' are an important unit of analysis for understanding learning and innovative processes when knowledge is broadly distributed among a number of participating actors. In making sense of these processes, the paper draws on the work of Lave and Wenger (1991) and Brown and Duguid (1991) and extends the concept of 'communities of practice' at the inter-organizational level of analysis. From this perspective, networks represent the locales in which knowing and learning occur. The degree to which firms learn about new opportunities and ideas is a function of the extent of their participation in the networks. Brown and Duguid (1991) emphasize this point by stating that learning is about becoming a practitioner, not learning about a practice. Participation in the network, however, is not homogeneous; it varies in terms of quality of interaction (i.e. the extent of knowledge sharing) and in terms of frequency and intensity of interactions. Learning is thus closely intertwined with participation and membership in networks of organizational actors.

The paper presents the findings from an exploratory study conducted in the British and Italian motorsport industries. The data have been gathered primarily through face-to-face interviews with managers and engineers in both racing car manufacturers and their component suppliers in both Italy and the United Kingdom. The research was conducted between January 2001 and April 2002. In total, 59 interviews were carried out. The analysis, based on the study of the nature of collaborative activities among buyer and supplier companies, takes into account the historical development of the British and Italian motorsport industries as well as the network formation strategies adopted by lead-firms in the industry in order to build effective knowledge sharing networks.

The paper is organized as follows. The first section sets out the theoretical background which informed our research. The second section presents the pre-network organizational field and reviews the key players of this study. The context in which motorsport companies operate seems to have influenced to some extent the subsequent strategies they have adopted in the structuring of the network. The third section presents the forms of network participation in the motorsport industry; it then focuses on the network formation strategies adopted by both racing car manufacturers and suppliers. The fourth and fifth sections take into consideration the formation of a network identity and the rules for knowledge sharing. The sixth section presents evidence of the building of 'sub-networks' within the main network on the part of major first-tier suppliers. The final section contains discussion and conclusion.

Theoretical background

Previous research has emphasized the role of powerful lead firms (Lorenzoni and Ornati, 1988), expert head firms (Inzerilli, 1990), and strategic centres (Lorenzoni and Baden-Fuller, 1995; Dyer and Nobeoka, 2000) in devising network architectures which are conducive to competitive advantage. These firms act as a focal point and have responsibility for managing the network; they co-ordinate and exploit the productive competencies of different companies. As Lorenzoni and Baden-Fuller (1995) and Nooteboom (2000) have advanced, these firms act as strategic centres and tend to view their roles as orchestrators.

The approach presented by these authors is consistent with the 'strategic choice' perspective (Child, 1972; 1997). According to this perspective, strategic choice is the process whereby power-holder actors decide upon courses of strategic action. Child (1997) highlights the importance of considering agency of choice and its influence both inside and outside firms' boundaries. Most importantly, the agency of choice draws attention to the dynamic process through which firms take strategic action. This process has been described as 'double structuration' between action and situation, consisting of two interrelated cycles. The first cycle is one of 'inner structuration' in which actors seek to work upon, and are simultaneously constrained by, existing structures and routines. The second cycle is one of 'outer structuration' in which actors seek to influence or reach an accommodation with the environmental conditions. Engaging in this double structuration process allows lead firms to work out strategic actions which take into consideration their current situations, the external environment and the reciprocal influence between courses of action and changing circumstances. In this sense, network formation can be understood as a dynamic process which stems from the mutuality of agency, action and constrain. Hence, networks do not necessarily emerge spontaneously but can be subject to managerial design (Nohria and Eccles, 1992; Madhavan et al., 1998; Lorenzoni and Lipparini, 1999; Dyer and Nobeoka, 2000).

The strategic structuring of inter-firm relationships is rooted in the ability of lead firms to create a network identity and to develop a sense of trust and reciprocity. Dyer and Nobeoka's (2000) work on Toyota illustrates how the lead firm has promoted participation and membership in the network though the creation of a network identity and clear rules for knowledge sharing. Similarly, Human and Provan (2000) describe the formation of multilateral networks and advocate the need for a sense of collective 'networkness' by which members see themselves as part of the network and are committed to network goals. Creating an identity for a collective or a sense of 'networkness' means that members feel a shared

sense of purpose with the collective. The identity of a network is defined by its boundaries which dictate who are (and who are not) members of the organization. Shared goals and values facilitate this demarcation and the patterns of interaction among firms give rise to a common framework for action. In more general terms, Das and Teng (2002) conceive network identity in terms of 'macroculture', that is, a system of shared assumptions and values deriving from occupational, professional, and industry-specific practices which create behavioural homogeneity between firms. Macroculture is particularly important for sustaining stable exchange relationships and reciprocity at the network level.

Dyer and Nobeoka (2000) identify four key processes through which Toyota creates an identity: (1) a supplier association (a network level forum for creating a shared social community); (2) Toyota's operations management consulting division (a network level unit giving accountability for knowledge processes); (3) voluntary small group learning teams (a sub-network forum for knowledge sharing); and (4) inter-firm employee transfers. According to Dyer and Nobeoka (2000), a strong network identity allows firms to openly share knowledge and mitigate the free rider problem. Most importantly, through the creation of a network identity, suppliers become motivated because they learn that participating in collective learning processes is far more advantageous than to try to protect and keep secret their proprietary knowledge. In addition, Toyota has also established a number of network rules and norms that prevent suppliers access to its knowledge unless they agree to openly share knowledge with other network members.

Other scholars have drawn attention to the importance of creating a collective sense of belonging. For example, Human and Provan (2000) refer to the concept of legitimization of the network. Legitimacy is defined as "a generalized perception that the actions, activities, and structure of a network are desirable and appropriate" (Human and Provan, 2000: 328). Lead firms need to legitimize three aspects: the network organization form; the network as an entity; and network interaction. Human and Provan stress the importance of developing a recognizable identity that will allow both members and outsiders to perceive the network as a legitimate entity. In establishing such a network identity, they suggest that the lead-firm's role is particularly important.

The 'communities of practice' approach developed by Lave and Wenger (1991) and Brown and Duguid (1991) offers some insights and new avenues to further explore the concepts of participation, network identity and norms of interaction put forward by the above perspectives. Central to the communities of practice approach is a social theory of learning (Brown and Duguid, 1991; Orr, 1996; Wenger, 1998). Learning in these communities occurs through active participation in daily practices. It is seen as a situated accomplishment which derives from the interactions between actors and their knowledge sharing through story telling and swapping of anecdotes (Orr, 1996). The relationships maintained in the community are informal and learning is voluntary. Brown and Duguid (1991) point out that communities of practice stimulate social learning by providing a suitable 'non-canonical' and informal environment which lies the foundations for learning to occur.

In these communities, learning is continually fostered and sustained through participation and active involvement of members. Lave and Wenger (1991) introduced the notion of 'legitimate peripheral participation' as a method of learning which involves active participation as opposed to learning from manuals. The notion of legitimate peripheral participation, in particular, draws attention to the fact that the mastery of competencies in

organizational settings requires the newcomers to move towards full participation in the socio-cultural practices of a community. As Brown and Duguid (1991: 50) claimed,

> "Learners need legitimate access to the periphery of communication – to computer mail, to formal and informal meetings, to telephone conversations, etc., and, of course, to war stories. They pick up invaluable 'know-how' – not just information but also manner and technique – from being on the periphery of competent practitioners going about their business".

Participation in the community also allows actors (both newcomers and old-timers) to get to know each other and to develop a sense of identity. Thus learning implies both learning a profession and acquiring an identity and a sense of belonging within the organization. This encourages the sharing of knowledge and creates a collective knowledge from which members can draw.

The communities of practice approach supplies valuable support for the study of networks. As Nohria and Eccles (1992) and Powell et al. (1996) have advanced, networks are an important unit of analysis for understanding knowledge and learning processes. In complex and dynamic environments, such as the biotechnology industry, knowledge is widely dispersed across a number of firms. Networks give access to that dispersed knowledge and are the locales in which learning occurs. By engaging in collaborative activities with others, firms not only acquire new competencies but also learn to participate and to be part of a community. Hence, actors learn by becoming members of a network community and in so doing they locate themselves in network positions which may offer significant competitive advantage.

In summary, we advance an argument that network formation is a dynamic process which may be prompted and moderated by lead firms' strategic actions. Lead firms may operate as orchestrators, encouraging participation in the network and working towards the development of a network identity and rules for knowledge sharing. By participating in the network, firms learn how to be part of a community and how to create and share new knowledge.

Network formation strategies in the British and Italian motorsport industries

Network formation processes are key to understanding how lead-firm actors organize their inter-organizational relationships. This study presents evidence of the network building strategies undertaken by racing car manufacturers and major first-tier suppliers. After introducing the pre-network organizational field in which the orgunizations under study operate, the paper looks into the forms of network participation and emphasizes the role played by racing car manufacturers in the strategic structuring of their network. The findings highlight that network building is fostered by the promotion of a network identity and the implementation of network rules for knowledge sharing. Networks, however, are not shaped exclusively by racing car manufacturers. As will be shown later in the paper, major first-tier suppliers also play a part in network structuring and their strategic actions influence network structures and relationship building.

Pre-network organizational field

The key players examined in this study involve racing car manufacturers (RCM-I1, RCM-I2, RCM-I3 in Italy and RCM-UK1, RCM-UK2 in the United Kingdom) and suppliers of components and services. RCM-I1, RCM-I2 and RCM-UK1 race cars in Formula One, RCM-I3 builds cars for Formula Three and Indy racing, and RCM-UK2 builds cars for Le Mans. In this paper we will refer to RCM-I1 as the dominant Italian racing car manufacturer because of its predominant position in the motorsport industry. Motorsport suppliers have been classified by looking at the activities they carry out and the capabilities they have. From the interviews the following types of suppliers have been identified: commodity supplier, process specialist, equipment specialist, production specialist, technology specialist, full system supplier, and technology partner. As will be discussed, these categories of supplier will inform our understanding of the forms of participation to be found within motorsport industry networks.

Table 1: Typology of supplier companies in the British and Italian motorsport industries.

Type of supplier	Type of components	Nature of the work performed
Commodity supplier	Low cost catalogue items	Product design and manufacturing
Process specialist	Relatively complex processes	Treatments and finishing of components
Equipment specialist	Relatively complex products	Design and manufacturing of equipment
Production specialist	Relatively complex parts. The racing car manufacturer knows the specifications in detail	Manufacturing and finishing
Technology specialist	Complex parts. The supplier retains the specialist knowledge	Product and process design, manufacturing and finishing
Full systems supplier	Complex parts. The supplier retains the specialist knowledge	Product and process design, manufacturing and finishing
Technology partner	Complex parts with innovative application	Product and process design manufacturing and finishing

The pre-network organizational field in which firms operate has been considered as a critical factor for understanding networks and their evolution. Several studies have described network formation as emerging from the presence of prior relationships (Larson, 1992; Larson and Starr, 1993; Gulati and Gargiulo, 1999; Steier and Greenwood, 2000). In this study we recognize the importance of the pre-network organizational field.

The findings of this study confirm the importance of the initial conditions in the organizational field prior to network formation and indicate that they set the stage for the strategies used by motorsport companies in building their networks. Four issues seem of particular importance for understanding the direction that network formation might take: the industry structure, the pre-network climate for collaboration, the support from the institutional environment, and the patterns of competition within the motorsport industry.

The analysis of historical and secondary data has shed light on the structure of the motorsport industries in the United Kingdom and Italy. While the British motorsport industry is organized in the form of a regional cluster (what has been called 'motorsport valley'), the Italian motorsport industry is highly fragmented, apart from a small concentration of firms in the area surrounding Modena.

As regards collaboration among firms, this is an essential feature for network success. Evidence from the motorsport industry indicates that in the past, relationships between racing car manufacturers and their suppliers were predominantly arm's-length, especially in Italy where major racing car manufacturers were largely vertically integrated. In the United Kingdom there is some evidence of pre-existing closer ties, which gave rise to informal networks of relationships. Overall formal pre-network ties were highly fragmented in both industries and motorsport companies had little history of network involvement. In addition, in both countries key institutions and, in particular, the state, have shown little interest in the motorsport industry or in network development, at least until recently.

What seems to have had a strong impact on network formation is the competitive nature of the motorsport industry. Competition among racing car manufacturers to win races is continuously leading to environmental changes (Madhavan et al., 1998) such as the rapid technological advancement and the growing complexity of the components required to build state of the art racing cars. In such circumstances racing car manufacturers cannot rely only on their internal competencies and capabilities, but have to look outside for capable suppliers. The changing requirements of racing car manufactures have led to boundary redefinition and new divisions of labour.

The four factors mentioned above have thus influenced to some degree the strategies undertaken by motorsport companies in building their networks. The findings indicate that networks tended to form and evolve to respond to the patterns of competition in the motorsport industry and to the consequent environmental changes such as the increased complexity of the technologies required to build racing cars. Network formation and participation in collaborative activities, however, had to be fostered by racing car manufacturers since formal networks were mostly an unknown to motorsport companies and government support was very limited. Moreover, extra efforts had to be made by the dominant racing car manufacturer in Italy because of the fragmented nature of the industry.

The following sections will present evidence of the strategies undertaken by racing car manufacturers. First of all, the encouragement of suppliers to participate in collaborative activities; second, the promotion and development of a shared identity to facilitate knowledge sharing processes.

Network formation

As advanced in the theoretical background, network formation is a social accomplishment in that it is akin to the notion of 'community of practice' (Brown and Duguid, 1991). This means that motorsport companies learn to participate in the network while collaborating with each other. Empirical evidence will be given of the processes of network formation both in the United Kingdom and in Italy with a focus on knowledge sharing and learning.

Participation

Participation is key to understanding knowing and learning in the motorsport industry. Collaboration assumes the characteristics of a 'generalized reciprocity' (Das and Teng, 2002) because there is no direct reciprocity among the participating firms. Generalized reciprocity is defined by Das and Teng (2002) as group-based exchange relationships in which members engage in social exchanges within the group but not necessarily with any specific member. In other words, what A receives from B is not contingent upon what A gives to B. Hence, reciprocity becomes a generalized norm that all members are expected to follow.

Through participation in the network, motorsport companies define and give existence to their collaborative activities and their collective body of knowledge. As advocated by Lave and Wenger (1991) and Brown and Duguid (1991), participation suggests action and connection; it describes the social experience of becoming a member in the network and of active involvement in the collaborative activities. Thus, participation is not only a source of identity, but also it is the ability to mutually create shared knowledge and experiences. Hence, participation and social interaction foster social capital and facilitate the sharing of knowledge.

In the motorsport industry the growing complexity of technologies and the search for new and lighter materials makes it increasingly difficult for a single racing car manufacturer to master all the knowledge and know-how required for the manufacture of its products. Racing car manufacturers have thus engaged in an increasing number of agreements with suppliers and subcontractors, technical partnerships and alliances with service companies (materials, processes). Consequently, suppliers are becoming more involved in the early stages of product design, development and manufacturing. As the Operations Manager of RCM-I2 in Italy states,

> "The aim of every team is to produce most of the components by themselves (design, manufacture and finishing in-house). In reality I don't think any team can live without suppliers and at certain times of the year nearly 50 percent of the components you need are coming from outside suppliers, and that is the busiest time. […] So suppliers play a big part in producing the car in those few months. In-house you employ sub-contract people to come and help you in things like producing carbon-fibre components, producing fabricated components, producing machined components."

This seems to be a generalizable picture of the motorsport industry and the United Kingdom is no exception. Racing car manufacturers RCM-UK1 and RCM-UK2 also outsource 50-60 percent of their activity especially during some periods of the year. Racing car manufacturers largely recognize that supplier relationships are important technically and economically, if they are to maintain and improve their competitiveness. The need to keep up with technological advancements suggests that it is important to look for external contributions, especially when a supplier is recognized as having a distinctive capability. Reliance on suppliers' unique capabilities also brings cost advantages to racing car manufacturers.

The findings suggest that social interaction between racing car manufacturers and their suppliers has developed over time and through ongoing participation in collaborative

activities. The building of social interactions has increased the intensity, frequency and breadth of knowledge exchanged and it has fostered the creation of social capital in each of its structural, relational and cognitive dimensions.

Participation has not only facilitated knowledge sharing by creating intense and repeated interactions, it has also enhanced racing car manufacturers' ability to recognize and evaluate pertinent external knowledge from their suppliers. Participation has provided racing car manufacturers insight on the specialized competencies and capabilities of their suppliers and it has resulted in the exchange of specialized knowledge and know-how. In the following sections it is shown how racing car manufacturers have learnt to select and assess their suppliers. In essence, participation has provided a better access to, and understanding of, their key suppliers' operations and more effective means of communicating and sharing knowledge with them.

Racing car manufacturers, however, are not the only players that contribute towards network formation. Major first tier suppliers also take part in the structuring of networks. From the findings it appears that major first tier suppliers are able to select their customers and to develop strong relationships with the ones that are more technologically advanced, especially in the British motorsport industry. In certain situations, as in the lower levels of motorsport, first tier suppliers may also become network orchestrators because racing car manufacturers are much more dependent on their capabilities. Moreover, first tier suppliers have also started to manage their own network of suppliers.

Forms of participation

Motorsport companies join and participate in the network in different ways. From the data collected at least four different forms of participation emerge (for a summary see Table 2):

- Partnership
- Co-development collaboration
- Problem-solving collaboration
- Manufacturing collaboration

Table 2: Forms of participation in the British and Italian motorsport industries.

Forms of participation	Activity type	Supplier type
Partnerships	Joint development Exploration of new and diverse knowledge	Technology partner Technology specialist Full systems supplier
Co-development collaborations	Joint development Exploitation of existing knowledge	Technology specialist Full systems supplier
Problem-solving collaborations	Joint problem-solving Application of existing knowledge to specific needs	Technology specialist Equipment specialist
Manufacturing collaborations	Co-makership Exploitation of existing knowledge	Production specialist Equipment specialist Process specialist

Partnership. At the top end of the motorsport industry is it possible to recognize some significant changes in the way suppliers are managed. It appears that suppliers are increasingly moving away from operating on the traditional 'build-to-print' basis, where they are required to manufacture components to a specification and design developed by racing car manufacturers. As a result suppliers, especially first tier suppliers such as technology specialists and full systems suppliers, are increasingly involved in product development. This extends from concept to design, prototype construction and testing. The focus of partnerships is on conducting joint research and joint development activities and on the exploration of novel knowledge combinations and ideas.

In the United Kingdom a Senior Sales Manager of a full-systems supplier company commented on the importance of developing partnerships with racing car manufacturers in order to be better able to communicate and develop a common understanding. He explains,

> "What we try to do here is to develop partnerships with our customers. So instead of being in what I would call a traditional relationship, where we have a customer, we have a supplier and there is no real technical interface - 'these are the products, would you like to buy them?' - what we try to do now is to work in partnership with the teams. So when they design a new car, we all sit around the table and when they look at the braking system or clutch system we have a discussion about what their needs are to make that car be better than anybody else's car."

Thus, there is a trend towards partnership, although this is not the prevailing mode of collaboration throughout the UK motorsport industry. This mode tends to be adopted by major racing car manufactures in Formula One or Rally and their strategic suppliers. However, the interviews reveal that this process has not been widespread throughout the industry. The Managing Director of a technology specialist company stated,

> "We [as a supplier] are starting now with technical partnerships, which are more in the research area."

Particularly some racing car manufacturers in Formula One seem to neglect the importance of establishing partnerships in order to gain competitive advantage. As the same Managing Director commented,

> "We have instigated most of them [partnerships]. It has been a two-way idea just with our first technical partnership."

Partnership agreements seem to be a much more established way of collaborating in the case of the racing car manufacturer RCM-I1. The Italian racing car manufacturer has built extensive partnerships with key strategic suppliers in order to be in a better position to explore new knowledge and exploit existing knowledge sources. The Relationship Manager of RCM-I1 underlines the strategic importance of partnerships for joint development work,

> "At the level of partnerships, for example, we work very closely with [supplier name] which is part of [holding name] and we have an exchange of ideas; they [supplier] develop for us certain products. So we have links with external companies, possibly Italian ones, and we collaborate with them for development work."

The Project Manager of a technology partner of RCM-I1 also emphasizes the close interaction between his company and RCM-I1 and the intense exchange of information during development projects. He states,

> "With [RCM-I1] we have a partnership agreement […]. There is a continuous innovation process and exchange of information between people from our organization and people at [RCM-I1]."

The same level of interaction, however, has not been found in the other two Italian racing teams interviewed, RCM-I2 and RCM-I3. While RCM-I2 recognizes the need to build closer relationships with key strategic suppliers and pursue co-innovation activities, RCM-I3 has declared to have no interest in developing its relationships with suppliers. The fact that RCM-I3 does not perceive any need to foster interaction with its suppliers may be because it belongs to a lower level category of racing, namely Formula Three and Indy Racing. Cars developed for these racing activities are much less technology-driven (and more cost-driven) than Formula One cars. Thus, RCM-I3 strategy is oriented towards maintaining durable arm's length relationships with key suppliers, while looking constantly for other suppliers of comparable or better quality which are more cost effective.

Co-development collaboration. Co-development refers to collaborations in which racing car manufacturers involve suppliers in the early stages of product development. The content of the collaboration can be either in the form of co-design where both companies contribute to the technical specifications of the components or in the form of requirements where the supplier undertakes the design and manufacture of the components. Contrary to partnerships, the focus of co-development collaboration is on the further exploitation of existing knowledge.

In the United Kingdom, the Chief Design Engineer of a full-systems supplier company explains how his company collaborates with racing car manufacturers and reports that much of the joint work is done at the levels of design, development and prototyping. He says,

> "Normally we have some discussions with the customers and either they would contact us as they got an idea - 'can we work together to develop this idea?'; or sometimes we have an idea, we tell to the customer we got this idea - 'can we work together to develop it?'. We have some discussions […] at the concept stage, but some customers sometimes they come to us with the concept. Certainly the design, the second part there, design, development and prototyping would be very much what we work for experts at that field. So when the customers come with the concepts we can deal internally with the entire design, all the calculations, analysis of that design and, then, we would manufacture all the parts and we can test the parts on the rig."

A Commercial Manager from another British full-systems supplier company recognizes the fact that with some of their customers they have quite close joint development activities, especially in order to promote innovative solutions at the interface between engine and the vehicle. He states,

> "[…] with those people [race teams] we will work at the interface between the engine and the vehicle. So we don't try to give advice on the aerodynamics of the car, but on the other hand we have to come up with innovative solutions on how perhaps an engine is mounted in the car. So we will work closely with the car designers to come up with materials or design features that allow us to get the best from the total package. So we try different things to see if they work."

Overall, co-development collaboration seems to be a much more established mode of collaboration between racing car manufacturers and suppliers in the United Kingdom than full-scale partnerships.

Co-development collaborations are also well established in the Italian motorsport industry where both RCM-I1 and RCM-I2 constantly work towards improving the level of interaction and participation with key suppliers. The Chief Production Manager of a technology specialist company of both racing car manufacturers comments on the collaborative activities undertaken at the level of co-development. He declares,

> "With our customers we constantly discuss and analyze construction techniques and their application; moreover, if the customer appears confused we try to give advice on the project and on the costs involved."

The Relationship Manager of RCM-I1 comments on how his company has established close relations with some Italian suppliers and points out the benefits achieved by his company through these co-development collaborations. In his words,

> "Among our strategic suppliers we have some local companies which are at the vanguard as regards technology development such as [suppliers' names]. I have to say that in Italy now we have very advanced aeronautic and mechanical technologies, a thing that fifteen years ago was mainly a British or French domain."

As previously stated, RCM-I2 is also trying to develop closer relationships with its key suppliers and to gain more experience at collaborating through partnership and co-development activities.

Problem-solving collaboration. Problem solving refers to collaborations in which racing car manufacturers ask suppliers (mainly engineering consultancy firms) for consultancy services (testing, design work) in order to solve specific problems they experience in parts of the car they develop in-house. Within the development process, these suppliers are located, and they intervene, in the advanced stages of the process (post-concept stages). Hence, the focus in problem-solving collaborations is on the application of existing knowledge to solve specific

problems that emerge during the design and setting up of car components and parts. Contrary to co-development collaboration, the content of collaboration and joint activity is confined to identified problems.

In the United Kingdom the Chief Engineer of a technology specialist company emphasizes that his company is expert at giving advice on development work, testing and producibility of parts. He observes,

> "We work together in aerodynamics and safety [with racing car manufacturers]; […] we will have programmes in which we will provide expertise in doing the test or development work, working aside the customer engineers."

The Managing Director of a full-systems supplier company explains that collaboration with customers is not always possible because, especially in Formula One, there is a tendency of issuing drawings without much input left to his company. However, in some instances and with some customers there is much more involvement and his company can advise customers on drawings, parts and also suggest changes whenever needed. He recalls,

> "We have everything from receiving the design from our customers and making parts to their drawings: depends on the project type. Within Formula One there's a tendency to issue drawings out, but we like to put our engineering into the parts and you can always improve, always. So we try to agree that Formula One engineers would give us their drawings and, then, we are allowed to give some inputs in the drawings, re-draw, re-model, make some changes and, then, we produce parts. Some people insist you just make to the drawing, other people just want the transmission and give us package information and it's for [name of this company] to design. For example, the very first sports car gearbox we did for [racing car manufacturer name] in 1999, because they were technically confident about the layout of the suspension pick-up points, they couldn't give to [name of this company] the information we needed to design the housing, so they said they would have designed the main housing, we designed and made all the internals. Every project here is different; it's a decision on cost, capability, capacity."

Also in Italy there is evidence of problem-solving collaborative activities. Most of these activities regard particular problems racing car manufacturer encounter in the development of the vehicle or of single components. The Chief Production Manager of RCM-I1 considers it extremely important for his company to collaborate with consultancy type suppliers in order to exploit their core know-how. He declares,

> "Suppliers are involved from the concept stage or, if we have already thought about a concept, they are involved to give advice and technical support on the processes we want to apply. In such cases, we have innovative processes which are not necessarily developed in-house but can be developed at the supplier's premises and, therefore, the technology and core know-how reside with the supplier with which we must collaborate."

A technology specialist company gives details of the collaboration process. As the Chief Manager comments,

> "Many times it happens that they [customers] ask us to investigate the factors that cause a part or a component not to work in they way they expected. […] And we give them the reasons, why that part or component is not working, based on our experimental data."

Respondents, however, declared that sometimes this type of collaboration may be partially hampered due to the fear of racing car manufacturers unwittingly revealing confidential information. The same Chief Manager reports this fact,

> "In racing each team tries to have its own facilities and equipment to conduct experimental studies in aerodynamics or new materials. They also may subcontract to other companies research projects on specific aspects…but just on specific aspects because they do not want other companies to acquire their know-how and to pass it on to their competitors."

What stems from the interviews is that problem-solving collaborations, although important, are used by racing car manufacturers with caution and sometimes entail limitations in the amount of knowledge exchanged. This type of collaboration also occurs frequently at lower levels of motor racing, as in the case of RCM-UK2 where the car manufacturer is more dependent on the knowledge detained by specialist suppliers and, consequently, it is more open to share problems and experiences.

Manufacturing collaboration. Manufacturing collaboration refers to the practice of co-makership. This option is adopted by racing car manufacturers when suppliers possess specialist knowledge of the manufacturing processes that can be used to achieve better results in the manufacturing of specific components.

In the United Kingdom respondents seem to emphasize the need for close interaction for the exchange of ideas. As the Director of a production specialist company comments,

> "What we do is we work very closely with our customers' designers and discuss with them manufacturability before the designers formalize them."

The same has also been reported by the Managing Director of another production specialist company. He says,

> "We will advise customers from a mechanical point of view, what can be achieved, what can be machined, what tolerances can be achieved; sometimes the graduate engineers they employ don't understand what our machines and tools are capable of doing. Sometimes we will advise that the feature they designed is not machinable or other details are achievable. So we can only help them from that point of view."

In general, production specialists in the United Kingdom pointed out the divide between design and manufacturing capabilities. The Managing Director of a production specialist company in the United Kingdom stressed,

> "Because manufacturing companies [racing car manufacturers] probably are not doing their manufacturing anymore, they are subcontracting more and more; but they keep in place product development through their own design, they subcontract the machining and, then, they retain assembly, testing and distribution. They are getting a divide between the designers and the engineers that actually make it [the component]."

The Managing Director also pointed out that better results could be achieved through a closer interaction between design and manufacturing. He states,

> "The great picture of a lot of graduate engineers is that they come to us direct from university tremendously good, but they have no idea how the component is going to be made. I've tried to develop [this idea] with this people [racing car manufacturers] that if we got a drawing I would like to see the designer here, so I can show him how the component is made. And I think the way to understand the processes we go through would enable them to become better designers."

Overall the findings suggest that manufacturing collaborations are limited and racing car manufacturers in the United Kingdom tend to keep production specialists at arm's length.

Motorsport companies in Italy on the other hand, as in the case of RCM-I1 and RCM-I2, seem to maintain close relationships with production and process specialists in order to benefit from their expertise and learn side by side with these suppliers. For example, the Chief Production Manager of RCM-I1 recognizes the importance of small local suppliers and their valuable contribution at the manufacturing level. He says,

> "We involve suppliers at the production stage […]. Nearby [towns close to RCM-I1 premises] we have a long tradition of mechanical expertise and our suppliers are really very good from the production point of view."

At lower technological levels of motorsport, collaborative activities also seem to be important. The Managing Director of a production specialist company that supplies rally teams points out that there is a lack of technical culture and engineers in the racing teams often are not able to say whether the components they design can be produced or not. He states,

> "Many engineers do not have a technical culture and they do not know if the components they design can be produced. In those circumstances we have to have a look at the drawings and make suggestions on the manufacturability of the components."

Hence, at lower levels of motorsport, car manufacturers seem to be much more dependent on the expertise of production specialist companies because of their lack of knowledge in manufacturability issues.

As mentioned earlier, participation in the network can be characterized in terms of 'legitimate peripheral participation' (Lave and Wenger, 1991). Evidence from the motorsport industry shows that suppliers join the racing car manufacturers' networks and are allowed to participate in different ways; for instance, relationships with suppliers of complex components and specialized services (full system suppliers, technology specialist and process specialists) are generally strong and involve the sharing of technical knowledge and experiences in order to produce tailored products. The degree of involvement of these suppliers, however, varies according to their capabilities, expertise, technological innovativeness, and their willingness to be part of a cooperative venture in which knowledge sharing and collective learning are the primary objectives. This is particularly true in Formula One, and in some instances in Rally, where racing car manufacturers tend to select the suppliers and intensify the relationships with the firms that are technologically more distant. The same cannot be said at lower levels of motorsport where racing car manufacturers depend heavily on the expertise of the suppliers (Rally and GT racing). As described by a Managing Director of a full-systems supplier company,

> "At the top end of the business, the customers have a lot of knowledge and they have a lot of fixed opinions about what they want from the gearbox; because it is such an inner part of the car, they are gonna hang the suspensions off it, they're gonna have an aerodynamic package, they are gonna have the engine oil tank built into the gearbox usually, you know. So you have to listen to many things. And at the lower end range or in GT cars, where the aerodynamics around the gearbox is not so important, they listen to you much more and it's up to us say we thought of this."

The Customer Support Engineer of another full-systems supplier company made a similar comment,

> "Some teams have a very high skill base […], so they can carry on easily work, the concept work, development work; we make parts for them and that's what the team would like and our relationship is as manufacturers. So there is very little design relationship, engineering relationship; it's a manufacturing relationship. But with some teams we do a lot of work for, so the relationship is closer as it is with rally teams."

The Customer Support Engineer goes on explaining how rally teams are far more dependent than Formula One teams,

> "The rally teams rely on us completely for design. […] a Formula One team doesn't, a Formula One team can design parts on its own. So we have more engineers working all year round on rally projects. Most Formula One teams will have one engineer working on that Formula One project, whereas the rally project would have maybe three engineers working for one rally project."

Relationships with suppliers of less complex parts or commodity items are kept arm's-length, although this is not always the case. Racing car manufacturers may decide to enter into a cooperative agreement with this type of supplier if they think they can have a benefit in terms of new technologies or new processes. Generally suppliers that enter these cooperative ventures are the leading ones in their category and they usually serve Formula One racing car manufacturers rather than other levels of racing. Suppliers who do not invest too much in advanced capabilities or that prefer to serve the lower end of motorsport, instead, are kept arm's-length.

In the definition of Lave and Wenger (1991) and Wenger (1998), peripherality has a positive connotation in that it provides an approximation of full participation and gives exposure to the everyday practices. As will be shown later in this paper, racing car manufacturers, in the process of developing a network identity, select and assess suppliers and allow them to become part of the network through an increased exposure to collaborating practices. The same seems to happen in lower levels of the network (sub-networks) where first-tier suppliers grant to second-tier suppliers and sub-contractors different degrees of participation. However, the interviews also revealed that peripherality in the motorsport industry can sometimes have a negative meaning, as seen above, in the sense of racing car manufacturers not recognizing the potentiality of partnerships or 'keeping suppliers at arm's length'.

Selecting suppliers

The previous section has highlighted the fact that network formation is a dynamic process and where participation may evolve from peripherality to full membership. This section emphasizes the role played by racing car manufacturers as lead-firms in the structuring of networks. By constantly selecting and assessing suppliers, racing car manufacturers strategically devise a network architecture which allows them to share and create knowledge. In this way, networks present shifting boundaries with companies joining them and other leaving.

The selection and management of the relationships with first tier suppliers and major subcontractors represents an important dimension of competitive advantage for racing car manufacturers. The criteria used by racing car manufacturers no longer concentrate just on short-term collaborative relationships, in which the price criterion plays a major part, but on building long-term relationships. Strong and long-term relationships seem to prevail, with suppliers that can contribute significantly to the general knowledge of the network, and to the knowledge of the firms involved in particular. However, as discussed above, weak relationships may be present at the same rate as strong ones, especially in the case of suppliers of less complex parts.

The interview findings suggest that racing car manufacturers, both in the United Kingdom and in Italy, consider 'specialist technologies' and 'ability to perform technical development' as the most important criteria to select suppliers together with the requirements of 'greater quality and precision' (see Table 3). In particular, racing car manufacturers constantly assess the suppliers' ability to undertake design work, the quality of their service and the provision of the latest technology and expertise. In this way, their purchasing departments are focusing more and more on the selection and maintenance of the relationships with suppliers. More interestingly, purchasing engineers take the role of relationship managers.

Table 3: selection criteria used by British and Italian racing car manufacturers to select suppliers.

Selection criteria (in order of importance)
Suppliers' capabilities and overall competencies
Innovation capabilities
Quality
Lead-times
Equipment levels
Location
Track record
Price

Other than selecting suppliers, racing car manufacturers also assess them on a regular basis. Assessment of suppliers' performance will dictate their relative permanence in the network or the likelihood of a loss of business.

Assessment of suppliers' capabilities

The performance of suppliers in terms of quality, delivery and costs are indeed constantly assessed and compared with other suppliers by the racing car manufacturers. If a supplier does not perform well, orders are reduced and, in the last resort, the supplier is changed. In the United Kingdom, a Purchasing Manager from RCM-UK1 clearly explains the situation,

> "Two years ago we were using a company to buy some special bearings. They would take a standard bearing, modifying it, add low friction and it was supposed to give us [RCM-UK1] additional benefits on the suspension area. But we could not just get hold of these bearings, they could not modify them on time and we had to look for bearings elsewhere. So we started purchasing a completely different bearing."

The same racing car manufacturer also uses audits to judge suppliers on a variety of aspects and to mutually compare them. Another racing car manufacturer, RCM-UK2, is not using formal indicators to assess suppliers yet. However, it has recognized the need to find a method suited to judge suppliers on their capabilities and on their ability to share knowledge.

On the other hand, racing car manufacturers also have interest in collaborating with the supplier to avoid switching and associated costs (time required to develop trust, time to learn the technology of production and set up coordinating activities). Consequently, racing car manufacturers often seek to continuously collaborate with suppliers, helping them to resolve problems and exchanging information in order to improve quality and delivery performance. As the Purchasing Manager at RCM-UK1 declared,

> "In my section I look after proprietary items and also the system side. One of my suppliers, one of my proprietary suppliers who supplies all consumables and

> tooling last year let me down, he could not deliver parts […]; we spent so much time sorting problems out. So I had a meeting with the sales manager and the branch manager. We discussed the problems, how we could put them right. We then implemented some of the problems we discussed and for a short period of time things got better. Obviously, I was continuously monitoring. It then slipped back a bit, so again I had a meeting, and this second time, I had a meeting with the Managing Director as well. We had to say [that] if they don't sort this problem out on an ongoing basis we may re-source part of the business. So again we had brainstorming sessions and they implemented the proposals we discussed. So far they have been ok. But we had to develop them and have meetings with them. It would be wrong for me just to go and re-source the business without having a meeting with them first."

The use of assessment for developing suppliers and to improve their performance is a tool also used by Italian motor racing companies. The Chief Production Manager of RCM-I1 explains this process,

> "Every year we establish new quality targets with respect to the previous years. And, then, we have software that measures the suppliers' performance, looking at all quality parameters; we can thus constantly assess the quality performance of each supplier. This is an instrument used by the purchasing department in order to guide and adjust the dealing process with suppliers. Moreover, this instrument is also used to suggest improvements and enhance suppliers' capabilities."

The findings suggest that the know-how generated by such relationships is twofold. On the one hand, it is technical, regarding the product and production processes. On the other hand, it is relational, that is, due to the incentives and knowledge creation generated through the participation in the collaborative activities. In this way, racing car manufacturers try to develop a common identity and a common understanding of how things need to be done in order to promote and increase the aggregate of knowledge within the network. Another Purchasing Manager of RCM-UK1 talks about this process in the following manner,

> "I suppose is talking with people, find out if they are good people to deal with, if they know what we are talking about so they understand the nature of what we want. If they can react, if they can understand the business."

Moreover, racing car manufacturers both in the United Kingdom and in Italy try to instill a norm for sharing knowledge and problems in order to develop better quality relationships in terms of knowledge sharing and learning. In this case an important role is played by the purchasing managers in that they act as developers of supplier relationships and as facilitators for the exchange of relevant information. These issues will be discussed in more detail in a later section.

First tier suppliers selecting and assessing customers

As mentioned at the beginning of the paper, racing car manufacturers are not the only actors which give shape to networks. Major first-tier suppliers may, in certain circumstances, take the lead and influence the structuring of networks. The empirical evidence reveals that major first tier suppliers, with a good reputation in their field, tend to choose their customer base in order to benefit from their relationships with knowledgeable customers. As regards Formula One customers, the selection process seems to be more pertinent in the United Kingdom than in Italy since there is more 'choice' of customers. At the medium/lower end of motor racing (e.g. Rally, GT racing) it constitutes a more general practice in both countries.

In the United Kingdom the Commercial Manager of a full-systems supplier company explains the reasons for selecting customers,

> "When you have a good product you can choose your customers; when you have a bad product you have no choice. Right now we have a good product, therefore we have a number of people that would like them, but we are not going to give it to anybody we are not happy with. […] We will assess them [customers] for both financial stability and the likelihood of them being successful with our products, because our brand image is very important to us and, therefore, supplying a team that has no chance of actually making best use of the product and making good reputation for it, it's not something we will do. So we will be looking for people that have a proven record of achievements."

Also the Business Development Manager of an Italian full-systems supplier company considers of utmost importance the selection of customers in that they have to be 'innovation driven' and 'quality conscious'. Selection processes tend to be applied at the medium/lower levels of motor racing. He states,

> "We are very cautious in bringing a new customer on board because we want to look beyond the first collaboration. We have to recognize their potential, they have to be quality conscious and innovation driven."

First tier suppliers, both in the United Kingdom and in Italy, have also admitted to assessing on an informal basis their customers, although it has not been possible to uncover the criteria used due to the confidential nature of these issues.

What stems from the findings is that first tier suppliers, in the same way as racing car manufacturers, try to select the relationships which are more valuable in terms of knowledge exchange and learning and try to find positions in the networks that are more conducive to competitive advantage. In this way first tier suppliers have the capacity to influence the structure of the network.

The creation of a network identity

The creation of a 'network identity' constitutes an important step towards the implementation of effective networks for knowledge transfer and learning. As noted above, knowledge is most effectively generated, combined and transferred when single organizations 'identify' with a larger collective. In so doing, they create a shared identity which is fostered by the joint patterns of interaction, by the shared goals and values and by the sharing of a common language (Dyer and Nobeoka, 2000). The empirical evidence from the British and Italian motorsport industries shows that racing car manufacturers, in the process of forming their network of relationships, have promoted different initiatives in order to spread this sense of unity and shared understanding.

In the United Kingdom racing car manufacturer RCM-UK1 explicitly referred to its intention to create 'a pool of specialized suppliers', especially selected for their particular capabilities and reliability, and working almost exclusively for the team. As the Purchasing Manager acknowledged, "there are some suppliers that supply just us, no one else's Formula One team". The same Purchasing Manager also described the way his team is trying to create a network identity with their pool of suppliers,

> "We're trying to get them to work the way we do, understand the nature of our business, come around and have a look, see the activity, see how information flows from the design office to production and manufacturing, look at our processes and procedures. We go to see their factory, look how they work and they may be end to be an extension of [RCM-UK1], because the way they work suits us. We know that their components are made to our standards, we know the inspection is to our standard, we know they are made by people that understand the nature of our business."

The intention of RCM-UK1 is to foster a sense of 'networkness' (Human and Provan, 2000) among its suppliers and to make them an 'extension of RCM-UK1'. Networkness refers to a sense of common identity by which member firms see themselves as part of the network and are committed to network-level goals. Hence, creating this identity means that individual network members feel a shared sense of purpose. More specifically, the identity, in this case, is defined by the shared goals and values, and by the patterns of interaction that give rise to a common understanding and to common working practices. In the case of RCM-UK1, respondents reported that this process is at the very initial stages and that more work needs to be done in this direction.

The strategic structuring of relations to create a network identity is even more advanced in Italy. Racing car manufacturer RCM-I1's strategy is to select the best suppliers in terms of services and knowledge offered and then to nurture a sense of community. The Italian racing car manufacturer has focused on the need to encourage participation as a way to share knowledge and experiences. The Chief Production Engineer explains the process in more detail,

> "Our aim is to have a pool of suppliers which collaborate with the company [RCM-I1] towards achieving the best solutions for each project […]; a group of

> suppliers which collaborate among themselves and with us – this has not been fully developed yet but it is a thing we are working on. So we are going towards an expansion of our working groups."

Participation has also been encouraged at the level of local suppliers traditionally kept more arm's length. The Chief Productions Manager comments,

> "Traditionally, for historical and cultural reasons, we have established more the first type of relationship [arm's length] with our local suppliers in the area of [city close to RCM-I1], all artisan companies; however, nowadays we are trying to help our suppliers to grow and to develop their expertise in order to have a proactive relationship. We do not want to have few suppliers, what we want is to have the best ones. Thus, our relationships are becoming more and more interactive every day."

The findings suggest that in this process suppliers are learning to work together and with RCM-I1, thus creating a sense of 'networkness'. In particular and in an approach similar to that described by Dyer and Nobeoka (2000) with Toyota, RCM-I1 has set up an annual meeting and used it as a mechanism to build support for the network and as a way of enabling suppliers to understand and learn about each other. As the Relationship Manager of RCM-I1 reports,

> "This year we have introduced an annual meeting with our suppliers in order to create with them a stronger relationship and a sense of community; they become partners to us."

RCM-I1's network identity serves as a mechanism to keep suppliers closer, as a part of a big 'family'. This allows RCM-I1 to benefit from the suppliers' expertise and to engage in collaborative projects with them. Key to this practice is the process of knowledge sharing and learning. The Relationship Manager explains,

> "At the annual meeting we have invited almost 2000 suppliers and we have given a prize to the most dynamic and proactive […]. For us knowledge exchange with our suppliers is fundamental: for example, [a supplier] supplies our racing department; [the supplier] prepares the brakes for our car and, in that case, we develop the products together. I mean, if [the supplier] is looking for a new type of brake pad, it comes to us and we can establish a collaboration to further develop the product."

Overall the findings reveal that attempts to create a network identity are more pronounced in Italy than in the United Kingdom.

Network 'rules' for knowledge sharing

Motorsport companies, in the process of creating a network identity, share some implicit rules and norms while collaborating. Such common rules and norms are predominantly legalistic and regard, as in the case of partnerships, the sharing of proprietary knowledge with network members and the non-disclosure to outside firms. By establishing these contractual and legalistic rules, motorsport companies lay the basis for the development of norms of reciprocity which derive from their mutual interaction over the longer term.

In Italy racing car manufacturer RCM-I1 has set up some joint teams with suppliers to study and co-develop new materials and new components. In this case, suppliers who want to be part of RCM-I1 network agree to share and exchange information and know-how. The Relationship Manager of RCM-I1 reports,

> "Yes, we have joint teams [with suppliers] to carry out studies and co-development work; the companies [suppliers] in exchange for being part of [RCM-I1] network, they share and transfer information and know-how with us. Moreover, for them is very stimulating to be able to say that they have developed a new material, a new thing with and for us – [they can say] [RCM-I1] wins a Grand Prix also thanks to our collaboration!"

The Relationship Manager emphasizes that this rule for sharing knowledge implies that suppliers have to be loyal to RCM-I1 and they have to maintain confidentiality if they are working with other racing car manufacturers. He states,

> "We have some joint development [work] with a number of suppliers; these suppliers have to be loyal to us and produce the component in exclusivity for us. For example, [supplier name] is a […] company that produces connecting rods. If with this company I co-develop a special connecting rod for my engine, it is obvious that the company [supplier] has some obligations towards me. [Supplier name] cannot produce tomorrow the same connecting rod for Ford or Renault, even if they ask 'can you produce that connecting rod for us?'. [Supplier name] cannot apply the same technology, developed together with us, to other customers for the next three years."

Failure to comply with these rules may result in sanctions, such as the withdrawal of business. In a few cases, companies have admitted to applying this type of sanction. However, protecting proprietary information from rivals proves to be a very difficult task and the mere withdrawal of the business may not be a valid solution. Some companies, both in the United Kingdom and in Italy, in fact, pointed out that it is very difficult to prevent the leakage of proprietary information due to the nature of knowledge. The movement of staff from one firm to another, in particular, is one of the primary factors causing the high mobility of proprietary ideas. Companies try to protect themselves not only by writing binding contracts for their staff, but also by establishing a strong network identity that prevents suppliers from leaking information to competitors. The Commercial Manager of a full-system supplier in the United Kingdom comments on this fact,

> "The motor racing industry is full of very bright engineers who move from company to company. If we have a clever idea today, when the engineer moves he takes our knowledge with him and we try to protect ourselves with employment contracts that say that they [engineers] are not allowed to use that information. And we try to protect ourselves by making sure that our suppliers don't deal with the other teams, even if they are approached for that particular idea."

The tacit and mobile nature of the proprietary knowledge makes legal attempts at protecting intellectual property rights of limited value. In this sense, legal rules do not determine action but rather lay the foundation for reciprocal norms of behaviour which emerge over time. However, it is the very tacitness and complexity of the knowledge that constitutes a good mechanism to protect proprietary ideas. The Commercial Manager explains this point in the following way,

> "Once somebody has learnt the answer to a problem, they can't not know it, they know it; therefore, in reality, you can't protect yourself from the use of knowledge. You can protect yourself to some degree from people to straightforward copying components and pieces, but even then you have to prove that they are actually doing it; let's take ourselves as engine manufacturer and another engine manufacturer: they are not going to tell us what is in their engine; so they might have things that we designed and developed. One of the ways of protecting yourself is by [developing] something that is unique, [so] the manufacturing process is unique and only known by a few people. So you can get to the point where your clever ideas can't be copied because they can't get enough people that have all the knowledge. You might need 10/20 people in order to be able to complete the picture."

Some of the respondents, on the other hand, appeared not to be so concerned about the fact that their knowledge might leak to competitors. They observed that their knowledge will spillover to competitors but by the time it does they will have already progressed. The Chief Design Engineer of a full-systems supplier company comments on this point,

> "It's too time consuming to protect them [ideas]. The speed of development it's so fast that if someone copies our ideas, then, by the time they've copied them and made the parts, we've changed the parts anyway; so the are behind us already."

Another rule that is emerging in the Italian motorsport industry regards the combination of collaboration and competition. In this case, firms engage in alternating dynamics of collaboration and competition. During the collaboration stage, firms jointly learn by combining their respective knowledge bases. This can help firms to economize on research costs and explore options for alternative research directions. During the competition stage, firms exploit individually the previously developed knowledge and apply it for specific applications. An Italian full-systems supplier has developed this rule in conjunction with a partner company and it sees the combination of collaboration and competition as a good

mechanism to learn and achieve competitive advantage. The Business Development Manager of the supplier company states,

> "Last year we purchased one of the biggest competitors in racing, [company name], and therefore we now own two different activities that are competing together; we wanted just to provide financial coverage to [company name]. There is just financial coordination, but then the two companies are competing. The engineering people do not know each other, they do not know anything about their respective projects […]. Also thanks to [company name] we started an activity in clutches, because they also produce quite sophisticated clutches."

The type of rule described above, however, is still limited in the Italian industry and no evidence has been found in the United Kingdom.

Creation of sub-networks

The trend towards first tier suppliers assuming responsibility for product development described in the previous sections has led to associated developments. One of these developments regards the fact that suppliers are seeking to develop and enhance their own expertise and capabilities. In the United Kingdom the Managing Director of a full-systems supplier company explains,

> "We changed almost everything in terms of manufacturing techniques in the last four years. We had a huge investment since 1995, so we moved the factory, we bought the land, we built the building, we've bought more and more machines. I don't know how much you would say we genuinely developed the techniques. What we've done is going out, bought the latest state of the art equipment and found the best way to use that within a motor racing environment."

Another development involves first tier suppliers increasingly assuming responsibility for and managing their own group of suppliers. The Commercial Manager of a full-systems supplier company describes how his company is trying to develop relationships with a pool of suppliers,

> "We intend to have probably meetings every six/eight weeks with everyone of these suppliers [their pool of suppliers] just to review how the business is going. They won't be meetings to talk about components, they won't be meetings to talk about individual issues; they will be meetings at the high level to talk about strategy and how things are working, whether they got problems with specific people. But also [we] try to advise them of [our] latest plans, where we see us going in the next 12 months, giving them an update on that. And we try to give them real feedback into what they have done so far."

Some major first tier suppliers try to establish close relationships with second tier suppliers and other subcontractors through frequent meetings and by sharing common problems and solutions. The idea is to create sub-networks of both strong and weak ties for the exchange of

tacit and codified knowledge. The Commercial Manager above mentioned comments on this process,

> "Right now we are working our way through a programme to bring something like 70 of our suppliers much closer to us. What we are doing is, we are meeting with every single key supplier to us and we are asking them to be critical of [company name] and we are asking for a more open communication on both pricing, on deliveries, on how do they operate, what they need from us to make their life easier, who their third party suppliers are, who their own suppliers are and maybe we can help them with these [issues]."

Also in these sub-networks there is a tendency towards creating a network identity by selecting a pool of preferred suppliers with whom first tier suppliers can engage in joint development activities. As the same Commercial Manager states,

> "We have several aspects to assess suppliers. First, it's their technical capability, which will be undertaken by our procurement engineers. Second, we assess their quality capability and their ability to use systems in a way that generates and guarantees the product right at the first time. Third, we sort out the commercial aspects of the suppliers; we assess the commercial status of a company, the financial status to make sure that they are going to be there. We also check out who they are currently working for, what the customer base is, which industry they work for. And we have some very extensive questionnaires, that go along with the visits; we don't just do visits, we don't just send questionnaires, we do both together. And all comes back to a recommendation of what type of components the supplier should make."

Also in Italy these processes of sub-network creation are being established, although limited evidence has been reported perhaps due to the secrecy of these matters.

Table 4 summarizes the processes of network formation in the British and Italian motorsport industries which have been described above.

Table 4: Comparing network formation in the British and Italian motorsport industries.

Representative findings comparing network formation in the United Kingdom and in Italy		
Network evolution	**United Kingdom** (RCM-UK1)	**Italy** (RCM-I1)
Pre-network organizational field		
Industry structure	Regional cluster	Fragmented
Climate for collaboration	Informal relationships (moderate)	Weak
Institutional environment	Weak	Weak
Environmental changes	Increased technological complexity	Increased technological complexity
Network formation		
Levels of participation	Partnership (limited) Co-development collaboration (well developed) Problem-solving collaboration (moderate) Manufacturing collaboration (limited)	Partnership (well developed) Co-development collaboration (well developed) Problem-solving collaboration (moderate) Manufacturing collaboration (well developed)
Network identity formation	Initial stages (developing)	Advanced stages (developing)
Rules for knowledge sharing	Developing	Well developed
First tier suppliers influence	Frequent	Moderate
Sub-networks formation	Initial stages (developing)	Initial stages (developing)

Discussion

This paper has described the strategies adopted by motorsport companies both in the United Kingdom and in Italy in their efforts to structure the inter-firm network of which they are part. Table 4 presents a summary of the findings.

The study contributes in a number of ways to the literature on networks. First of all, it provides insights into the formation and evolution of network forms of organization. The formation and development of networks in the motorsport industry, both in Italy and the United Kingdom, suggest that it takes time to nurture the relationships and processes necessary to facilitate knowing and learning. A key role, in this respect, is played by the lead firms' strategic actions (Child, 1972, 1997). The paper has also highlighted the importance of the initial conditions of an organizational field in understanding network formation and the strategies used by motorsport actors in building network relations. In contrast to studies that see network formation as stemming only from the existence of prior relationships (Larson, 1992; Larson and Starr, 1993; Gulati and Gargiulo, 1999; Steier and Greenwood, 2000), this

study has extended research done by Madhavan et al. (1998) and by Human and Provan (2000) and has taken into consideration four initial conditions which seem to play a fundamental but not determining role in network formation. These conditions are: the industry structure, the pre-network climate for collaboration, the support from the institutional environment, and the patterns of competition within the industry. The findings indicate that, in both countries, increased competition in the motorsport industry and the growing complexity of the technologies used in racing cars, combined with the lack of support from the government, have forced racing car manufacturers to vertically disintegrate and to rely on the competencies of key suppliers. Thus, in both countries, racing car manufacturers had to build their networks from a relatively low base of activity. This is consistent with the work of Madhavan et al. (1998), who found that key industry events, such as technological advancements or the entry of a prominent competitor, provide occasions for network restructuring.

The two countries, however, display differences in the industry structure and in the pre-network climate for collaboration. In the United Kingdom, the motorsport industry is regionally clustered and has historically been founded on a myriad of informal relations which have provided a moderately supportive climate for collaboration. In Italy, the industry has always been fragmented with weak levels of collaboration. These two conditions have prompted different patterns of network development in the two countries. While in the United Kingdom motorsport companies continue to rely more on informal relationships based on friendship and trust, in Italy, companies responding to the disadvantages of the pre-network context, have been more active in promoting more formal and structured relationships. Gradually Italian companies have been able to establish a network infrastructure which supports effective knowledge sharing.

In making sense of the development of networks in the British and Italian motorsport industries, the research has then extended the work of Lave and Wenger (1991), Brown and Duiguid (1991), and Wenger (1998) and has used the concept of 'communities of practice' at an inter-organizational level of analysis. The paper has shown that actors in the motorsport industry, both in Italy and the United Kingdom, by participating in joint collaborative activities, engage in a social learning process which gradually may make them part of a network community. Participation in the network resembles what Lave and Wenger (1991) have called 'legitimate peripheral participation' in that actors progressively acquire the ability to act in socially recognized ways. This ability to act in 'socially recognized ways' is a learning process in which actors may move from peripheral and marginal positions to full membership in the network. In the case of the motorsport industry, actors join and participate in networks in four different ways: through partnerships, through co-development collaborations, through problem-solving collaborations, and through manufacturing collaborations. Each of these forms of participation indicates different levels of involvement in product development activities and different levels of embeddedness and knowledge sharing in the network. Hence, by learning to participate and collaborate, motorsport actors also learn how to organize knowledge within the networks. As advanced earlier, the degree to which firms learn about new opportunities and ideas is a function of the extent of their participation in the network.

Knowing in the motorsport industry is sustained over time through the development of a sense of 'networkness' (Human and Provan, 2000) and by creating a network identity and rules for knowledge sharing. This view is consistent with work done by Dyer and Nobeoka

(2000), who found that network identity was an important element in encouraging knowledge sharing in the Toyota production network. This study is also in line with Das and Teng's (2002) concept of 'macroculture'. According to the authors, 'macroculture' is a system of shared assumption and values, deriving from occupational, professional, and industry-specific practices, that creates behavioural homogeneity between firms. In this sense, macroculture is particularly important for sustaining stable exchange relationships and generalized reciprocity at the network level. Since member firms share a common understanding of the joint objective, they will be more confident that their contributions will be reciprocated in a way that advances the collective interests of the firms. A strong macroculture also ensures that social sanctions, whenever needed, will be imposed collectively. The evidence presented here shows how the strategic actions of key actors can promote generalized reciprocity and encourage the development of a sustaining macroculture.

Following from the above, this study also extends ideas developed by Dyer and Nobeoka (2000) by providing comparative evidence of networks with different degrees of success at knowledge sharing. The empirical evidence has shown that the dominant racing car manufacturer in Italy has led British competitors in the creation of a highly interconnected network for knowledge sharing. This has been achieved, as seen above, through the promotion of active participation and membership on the part of key supplier companies and the establishment of clear network rules for knowledge sharing. In this way, the dominant racing car manufacturer in Italy has been able to create a network architecture where expertise is located both internally and externally, and supplier companies actively contribute to the creation of new knowledge. In this case, the dominant racing car manufacturer acts as 'orchestrator' (Lorenzoni and Baden-Fuller, 1995; Nooteboom, 2000) of the network through the co-ordination of the productive activities of others. Within this architecture, the orchestrator learns to interact with the other network actors and to appreciate, select, and mobilize the required external capabilities. Thus, the empirical evidence suggests that network formation is a dynamic process which may be promted and moderated by a lead firm's strategic actions and is subject to managerial design(Nohria and Eccles, 1992; Lorenzoni and Baden-Fuller, 1995; Lorenzoni and Lipparini, 1999).

Networks are also shaped through the strategies adopted by major first tier suppliers, which in certain cases can assume the role of orchestrators of the networks. Evidence of this has been found in the United Kingdom where a limited number of major first tier suppliers have tried to organize their relationships with racing car manufacturers in a more structured way. This tendency seems to contrast with the strategies adopted by racing car manufacturers and their preference for less formalized ways of collaboration. Moreover, a number of major first-tier suppliers have been active in organizing their own network of second-tier suppliers. This leads to the creation of 'sub-networks' within the larger networks. However, as the empirical evidence has indicated, the creation of sub-networks is at the early stages of development both in Italy and the United Kingdom.

This study extends existing network conceptualizations (Powell et al., 1996; Dyer and Nobeoka, 2000) by conceiving networks as the locales for effective problem solving, learning, and knowledge creation. The learning that takes place in these networks stems not only from the exploitation of the existing knowledge, but also from the exploration and blending of knowledge which originates from different contexts, practices, and domains of expertise. The findings thus support the 'learning through networks' argument suggested by

Powell et al. (1996) and they add further clarity to its meaning by providing a detailed account of the learning processes and activities which take place at the network level.

Conclusion

The paper has presented empirical evidence of the strategic structuring of inter-organizational relationships operated by lead firms. In general, the findings suggest that network formation and development are emergent from the strategies and actions undertaken by both racing car manufacturers and major first tier suppliers. This sheds light on the fact that networks are not static, but dynamic and with shifting boundaries. In this way, motorsport companies' collaborative decisions produce, reproduce and transform the network structure through deliberate attempt at forming and structuring relationships as they seek to gain network advantage and superior performance. Moreover, the findings highlight the fact that networks can emerge even if prior close relationships are lacking, as in the case of the dominant racing car manufacturer in Italy. While we must be cautious not to overstate the power of individual actors to determine network relationships, our study confirms others that have highlighted the key significance of strategic action in network formation and development.

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