

LEARNING TO SHARE KNOWLEDGE IN THE BRITISH AND ITALIAN MOTORSPORT INDUSTRIES

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Abstract

This paper reports empirical research into the processes of knowledge sharing and learning in the British and Italian motorsport industries. The research outlines a perspective on learning how to share knowledge and it highlights the essential role of participation in collaborative activities. This perspective suggests that knowledge sharing is not something achieved through the simple transfer of resources, but rather is an ongoing social accomplishment in which network firms constitute and reconstitute knowledge while engaging in collaborative activities. In particular, it is shown that there have been extensive efforts in the Italian industry to promote participation and a culture of 'working together' in product development activities. This is contrasted with the way collaborative activities and knowledge sharing are developing in the British motorsport industry. In making sense of these developments, the paper extends the work of Lave and Wenger (1991), Brown and Duguid (1991), and Tsoukas and Vladimirou (2001) at an inter-organizational level of analysis.

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Suggested track: D Knowledge sharing

1 Introduction

Knowledge transfer and learning are widely discussed in network studies. The knowledge-based perspective claims that in addition to internal knowledge and resources, firms ought to look at inter-organizational networks as a source of sustainable competitive advantage. This view, however, has been recently challenged on the grounds that it fails to take into consideration the social aspects of knowledge. In particular, Brown and Duguid (1991, 1998), Cook and Brown (1999), and Tsoukas and Vladimirou (2001) call for a more contextual, processual, and situated view of knowledge.

This paper outlines a perspective on learning how to share knowledge and it highlights the essential role of participation in collaborative activities. The perspective suggests that knowledge sharing is not something achieved through the simple transfer of resources, but rather is an ongoing social accomplishment in which network firms constitute and reconstitute knowledge while engaging in collaborative activities.

2 Theoretical background

The importance of inter-organizational networks for knowledge sharing and learning has been recently recognized (Powell et al., 1996; Inkpen and Dinur, 1998; Lane and Lubatkin, 1998; Larsson et al., 1998; Dyer and Nobeoka, 2000). A growing body of network research is directed at understanding network processes and structures, and their impact upon performance. A key contribution stems from the knowledge-based view of the firm (Grant and Baden-Fuller, 1995; Grant, 1996; Dyer and Singh, 1998) which considers the ability to integrate knowledge and the efforts of different actors as important as the capacity to innovate. This approach supplies considerable theoretical support for the assertion that a firm's performance is directly linked to its efforts in competence building and renewal. In this case, inter-firm relationships are of the utmost importance for learning, knowledge access and transfer. Hence, a fundamental challenge for firms is to be able to exchange and leverage resources and knowledge developed by external sources (Inkpen and Dinur, 1998; Lorenzoni and Lipparini, 1999).

However, transferring knowledge is not easy. The literature has identified several factors which influence the acquisition of knowledge within an organization. Of particular relevance are the barriers to knowledge transfer. Due to the complexity and tacitness of knowledge (Szulanski, 1996), as well as causal ambiguity (Simonin, 1999), firms find it difficult and onerous to exchange knowledge. In addition, some studies have suggested that difficulties in knowledge transfer within and between firms will occur because of organizationally embedded barriers (Hamel, 1991; Larsson et al., 1998; Simonin, 1999). Factors such as lack of learning intent, organizational and cultural distance, and arduous relationships between the source and the recipient may seriously impede knowledge transfer (Hamel, 1991; Szulanski, 1996; Larsson et al., 1998).

By developing this line of thinking, Cohen and Levinthal (1990) propose the concept of 'absorptive capacity' as a mechanism to circumvent the above mentioned problems. Absorptive capacity is defined as prior related knowledge, including knowledge of the most recent scientific and technological developments, that confers an ability to recognize the value of new information, assimilate it, and apply it to commercial ends (Cohen and Levinthal, 1990). Cohen and Levinthal underline the fact that the notion of absorptive capacity is a function of prior related knowledge and they argue that the acquisition of new knowledge from external sources tends to be more successful when a firm possesses existing knowledge related to the knowledge being acquired. Several researchers (Hamel, 1991; Inkpen, 1996; Lyles and Salk, 1996) have thus focused on the ability of firms to learn, and they have suggested that the effectiveness of acquiring and transferring knowledge between firms is closely related to Cohen and Levinthal's (1990) notion of absorptive capacity.

Although the knowledge-based perspective has enhanced our understanding of the strategic implications of knowledge transfer across firms' boundaries, it treats knowledge as an object that can be easily transferred, captured, or stored. Yet in practice, this view of knowledge does not hold. Empirical evidence from a growing body of literature shows that knowledge is best conceived as a process and as a collective accomplishment (Lave and Wenger, 1991; Brown and Duguid, 1991; Tsoukas, 1996; Cook and Brown, 1999; Tsoukas and Vladimirou, 2001). In particular, the communities of practice perspective (Brown and Duguid, 1991, 1998) suggests a view of knowledge as emergent and action-based. This means that knowledge is not simply transferred,

but is continuously generated in action; it is both a recurrent and situated social accomplishment and a learning process. Hence, recognizing knowledge as a dynamic and social accomplishment has important implications for how knowledge sharing and learning can be conceived.

Building on the communities of practice perspective, Tsoukas and Vladimirou (2001) define knowledge as what is pragmatically being used in organizations in the course of action. Knowledge is not primarily about data and information, but about socialization processes. As Tsoukas and Vladimirou (2001: 991) put it, 'managing organizational knowledge does not narrowly imply efficiently managing hard bits of information but, more subtly, sustaining and strengthening social practices'. In particular, Tsoukas and Vladimirou see knowledge as the individual capacity to exercise judgement. Judgement requires two things. First of all the ability of an actor to draw distinctions and, secondly, the location of that actor within a collectively generated context of action, such as a practice or a social community. Therefore, the individual capacity to exercise judgement and create knowledge is based on a process of socialization. This means that the ability to exercise judgement requires an actor to be knowledgeable about the practices within a particular context (Tsoukas and Vladimirou, 2001). This leads to a social and dynamic view of knowledge rather than the dominant functionalist view in strategic management studies. This social and dynamic view entails that knowledge and meaning are produced, mediated and contested through social interaction. Moreover, being knowledge embedded in social practices, it cannot be self-contained; instead, it is unevenly distributed and, more importantly, highly contextual. As Tsoukas (1996: 13) affirms 'firms are distributed knowledge systems in a strong sense: they are decentered systems. A firm's knowledge cannot be surveyed as a whole; it is not self-contained; it is inherently indeterminate and continually reconfiguring'. Thus, knowledge is not given but created through social practice.

While the communities of practice approach and the work of Tsoukas and Vladimirou have examined a variety of settings, they have mainly focused on knowledge sharing at individual levels of analysis. Little is known about the processes of knowledge sharing and learning at the inter-organizational level. The inherent complexity of inter-firm networks and the involvement of multiple actors makes imperative to rethink how we study knowledge and how organizational interaction can contribute to its

understanding. In this paper I aspire to bring forth a perspective on learning to share knowledge.

In making sense of the knowledge sharing processes occurring at the network level, I draw on sociological research and network theory. Notions such as 'embeddedness' (Granovetter, 1985), 'social capital' (Nahapiet and Ghoshal, 1998), and 'strong/weak' ties (Granovetter, 1973; Uzzi, 1996) have been used in order to highlight the importance of social ties and their influence on the knowledge to be exchanged. In particular, researchers have suggested that embedded relationships and social capital facilitate knowledge sharing by developing trust and creating common values and norms. For example, Dyer and Nobeoka (2000) studied the role of networks at Toyota in the US in creating and maintaining high performance. They found that a strong-tie network had established a variety of institutionalized routines that facilitated multi-directional knowledge flows. Powell et al. (1996) claimed that inter-firm relations are also important for knowledge creation. Powell et al. (1996: 118) noted that knowledge creation takes place in the context of an evolving community of partners, where the sources of innovation are "...commonly found in the interstices between firms, universities, research labs, suppliers and customers". In other words, knowledge creation is by definition a dynamic process of interaction and one that involves dissimilarly endowed partners.

3 Research context and method

3.1 The British and Italian motorsport industries

The motorsport industry is a high value-added and highly innovative business sector. Recent years have seen racing car manufacturers, especially in Formula 1, increasingly reliant on the contributions of key suppliers and major service subcontractors in innovation. This has led to changes in the nature of relationships and collaborative patterns. Racing car manufactures have vertically disintegrated, changed procurement strategies and actively encouraged increased collaboration and greater network identity amongst supplier firms.

The industry structure in both countries has significantly influenced the development of networks (Mariotti and Delbridge, 2004). The British motorsport industry is largely organized in the form of a regional cluster (what it has been called the 'motorsport valley') (Pinch and Henry, 1999; Henry et al., 2001), and companies over the years have tended to establish and maintain informal relationships. In contrast, in Italy the motorsport industry is highly fragmented, apart from a small concentration of firms in the area surrounding Modena. This has led Italian motorsport companies to promote more formal and structured network relationships.

3.2 Methodology

Consistent with an exploratory design, the study is essentially qualitative, based on data from in-depth interviews. Primary data have been supplemented with a variety of archival and historical records. The research was conducted between January 2001 and April 2002. The key players examined in this study are racing car manufacturers and suppliers of components and services. The focal point of comparison will be between Italy-F1 and UK-F1, both racing cars in Formula One. In particular, Italy-F1 is regarded 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. Initial information about the range of activities performed in the motorsport industry was obtained from the *Autosport Directory* (2001). Further clarification of the roles and activities of supplier companies was gained through the interviews and the following types of suppliers were identified: commodity supplier, process specialist, equipment specialist, production specialist, technology specialist, full system supplier, and technology partner (see Table 1). These are not mutually exclusive categories as one supplier may assume different roles for different customers or products, e.g. full-systems suppliers may also be technology partners. This typology represents an increasing level of technological complexity of suppliers.

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

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

In total, 37 companies were selected (21 in the United Kingdom and 16 in Italy) and 59 interviews were carried out, 37 in the United Kingdom and 22 in Italy. In several companies, more than one interview was conducted. Interviews have been conducted with three categories of people: directors and managers, engineers (mainly in the area of product development) and other employees from the production/technical division responsible for production. The interviews were held with people at different organizational levels and performing different tasks to access multiple perspectives. Overall, given the number of interviews conducted, the range of firms involved and the different people interviewed the findings can be considered reasonably representative of the industry.

4 Knowing and learning in networks

Learning in the motorsport industry is grounded in the collaborative activities through which racing car manufacturers and their suppliers share their experiences and competencies. The focus of these collaborations is on knowledge sharing. In particular, motorsport companies, both in the United Kingdom and in Italy, are starting to engage in a series of knowledge sharing processes which can be seen to constitute what may be called learning to share knowledge. The knowledge sharing processes entail aligning efforts, the use of resident engineers, shared education and training, and shared equipment and facilities. These knowledge sharing processes are developing gradually and constitute motorsport companies' knowing how to build close interactions, knowing

how to innovate and search for new ideas, and knowing how to develop capabilities for doing product development (see Table 2).

Table 2. Knowledge sharing processes in the British and Italian motorsport industries

Knowledge sharing processes	Key learning activities
Aligning efforts	Promoting participation
	Building close and intimate relationships
	Innovate and search for new ideas
Co-location and use of resident engineers	Building social capital
	Gaining respect and commitment
	Innovate and search for new ideas
Shared education and training	Investing in personnel development
	Building capabilities for doing product development
Shared plant and equipment	Supporting competence development
	Building capabilities for doing product development

The engagement in those knowledge sharing processes, however, is not without difficulties. Learning how to share knowledge may be inhibited by factors such as racing car manufacturers' resistance to sharing knowledge, suppliers' resistance to sharing core knowledge, and common suppliers (suppliers which supply components and services to more than one racing car manufacturer).

The knowledge sharing processes discussed below are closely interlinked and constantly overlapping. Their presentation below in a separate form is an analytic convenience only. It should also be borne in mind that the processes are continually constituted through motorsport companies' interactions. For a summary, see Table 3.

Table 3. Presence of knowledge sharing processes: comparing UK-F1 and Italy-F1

Knowledge sharing processes	UK-F1	Italy-F1
Aligning efforts	Moderate (developing)	Well developed
Co-location and use of resident engineers	Limited	Well developed
Shared education and training	Not present	Well developed
Shared equipment and facilities	Limited	Limited (developing)

4.1 Aligning efforts

Generating and sustaining a high level of innovativeness in product development is a significant challenge for any organization; it is even more so in the case of racing car manufacturers due to the distributed nature of the knowledge and capabilities required to build state of the art racing cars. The empirical evidence indicates that racing car manufacturers address this challenge by progressively fostering close interaction and participation, the building of social relationships and the sharing of knowledge with their suppliers; that is, by aligning efforts.

In the United Kingdom the process of aligning efforts is at the initial stages. The empirical evidence shows that racing car manufactures are starting to develop closer interactions with their suppliers, especially with the formation of partnership agreements. As the Programme Manager of a technology specialist company reports,

We will have a technical partnership with a Formula One team. [...] If we have a technical partnership we share our technology; normally if there's something which is a new process out of a specific partnership, exclusivity is given to the team for a pre-agreed period of time.

In this case, the intent of the partner companies is to share knowledge and technology information throughout the new product development process to ensure customers' requirements are met. The use of contractual mechanisms such as confidentiality agreements, non-disclosure agreements and exclusivity clauses seem to be very important in that they allow for higher levels of knowledge sharing and safeguard the interests of both parties.

Hence, motorsport companies in the United Kingdom try to have closer interactions and benefit more from a two-way communication of needs and requirements. Especially UK-F1, along with creating a network-like form of organization with its suppliers, is making efforts to involve them in the early stages of product development and ask them for suggestions. However, not all relationships have reached yet a sufficient degree of familiarity and intimacy. Besides having close relationships with a number of suppliers, UK-F1 still maintains arm's length relationships with some full-

system suppliers or technology specialists. In those cases exchanges revolve around requirements, specifications, measures specified by the racing car manufacturer.

Racing car manufacturers tend to establish and maintain arm's length relationships also with manufacturing and process specialists, keeping them at the periphery of their networks. This means that these suppliers are issued with fixed specifications which normally cannot be modified. As the Director of a manufacturing and process specialist company in the United Kingdom states,

We don't collaborate in design and development. People like [companies' names] will issue us with drawings, with no alterations to those drawings.

The Director explains that his company is seeking opportunities for collaboration with racing car manufacturers. His company's experience in the design of castings and forging could help and give assistance to racing car manufacturers,

We actively seek collaboration because we believe we've got the experience that will help them [racing car manufacturers] in design, especially the design of castings and forgings. Some of the problems are that we don't get the opportunity to collaborate. We do actively seek it [collaboration] when new projects are coming, then we do ask them [racing car manufacturers] to be involved in the early stages, particularly from the design point of view.

In general, racing car manufacturers in the United Kingdom have put significant efforts in promoting a network-like form of organization with the more technologically advanced suppliers. However, they are only beginning to form close relationships and promote a culture of working together. On the other hand, suppliers of less complex products are kept arm's-length. Moreover, what emerges from the findings is that some supplier companies are comparatively more oriented towards the development of closer interactions and the enactment of socialization processes, and in some cases, they may take the lead in this process.

In Italy, the process of aligning efforts is evident in most of the partnership agreements established by Italy-F1. The Relationship Manager points out that some of these

partnerships regard research into new materials and involve a synergistic collaboration in terms of knowledge generation. In his words,

Among our partners, we have suppliers like [list of suppliers' names] which are all worldwide companies and which produce turbines, helicopters, and jets; here research into material and new metals is very advanced and we have a synergistic collaboration with them. [...] We exchange technological know-how and information.

In this way supplier companies become an 'integrated part' of Italy-F1. The Racing Unit Manager of a partner company describes the relationship with Italy-F1 as,

With [Italy-F1] we have a partnership; the relationship is quite unique: we are an integrated part of their team.

Hence, Italy-F1 seems to be quite proactive in the management of partnership agreements, both with Italian and British suppliers, in order to create synergies with suppliers and co-explore new ideas and applications. The reason for the development of such close relationships seems to be directly linked to the fragmented nature of the Italian motorsport industry and the lack of previous close relationships. Moreover, Italy-F1 has been able to develop such relationships because of its dominant position in the industry.

Italy-F1 establishes synergistic relationships not only with partners but also with suppliers such as technology specialists, process specialists and manufacturing specialists. In such cases Italy-F1 tries to involve suppliers in the development processes and strongly encourage their participation and their contributions in terms of know-how and skills.

Overall, the empirical data indicate that Italy-F1 tries to develop close and intimate relationships with an increasing number of suppliers; however, in some cases relationships are more distant and approach arm's length arrangements. A case in point is represented by the relationship with some equipment specialists. The Chief Production Manager of Italy-F1 explains that quite often his company needs particular machinery or equipment and, in those circumstances, they issue detailed specifications

to obtain a customized item. However, he recognizes the need to develop closer relationships with equipment specialists.

Comparatively the dominant racing car manufacturer in Italy, Italy-F1, seems to pay more attention to manufacturing relationships, especially with local suppliers, and to benefit from the technical suggestions coming from manufacturing and process specialists. The reason for this difference with UK-F1 may be that, in Italy, Italy-F1 has less of a choice of suppliers and, consequently, it tends to develop closer relationships with them.

This first knowledge sharing process, aligning efforts, has placed emphasis on the importance of a logic of 'working together'. This process may be further sustained and fostered through a second knowledge sharing process, the use of resident engineers. The next section illustrates the process.

4.2 The use of resident engineers

The concept of 'guest engineer' is not widely known, but has existed in the automotive industry for quite some time. In the literature, this concept has been labelled in various ways, such as 'guest engineers' (Dyer and Ouchi, 1993; Nishiguchi, 1994), 'kaizen engineers' (Hartley and Choi, 1996), 'resident experts' (Macbeth and Ferguson, 1994), but no single definition has been given. In this study, we describe the concept of resident engineer as the process of placing an engineer from one company in a customer's premises (or a supplier's premises) to facilitate knowledge sharing and the creation of knowledge. This engineer will become resident for a specified period of time, or on an on-going basis.

In Italy, the use of resident engineers is constantly fostered, especially by Italy-F1. The Italian racing car manufacturer considers the use of guest engineers as an extremely important learning mechanism. As the Relationship Manager of Italy-F1 asserts,

People [suppliers] come to our premises as well as we go to their premises [suppliers] – there is a two-way exchange. It is more likely that our people go to their premises to operate, to study, and to look at new [things];

especially with companies like [suppliers' names] which do research on materials. In the world advances in technological development are based exclusively on new materials research; materials evolution allows us to improve the features of the car.

Italy-F1's intent is to learn together with supplier companies and constantly improve knowledge and capabilities. The Relationship Manager states,

When we work with composites, the exchange of personnel extends not only to the engineers but also to the composite and fibre technicians because, in that case, we need to know more about the actual processes – we have discussions on how to make a part in carbon fibre, a wing for instance.

Most of Italy-F1's strategic suppliers lend their personnel on a quasi-permanent basis or provide permanent 'task forces'. This occurs not only in the case of technology specialists, production or process specialists, but also with some equipment specialists such as software companies.

Motorsport companies in Italy have also emphasized the importance of face-to-face communication and teamwork for establishing and sustaining social relationships. The literature has described this phenomenon in terms of co-location and social interaction (see Tyre and von Hippel, 1997). According to Italian motorsport companies face-to-face interaction allows them to know each other and each other's commitments to conduct collaborative activities. In general, the use of resident engineers and teamwork helps motorsport companies know how to collaborate and how to do product development.

The use of guest engineers is not so widespread in the British motorsport industry. Only one technology specialist company has revealed it is starting to send personnel into one of its customer's premises on a quasi-permanent basis. The Managing Director of this company acknowledges,

We are actually starting to put our technicians and scientists in a team for a period of time; two, three weeks initially and then follow up with regular

visits. We would have a desk inside of the team and we will become part of the team.

In most cases, these exchanges take the form of visits both at the supplier's and at the customer's premises. The Managing Director of a technology specialist company comments on the importance of having customer engineers on site because face-to-face interaction allows face-to-face communication. He says,

It would be normal for us to have customer engineers on site; we actually encourage it. Providing you're not having a clash of confidentiality, you are talking face-to-face and there's much less risk of errors, or problems or misunderstandings. It's very efficient to have the engineering teams under one roof.

Overall the findings suggest that in the United Kingdom the use of resident engineers is quite limited. This is also confirmed by respondents at UK-F1. Exchange of personnel tends to take the form of short visits both at the customers' and at the suppliers' premises in the course of some development work or during tests. A possible explanation for the prevalence of short visits may be the geographical proximity of motorsport companies in the United Kingdom. The immediacy of the interaction between closely located companies allows them to meet frequently and for shorter periods.

As seen above, this knowledge sharing process creates incentives for collaboration, mutual respect, and long-term commitment. These may be reinforced by a third knowledge sharing process, shared education and training.

4.3 Shared education and training

In Italy there is a tendency to train people in-house due to the lack of manufacturing skills. In addition, Italy-F1 encourages and promotes forms of ad hoc shared education. These joint programmes are closely linked with the use of resident engineers discussed earlier. The Production Manager of Italy-F1 stressed the importance of forms of joint learning and explains that in his company this is achieved through the use of resident engineers and the running of apprenticeships at the suppliers' premises. He states,

This is one of the things we are insisting at, especially for the future; we have already some examples of resident engineering here [of suppliers] for a period of time, and we also send our technicians at our partners' facilities, if we think there are interesting areas of technology to develop. In the last two or three years we had several cases of resident engineering and stages at our suppliers' facilities for days and even months. Our technicians stay put at our suppliers' facilities to learn and gain experience about a particular technology or concept that is somehow diverse from what we know; in this way we can learn something new and we can understand a certain technology or a certain way of thinking about a new component.

As the above quote illustrates, Italy-F1 makes use of shared training programmes to actually learn new capabilities and skills which are to some extent 'diverse' from its core knowledge. Thus, contrary to Cohen and Levinthal (1990) who predicted that successful knowledge transfer is only achieved when firms possess prior related knowledge, or what they called 'absorptive capacity', this example shows that firms lacking prior knowledge can learn and develop their absorptive capacity. This is accomplished through joint interaction with partner companies and through socialization processes. Also important to note is that these activities recurrently enact a knowing how to develop capabilities for doing product development that advances both Italy-F1's skills and experiences and those of its suppliers.

Contrary to Italy, evidence has not been found of shared education and training in the United Kingdom. Instead, most of the motorsport companies interviewed run training programmes in-house also due to the difficulty in finding the right skills on the market.

One potential negative consequence of this knowledge sharing process is that despite motorsport companies' efforts, talented employees may leave and take with them years of invested development, experience, and expertise. The next section introduces the fourth knowledge sharing process, shared equipment and facilities.

4.4 Shared equipment and facilities

The practice of sharing facilities seems not to be extensively used in the motorsport industry either in the United Kingdom or in Italy. Limited evidence of this knowledge sharing process has been found in the United Kingdom at the level of first tier

suppliers. The Commercial Manager of a full systems supplier company declared to have shared investments in facilities and equipment with another company. These shared investments are generally associated with the need to acquire and master technologies and capabilities that reside in other companies. Moreover, the sharing of physical assets allows his company to share openly information and knowledge regarding the casting process and its operational mechanisms. He comments,

What we've done in casting is to go from having a normal customer-supplier relationship [to a] much deeper [relationship] than that and what we have done, we have identified who we believe to be the best foundry in the UK and we sat down with them and said: 'we would like to develop a state of the art foundry, but we [company name], we are not skilled enough to understand what the state of the art is'. So we started with a plain sheet of paper and we did a tour of the world to see what technologies are out there and we went to many different companies, and we brought back those ideas and we got a team of suppliers together [from which] we have to buy pieces of technology – and we put all the package together in a new state of the art foundry that [we] own but our supplier/partner runs for us. So as a result we have our own discrete unit that we can feed [with] all of our requirements and we developed a CAD/CAM process because there isn't a confidentiality issue, so that works very easily. We developed better tooling practices, we developed better metallurgy, and the casting process. We believe we have made a significant step forward in castings through that collaboration with a major supplier and a significant investment in the plant.

Limited evidence has also been found with regard to the used of shared tooling and equipment. This may occur when racing car manufacturers need custom parts to be made by their suppliers. However, as noticed earlier, Italy-F1 seems to recognize the importance of establishing closer links with equipment specialists.

After having reviewed the four knowledge sharing processes, the remainder of the paper will look at a number of factors which inhibit the formation of close relationships and, consequently, the sharing of knowledge.

5 Impediments to knowledge sharing

A number of impediments to open communication and knowledge sharing are present in the motorsport industry. Data analysis has allowed us to identify the most prominent

factors negatively influencing motorsport companies' ability to share knowledge. These factors are: racing car manufacturers' resistance to the sharing of knowledge, suppliers' resistance to the sharing of core knowledge, and common suppliers. The following sections present each of these impediments to knowledge sharing (for a summary see Table 4).

Table 4. Presence of knowledge sharing impediments: comparing UK-F1 and Italy-F1

Knowledge sharing impediments	UK-F1	Italy-F1
Racing car manufacturers' resistance to share knowledge	Moderate	Limited
Suppliers' resistance to share core knowledge	Moderate	Limited
Common suppliers	High	High

5.1 Racing car manufacturers resistance to share knowledge

Despite the potential benefits, integrating suppliers into new product development is a relatively new and sometimes uncomfortable way of doing business for racing car manufacturers. Racing car manufacturers' resistance to sharing knowledge has been reported by some supplier companies. The usual concern is that such knowledge may be revealed intentionally or unintentionally to competitors. The interviews suggest that this behaviour is more frequent in the case of problem-solving collaborations. As the Managing Director of a full systems supplier company in the United Kingdom pointed out,

Very often it can be quite a problem [with racing car manufacturers]. I mean one big customer we have been making their gearbox for two years and they wouldn't let us see a layout drawing of the gearbox. We were making the parts and we didn't know where the parts went. And then sometimes the customer was complaining about the parts, so we said to them we must see the gearbox because we don't understand. It's embarrassing when we speak to the customer, you know, without understanding. It can be very difficult, there's a lot of secrecy. And then it got better [...], but very often they do restrict [information]. They are worried that their knowledge would leak to other car companies. I think in Formula One they get a lot of gearbox parts made by six different companies, so no one of them has enough knowledge about all of it.

Another barrier to knowledge sharing is a 'not invented here' culture, which poses a challenge to the acceptance of ideas coming from suppliers, and the customer designers and engineers may resist giving up any control over design decisions. As the Business Development Manager of a technology specialist company reports,

We have suffered when our customer has deliberately not executed a two-way relationship. We tried to have a two-way relationship, we also allocated an engineer to our customer, but if the customer will not confide and talk to the engineer and, therefore, will not feedback the results of development because he thinks he knows better and thinks he has better plans - then it goes wrong.

Also in Italy this problem exists, but seems to be less acute, at least in the case of Italy-F1. This may be due to the fact that Italy-F1 has been able to create a highly interconnected network of relationships with its suppliers.

5.2 Suppliers' resistance to share core knowledge

Other than racing car manufacturers, the interviews have revealed that suppliers also may resist sharing knowledge, especially new developments or particular technologies. The companies which tend more frequently to adopt this behaviour are often full systems suppliers. In the United Kingdom the Purchasing Manager of UK-F1 comments on this problem,

If you take say proprietary parts, or aerospace parts or specialist methods of manufacturing, then some suppliers don't tell us how they make the product or what material it is made from [...]; again [for example] some of the gearbox components we buy from a company called [supplier name], on their drawings there's a material specification [...], but it's their own specification, they won't tell us what the actual specification is because they are one of the leading companies in gearbox technology and they don't want teams to know really how those parts are made.

This appears to be a frequent problem in the British motorsport industry. Due to the geographical concentration of the industry and the presence of alternative companies supplying similar products, suppliers tend to guard against the dangers of knowledge spillover and keep proprietary knowledge in-house.

Some evidence of suppliers not willing to share their core knowledge has also been found in Italy, although it seems to be confined to a limited number of companies. For example, the Racing Unit Manager of a full systems supplier company declares,

The main know-how is resident in the company. The internal policy is to keep the internal know-how and innovations inside the company.

Overall, suppliers' resistance to sharing knowledge is more prominent in the United Kingdom. This may be the result of the insufficient commitment of racing car manufacturers to align efforts with their suppliers. It also may be due to a greater number of independent full-system suppliers than in Italy. As noted before, in Italy, the limited number of car makers may 'force', to some extent, suppliers to seek close collaboration with them and, consequently, to share more openly knowledge.

5.3 Common suppliers

Another important barrier to knowledge sharing among motorsport companies, both in the United Kingdom and in Italy, is the presence of common suppliers. Many component suppliers work for more than one racing car manufacturer making parts according to the customers' requirements and specifications. Clearly, it is in the interest of these component suppliers not to disclose the secrets of each of the racing car manufacturers for whom they work to other ones or they would be soon out of business. Racing car manufacturers, and especially Italy-F1 in Italy, are devising rules for knowledge sharing. The Relationship Manager of Italy-F1 underlines the risks related to have common suppliers, but an important issue is confidentiality; suppliers have to be trusted not to spillover sensitive information. He states,

Some of our strategic suppliers supply also rival teams; therefore, suppliers have not to spread confidential information. [...] This absolutely has not to happen.

However, some companies both in Italy and the United Kingdom seem not to be so concerned about common suppliers. As long as they know they can keep ahead of their rivals, it is not a major problem if the ideas eventually get transferred throughout the industry.

6 Discussion and conclusion

The paper has attempted to show the extent to which motorsport companies both in the United Kingdom and in Italy have learned how to work together to undertake product development. A key concept is knowledge sharing. Knowledge is here understood not as a resource or as an object that can be easily transferred, captured or stored. Instead, it is a social accomplishment in that motorsport companies constitute and reconstitute knowledge while engaging in collaborative activities. A repertoire of four knowledge sharing processes has been articulated – aligning efforts, the use of resident engineers, shared education and training, and shared equipment and facilities. These knowledge sharing processes represent the mechanisms through which motorsport companies learn how to share knowledge. They also constitute what can be termed ‘inter-organizational knowledge’. By engaging in ongoing collaborative activities, motorsport companies create a collective memory of experiences and practices from which they continuously draw, constituting and reconstituting it

The study builds on the knowledge-based view of the firm. This perspective has informed our understanding of how knowledge creation and transfer contribute to product development in a high technology environment such as the motorsport industry. Empirical evidence has shown that successful product development depends on firms’ ability to recognize and assess external knowledge, to establish relationships based on repeated and intense interactions, and on the willingness of firms to share information (Cohen and Levinthal, 1990; Dyer and Singh, 1998; Lane and Lubatkin, 1998). In the British and Italian motorsport industries this has been achieved through the progressive abandonment of conventional arm’s-length relationships and the investment in embedded relationships.

This study, nevertheless, diverges from the knowledge-based view of the firm as regards the conception of knowledge. Following the works of Lave and Wenger (1991), Brown and Duguid (1991), Tsoukas (1996), Cook and Brown (1999), and Tsoukas and Vladimirou (2001), knowledge is here conceived as a process and as a collective accomplishment. Product development, therefore, has not to be understood in terms of resource transfer and management, but as a collective and distributed competence,

grounded in the repertoire of the knowledge sharing processes put in place by motorsport companies. As such, product development has to be understood as a situated and ongoing *social* accomplishment that emerges from motorsport companies' collaborative activities.

Recognizing knowledge as a dynamic and social accomplishment has important implications for how knowledge sharing and capabilities development can be conceived. This perspective suggests that knowledge and best practices cannot be 'transferred' or moved (Cohen and Levinthal, 1990; Hamel, 1991; Szulanski, 1996; Simonin, 1999). They are not resources or objects to be packaged and exchanged. It thus may be more effective to think about knowledge sharing processes in which knowledge is generated in the collaborative activities of network firms. The paper has shown that, by participating in product development activities, motorsport companies mutually define what constitutes these competencies and capabilities and in doing this they share knowledge. In particular, knowledge generation in the British and Italian motorsport industries takes place through four knowledge sharing processes. Companies' ongoing engagement in collaboration, and thus the reproduction of the knowing generated in those processes, is how they constitute and re-constitute their knowledge and how they learn to share knowledge.

Embeddedness (Granovetter, 1985; Uzzi, 1996) and social capital (Nahapiet and Ghoshal, 1998) seem to play an important role in how knowledge is generated and how the knowledge processes are organized. Central to our argument is that embeddedness and social capital influence the knowledge available in the network of relationships and the possibility of actually exchanging that knowledge. In particular, the findings of this study has shown that motorsport companies build social capital by engaging in the four knowledge sharing processes mentioned above. First of all, motorsport companies build social capital by aligning efforts and promoting a culture of 'working together'. This has allowed motorsport companies to abandon conventional arm's length arrangements and develop closer and intimate relationships. Other than through the alignment of efforts, motorsport companies build social capital also through a second knowledge sharing process, the use of resident engineers, which allows them to get to know each other. The findings, in particular, have highlighted that greater social interaction provides racing car manufacturers better access to, and understanding of, key suppliers' competencies and know-how. Finally, motorsport

companies promote social capital through both shared education and training and shared equipment and facilities. These processes have the potential to develop motorsport companies' capabilities for doing product development. Thus, by building social capital, motorsport companies enhance their ability to recognize and evaluate pertinent knowledge (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998) and facilitate the sharing of knowledge.

Another important factor which seems to have facilitated knowledge sharing processes among motorsport companies, and related to the above, is the establishment of relationships based on trust and reciprocal expectations (Nahapiet and Ghoshal, 1998; Dyer and Nobeoka, 2000). Motorsport companies, both in Italy and the United Kingdom, have invested more efforts in establishing a culture of working together which has allowed for higher levels of trust to emerge. The promotion of a culture of working together has relied on the nurturing of both informal and formal relationships and on the development of norms and rules for knowledge sharing (Dyer and Nobeoka, 2000). In this way, motorsport companies have benefited from the sharing not only of the observable, but also the deeper tacit components of knowledge.

While dominant actors may attempt to manage and orchestrate their network activities, this is not entirely within their control. Despite the efforts of racing car manufacturers to set up a network of relationships based on trust and mutual expectations, there is still some resistance to sharing knowledge on the part of both racing car manufacturers and supplier companies. The main reason for this resistance is the spillover of proprietary knowledge to competitors and, thus, the loss of competitive advantage. Another problem, which has been mentioned by respondents, is the so called 'not invented here' syndrome. This can be explained in terms of the reluctance of motorsport companies to accept ideas and suggestions coming from outside. These impediments to knowledge sharing seem to be more pronounced in the United Kingdom, whereas in Italy the dominant racing car manufacturer has learned how to dilute and preclude those impediments through the predisposition of rules and norms of interaction.

In general, embeddedness, social capital and trust appear to be key factors in explaining differences in the organization of knowledge flows in Italy and the United

Kingdom. As this paper has advanced, the dominant racing car manufacturer in Italy has made considerable efforts to mobilize pertinent network partners and promote high levels of social interaction and knowledge sharing. In this regard, the Italian racing car manufacturer has learned how to orchestrate its network and how to manage its relationships with suppliers in order to create an architecture of competencies which supports product development. A possible explanation of this diversity may lie in the fact that the Italian racing car manufacturer, given the fragmented nature of the industry, has felt more pressure to organize its relationships in a formal and structured way than UK-F1 which, instead, can rely on a network of proximate informal relationships. Moreover, the limited number of car makers in the industry may 'force', to some extent, supplier companies to develop closer relationships with them.

7 References

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